DOI: 10.1590/1980-549720190046

ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Food consumption according to degree of processing and sociodemographic characteristics: Estudo Pró-Saúde, Brazil

Consumo alimentar segundo o grau de processamento e características sociodemográficas: Estudo Pró-Saúde

Talita Lelis Berti[I], Thalita Fialho da Rocha[II], Cíntia Chaves Curioni[III], Eliseu Verly Junior[IV], Flávia Fioruci Bezerra[V], Daniela Silva Canella[VI], Eduardo Faerstein[VII]

ABSTRACT: ***Objective:*** To investigate the food consumption according to the degree of processing and associations with sociodemographic characteristics. ***Methods:*** A cross-sectional study of the *Estudo Pró-Saúde* (Pro-Health Study), with 520 civil servants of university *campuses*, Rio de Janeiro, 2012–13. A food frequency questionnaire was used to classify food consumption: 1) *in natura*, minimally processed, food preparations based on these foods; 2) processed foods; 3) ultra-processed foods. The relative energy contribution of each group was determined, and a *seemingly unrelated equations regression* (SUR) regression model was used to estimate associations with sociodemographic characteristics. ***Results:*** The *in natura* food group (1) contributed with 59% of the energy consumption and was directly associated with age [45–49 years ($\beta = 1.8$ confidence interval of 95% — 95%CI -1.2; 4.8); 50–54 ($\beta = 1.5$ 95%CI -1.5; 4.5); 55–59 ($\beta = 2.9$ 95%CI -0.4; 6.3) and ≥ 60 ($\beta = 4.6$ 95%CI 1.1; 8.2)], compared to age ≤ 44. In contrast, the group of ultra-processed foods contributed 27% and were inversely associated with age [45–49 ($\beta = -1.7$ 95%CI -4.3; 0.9); 50–54 ($\beta = -1.8$ 95%CI -4.3; 0.9); 55–59 ($\beta = -4.9$ 95%CI -8.0; -2.0); ≥ 60 ($\beta = -4.5$ 95%CI -7.6; -1.5)]. Gender, income and schooling were not associated with food consumption. ***Conclusion:*** Younger adults had higher consumption of ultra-processed foods, indicating the need for interventions mainly in this age group. The absence of association with other sociodemographic characteristics may be due to the influence of contextual factors.

Keywords: Food consumption. Socioeconomic factors. Cross-sectional studies. Regression analysis.

[I]Graduate Studies Programs in Collective Health of the Institute of Social Medicine, Universidade do Estado do Rio de Janeiro – Rio de Janeiro (RJ), Brazil.

[II]Postgraduate Program in Food, Nutrition and Health, Institute of Nutrition, Universidade do Estado do Rio de Janeiro – Rio de Janeiro (RJ), Brazil.

[III]Department of Social Nutrition, Institute of Nutrition, Universidade do Estado do Rio de Janeiro – Rio de Janeiro (RJ), Brazil.

[IV]Department of Epidemiology, Institute of Social Medicine, Universidade do Estado do Rio de Janeiro – Rio de Janeiro (RJ), Brazil.

[V]Department of Basic and Experimental Nutrition, Institute of Nutrition, Universidade do Estado do Rio de Janeiro – Rio de Janeiro (RJ), Brazil.

[VI]Department of Applied Nutrition, Institute of Nutrition, Universidade do Estado do Rio de Janeiro – Rio de Janeiro (RJ), Brazil.

[VII]Department of Epidemiology, Institute of Social Medicine, Universidade do Estado do Rio de Janeiro – Rio de Janeiro (RJ), Brazil.

Corresponding author: Talita Lelis Berti. Instituto de Medicina Social, Pró-Saúde, Universidade do Estado do Rio de Janeiro. Rua São Francisco Xavier, 524, Maracanã, Bloco E, 7º andar, CEP: 20550-013, Rio de Janeiro, RJ, Brasil. E-mail: talita.lberti@gmail.com

Conflicts of interest: nothing to declare – **Funding source:** Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (Faperj), no. E-26/110.119/2013.

RESUMO: ***Objetivo:*** Investigar o consumo alimentar segundo o grau de processamento e associações com características sociodemográficas. ***Métodos:*** Estudo transversal de subamostra do Estudo Pró-Saúde, com 520 funcionários públicos de *campi* universitários, Rio de Janeiro, 2012–13. Questionário de frequência alimentar foi utilizado para classificar o consumo alimentar: 1) *in natura*, minimamente processados, preparações culinárias à base desses alimentos; 2) alimentos processados; 3) alimentos ultraprocessados. Determinou-se a contribuição energética relativa de cada grupo, e foi utilizado modelo de regressão *seemingly unrelated equations regression* (SUR) para estimar associações com as características sociodemográficas. ***Resultados:*** O grupo de alimentos *in natura* (1) contribuiu com 59% do consumo energético e foi diretamente associado à idade [45–49 anos (β = 1,8 intervalo de confiança de 95% — IC95% -1,2; 4,8); 50–54 (β = 1,5 IC95% -1,5; 4,5); 55–59 (β = 2,9 IC95% -0,4; 6,3) e ≥ 60 (β = 4,6 IC95% 1,1; 8,2)], comparado à idade ≤ 44. Em contraste, ultraprocessados contribuíram com 27% e foram inversamente associados à idade [45–49 (β = -1,7 IC95% -4,3; 0,9); 50–54 (β = -1,8 IC95% -4,3; 0,9); 55–59 (β = -4,9 IC95% -8,0; -2,0); ≥ 60 (β = -4,5 IC95% -7,6; -1,5)]. Sexo, renda e escolaridade não foram associados ao consumo alimentar. ***Conclusão:*** Adultos mais jovens apresentaram maior consumo de ultraprocessados, indicando a necessidade de intervenções principalmente nessa faixa etária. A ausência de associação com demais características sociodemográficas pode ser por conta da influência de fatores contextuais..

Palavras-chave: Consumo de alimentos. Fatores socioeconômicos. Estudos transversais. Análise de regressão.

INTRODUCTION

Overall, the food system has undergone changes, from the form of production to the distribution of food[1]. In several medium- and high-income countries, one of the main changes has been the increase in the supply and consumption of ultra-processed foods[2,3-6]. The same trend has already been detected in Brazil, accompanied by a reduction in consumption of *in natura* foods, minimally processed, and of culinary ingredients based on these foods[7].

In addition to the low nutritional quality of ultra-processed foods[8,9], its high consumption has been associated with adverse health outcomes, such as obesity in all ages[10], metabolic syndrome in adolescents[11], changes in the lipid profile of children[12] and risk of breast cancer[13].

Due to this scenario, the new edition of the Food Guide for the Brazilian Population (*Guia Alimentar para a População Brasileira*)[14] adopted the NOVA[15] classification as theoretical reference for its recommendations, which considers the purpose and extent of industrial processing of food. This classifies food in the following categories: *in natura* or minimally processed foods, culinary ingredients, processed and ultra-processed foods[14-16].

Few studies have investigated the independent association between sociodemographic characteristics and food consumption, according to the degree of processing, mainly because the NOVA classification is relatively recent. Among the international studies, there was an inverse association between the consumption of ultra-processed foods with age[17-20]. Regarding the association with schooling and income, results were controversial[18,20]. Most of

these studies did not find a statistically significant association between gender and food consumption according to the degree of processing[18-20].

Among the national studies, a direct association was observed between the consumption of ultra-processed foods and women, schooling[21] and income[7,22], however, these studies did not evaluate the association with age, with two them referring to family acquisition of food, not to the real consumption of the study population[7,22].

In the present study, food consumption was investigated according to the degree of processing and the association with sociodemographic characteristics, in a population of Brazilian adults participating in the Pro-Health Study (*Estudo Pró-Saúde* – EPS).

METHODS

This is a cross-sectional study in a subsample of participants from the EPS. The EPS is a longitudinal study competing with effective technical-administrative employees of university campuses in the state of Rio de Janeiro, with a focus on the investigation of social and behavioral determinants related to health[23]. To date, four phases of data collection have been carried out (1999, 2001–2, 2006–7 and 2011–13). In phase 4, a subsample of 520 individuals (16% of the baseline) was randomly selected in strata of gender, age and schooling, considering the proportions of these strata among baseline participants. In this sub-sample, additional measurements and face-to-face interviews were conducted, including the application of the Food Frequency Questionnaire (FFQ). Data collection was performed by trained interviewers, between July 2012 and 2013.

FOOD CONSUMPTION EVALUATION

In order to evaluate the food consumption, the semiquantitative FFQ, validated by Sichieri and Everhart[24], was used containing 82 foods or food groups with predefined quantities presented in household measures or per unit of food.

Respondents were asked to indicate the frequency (> 3 times/day; 2–3 times/day; 1 time/day; 5–6 times/week; 2–4 times/week, 1 time/week; 1–3 times/month; never or almost never) and the mean amount of consumption for the last six months.

CONSTRUCTION OF THE OUTCOME VARIABLE

The amount of the portion reported in the FFQ was transformed into the equivalent home-measured amount in grams or milliliters. The reported frequency of consumption was transformed into daily frequency and, subsequently, associated with the amount of the portion reported to calculate the energy value of each food item. Information on the energy

value of food items was obtained from the United States Department of Agriculture[25] and the Brazilian Table of Food Composition[26]. Then, each food item was divided by the total of calories consumed per day, for each individual, obtaining the relative percentage of calories of the food item.

FFQ foods and preparations were classified into three groups:

1. *in natura*, minimally processed or food preparations based on these processed foods;
2. processed food;
3. ultra-processed foods.

We chose to classify foods into three groups[27] (instead of four, according to the classification NOVA), including culinary preparations based on *in natura* or minimally processed food, in the first group, because of the few FFQ items for that group.

Considering that some foods could be classified into more than one group, it was decided to divide, by means of an estimate, the participation of these foods in more than one group, according to the consumption observed in the Brazilian Family Budget Survey (*Pesquisa de Orçamento Familiar Brasileira*) (2008–9)[28] and in the National Food Survey (*Inquérito Nacional de Alimentação*)[27]. Thus, for the item "French bread or bread loaf", the calories were allocated in the proportion of 75% in the group of processed foods and 25% in the ultra-processed one[27]. The same was done for the items "butter or margarine" (17 and 83%, respectively)[28] and for pizzas and "pasta, such as lasagna, gnocchi, ravioli", with half the calories allocated to each group.

The total relative percentage of calories from food items belonging to each group was distributed to each of them, thus obtaining the outcome variable (continuous): the relative energy participation of food groups according to the degree of processing.

COVARIATES

Covariates studied were gender, age (categorized in ≤ 44, 45 to 49, 50 to 54, 55 to 59, ≥ 60 years), schooling (up to complete elementary school, including incomplete secondary school, complete secondary school, including incomplete college, and complete college degree or more) and equivalent household income (categorized as ≤3 minimum wages, 3-6 minimum wages and > 6 minimum wages), considering the minimum wage of R$ 622 or US$ 428, in 2012.

The household income question had a pre-coded format, containing the open top category (> R$ 7,000, or US$ 3,139). The average value of the last category (open category) was estimated at R$ 9,429.16, using formulas based on the Pareto curves of income distribution described by Parker & Fenwick[29]. For the calculation of equivalent household income[30], the mean points of each category of the household income divided by the square root of the number of people dependent on the income were used, thus, considering the weight of each individual in the total cost of living of the family.

DATA ANALYSIS

A descriptive analysis was performed of the relative energetic participation of each food group and its food items, for the population studied. The relative energy participation of each of the three food groups was described according to sociodemographic variables.

To analyze the association between the consumption of each of the food groups and the sociodemographic characteristics of the participants, the seemingly unrelated equations regression (SUR) model was used. This model, initially applied in econometrics[31], is a generalization of the linear regression model. In the SUR regression, dependent variables are modeled simultaneously and their correlation is considered in the modeling, increasing the precision of the estimates. When compared to the traditional method, with separate regressions for each of the food groups, the correlations between the dependent variables and between the errors of the equations are not considered[32]. As the food consumption of a group, according to the degree of processing, is related to the consumption of foods of the other groups, the analyses were carried out including, simultaneously, the three food groups. This method is recommended when samples are small and when models do not have the same amount of explanatory variables and are not nested[33]. The final model included the covariates age, gender, equivalent income and schooling. Additionally, simple and quantile linear regression models were used to evaluate the proposed association. All statistical analyzes were performed in the *software* Stata version 13.0[34].

ETHICAL ASPECTS

The study was approved by the Research Ethics Committee, CAAE no. 0041.0.259.000-11, on October 18, 2011, and CAAE no. 04452412.0.0000.5260, on September 6, 2012, of the Institute of Social Medicine of the Universidade do Estado do Rio de Janeiro.

RESULTS

Of the 520 participants in the study, approximately half were women; aged 45-54, with full tertiary education, and 2/5 of the participants had *per capita* income of three to six minimum wages.

For the average energy consumption of 2.470 kcal, the group of *in natura* and minimally processed food or food preparations based on these processed items contributed with more than half of the energy total (60%), followed by the group of ultra-processed foods, which contributed about one third of the total energy (27%) (Table 1). Fruits and beef or pork were the largest energy contributors in the *in natura* food group, corresponding to 9 and 6.5% of the total energy, respectively. Among processed foods, French bread was the

Table 1. Means and 95% confidence intervals (95% CI) of relative food consumption according to the degree of processing. *Estudo Pró-Saúde*, Rio de Janeiro, Brazil, 2012–13.

Food groups and consumer items	Percentage of total energy intake (%)	95%CI
in natura foods and minimally processed foods or food preparations based on these processed foods	59.9	58.9 – 60.9
Fruits	8.8	8.3 – 9.4
Beef and pork	6.1	5.7 – 6.5
Rice	5.5	5.1 – 5.8
Chicken meat	5.3	5.0 – 5.7
Milk	5.2	4.7 – 5.6
Pasta	5.0	4.6 – 5.5
Bean	4.7	4.4 – 5.1
Fresh fish	2.4	2.2 – 2.6
Greens and vegetables	2.4	2.3 – 2.5
Addition sugar	2.4	2.1 – 2.6
Pulp or fruit juice	2.0	1.7 – 2.2
Roots and tubers	1.9	1.8 – 2.1
Barbecue	1.6	1.4 – 1.8
Eggs	1.2	1.1 – 1.3
Other foods*	5.7	5.4 – 5.9
Processed food	13.2	12.6 – 13.7
French bread	6.9	6.5 – 7.3
Cheese	2.9	2.6 – 3.1
Processed meats**	1.0	0.9 – 1.2
Milk-based sweets	1.5	1.2 – 1.7
Fruit-based sweets	1.0	0.8 – 1.2
Canned vegetables***	0.1	0.1 – 0.2
Ultra-processed foods	26.9	26.0 – 27.7
Sweets (candies, chocolates, ice cream)	4.1	3.8 – 4.5
Salted crackers, popcorn, peanuts	3.3	3.1 – 3.6
Sausages****	3.0	2.7 – 3.2
Cake	2.7	2.4 – 3.1

Continue...

Table 1. Continuation.

Food groups and consumer items	Percentage of total energy intake (%)	95%CI
Loaf bread	2.3	2.2 – 2.4
Margarine	2.3	2.1 – 2.4
Soft drinks	1.9	1.7 – 2.1
Sweet biscuits	1.9	1.6 – 2.2
French fries, potato sticks and chips	1.7	1.5 – 1.9
Other ultra-processed foods*****	3.3	3.0 – 3.5

*Cassava flour, mush, peas/lentils, lasagna/gnocchi / ravioli, butter, pizza, viscera, snacks (*coxinha*/*rissole*), coffee and tea; **sardines/canned tuna, bacon, meat/fish preserved in salt, cod, beef jerky; ***peas, palm hearts, olives, etc.; ****hamburger, sausages, mortadella, hams, formed hams, salami; *****lasagna, gnocchi, ravioli, pizza, cream cheese, yogurt, mayonnaise.

largest contributor (7%), and, among ultra-processed foods, sweets (candies, chocolates, ice cream) followed by salted cookies, which contributed with 4 and 3% of energy intake, respectively (Table 1).

It was observed the presence of traditional foods of the Brazilian food culture, such as rice and beans, contributing to the *in natura*, minimally processed or food preparations food group. In the group of processed foods, we highlight French bread (6.9%), characteristic food of the Brazilian breakfast (5.5%). In the group of ultra-processed foods, soft drinks were highlighted by contributing with the same energy percentage from natural fruit juice, of the group of *in natura* and minimally processed food or food preparations based on these processed items.

The mean energy percentages of the three food groups, with their respective 95% confidence intervals (95%CI), according to sociodemographic characteristics, are described in Table 2. For the three food groups, similar consumption caloric intakes were observed in the strata of gender, schooling and income, with the maintenance of the *in natura*, minimally processed or food preparations food group as the major energy contributor. Among the elderly strata, there was an increase in the consumption of *in natura* and minimally processed foods or food preparations, concomitantly to the discrete reduction of consumption of ultra-processed foods.

In the multiple analysis (Table 3), when compared to younger subjects (≤ 44 years), those aged ≥ 60 years presented higher intakes of *in natura* and minimally processed foods or food preparations based on these processed foods (β = 4.6 95%CI 1.1; 8.2). In contrast, ultra-processed consumption was lower in individuals aged between 55 and 59 years (β = - 4.9 95%CI -8.0; - 2.0) and ≥ 60 years (β = -4.5; 95%CI -7.6; -1.5), compared to younger ones (≤ 44 years). No association was found with the other sociodemographic characteristics investigated.

DISCUSSION

In this study, conducted with public servers from the state of Rio de Janeiro, age was associated with food consumption, according to the degree of processing, among the sociodemographic characteristics investigated. Younger adults (≤ 44 years) had higher consumption of ultra-processed foods, concomitantly with the lower consumption of *in natura* and minimally processed foods, and food preparations based

Table 2. Means and 95% confidence intervals (95%CI) of the relative consumption of the food groups according to sociodemographic characteristics. *Estudo Pró-Saúde*, Rio de Janeiro, Brazil, 2012–13.

	n	in natura and minimally processed foods, or food preparations based on these foods		Processed food		Ultra-processed foods	
		Mean (%)	95%CI	Mean (%)	95%CI	Mean (%)	95%CI
Gender							
Female	270	58.4	57.0 – 59.8	13.4	12.6 – 14.2	27.2	26.0 – 28.4
Male	250	58.8	57.4 – 60.1	12.9	12.2 – 13.6	26.5	25.2 – 27.7
Age (years)							
≤ 44	100	56.5	54.5 – 58.5	13.5	12.4 – 14.7	29.4	27.5 – 31.3
45 to 49	115	58.4	56.3 – 60.6	13.0	11.9 – 14.2	27.4	25.7 – 29.2
50 to 54	128	58.2	56.1 – 60.3	12.9	11.8 – 14.0	27.4	25.5 – 29.2
55 to 59	82	59.3	56.7 – 62.0	13.7	12.1 – 15.3	24.7	22.4 – 27.0
≥ 60	95	60.7	58.5 – 62.9	12.7	11.6 – 13.8	24.5	22.6 – 26.5
Schooling							
Elementary school	49	58.9	55.4 – 62.4	12.7	11.0 – 14.5	25.4	22.1 – 28.7
Secondary school	184	59.4	57.7 – 61.0	12.9	12.0 – 13.8	26.2	24.9 – 27.6
College	283	58.0	56.6 – 59.3	13.4	12.7 – 14.2	27.5	26.3 – 28.7
Equivalent income							
≤ 3 MW	153	59.5	57.8 – 61.3	13.2	12.2 – 14.3	25.8	24.3 – 27.3
3–6 MW	206	57.8	56.2 – 59.4	13.0	12.1 – 13.9	27.6	24.3 – 27.1
> 6 MW	151	59.1	57.2 – 61.0	13.3	12.4 – 14.3	26.2	24.6 – 27.8

MW: minimum wages.

on these foodsThis relationship was reversed among older adults, especially among the elderly.

The percentage of energy from ultra-processed foods observed in this study (27%) was lower than that found in high income countries such as Canada (48% in 2004)[35], the United States (58% in 2007–12)[20] and the United Kingdom (53% in 2008–12)[12,17]. Our results were similar to those of studies carried out in Chile (29% in 2010)[18] and in Mexico (30% in 2012)[19]. In representative samples of the Brazilian adult population, in 2008-9, daily consumption of

Table 3. Association (*seemingly unrelated equations regression* — SUR) of food consumption according to the degree of processing and sociodemographic characteristics. *Estudo Pró-Saúde*, Rio de Janeiro, Brazil, 2012–13.

	in natura foods*		Processed foods		Ultra-processed foods	
	crude β	adjusted β **	crude β	adjusted β **	crude β	adjusted β **
	(95%CI)		(95%CI)		(95%CI)	
Gender (reference category: male)						
Female	-0.4 (-2.3; 1.6)	-0.4 (-2.3; 1.5)	0.5 (-0.6; 1.6)	0.6 (-0.5; 1.7)	0.7 (-1.0; 2.5)	0.6 (-1.1; 2.3)
Age (reference category: ≤ 44 years)						
45 to 49	1.9 (-1.1; 5.0)	1.8 (-1.2; 4.8)	-0.5 (-2.2; 1.2)	-0.6 (-2.3; 1.1)	-2.0 (-4.6; 0.7)	-1.7 (-4.3; 0.9)
50 to 54	1.7 (-1.2; 4.6)	1.5 (-1.5; 4.5)	-0.6 (-2.2; 1.0)	-0.6 (-2.4; 1.0)	-2.0 (-4.6; 0.6)	-1.8 (-4.3; 0.9)
55 to 59	2.8 (-0.4; 6.1)	2.9 (-0.4; 6.3)	0.2 (-1.6; 2.0)	0.3 (-1.5; 2.3)	-4.6 (-7.5; -1.7)	-4.9 (-8.0; -2.0)
≥ 60	4.3 (1.1; 7.4)	4.6 (1.1; 8.2)	-0.8 (-2.6; 0.9)	-1.0 (-2.9; 1.0)	-4.9 (-7.6; - 2.1)	-4.5 (-7.6; -1.5)
Education (reference category: elementary school)						
Secondary school	0.4 (-3.1; 4.1)	2.0 (-1.5; 5.7)	0.2 (-1.8; 2.1)	-0.4 (-2.5; 1.6)	0.8 (-2.3; 4.0)	-0.2 (-3.4; 2.9)
College	0.7 (-1.2; 2.6)	1.1 (-2.7; 4.9)	0.7 (-1.2; 2.6)	-0.3 (-2.4; 1.9)	2.1 (-0.9; 5.1)	0.9 (-2.4; 4.3)
Equivalent income (reference category: ≤ 3 MW)						
3 to 6 MW	-1.7 (-4.1; 0.6)	-1.4 (-3.9; 1.0)	-0.2 (-1.5; 1.1)	-0.4 (-1.8; 0.9)	1.8 (-0.3; 3.9)	1.3 (-0.9; 3.4)
> 6 MW	-0.4 (-3.0; 2.1)	0.1 (-2.7; 2.9)	0.1 (-1.3; 1.5)	-0.2 (-1.8; 1.3)	0.4 (-1.8; 2.6)	-0.5 (-2.9; 2.0)

*Minimally processed or food preparations based on these processed foods; **adjustment by gender, schooling, age (continuous) and income (continuous); MW: minimum wages.

21% of the calories from ultra-processed foods was estimated[8], a result similar to that found by Martins et al. (25%), using food availability data[7]. Bielemann et al. analyzed data for 2004-05 from the Pelotas cohort, located in southern Brazil, and found among young adults (21 to 23 years old) a contribution of 51.2% of ultra-processed foods in total energy consumed[21].

When the association between sociodemographic characteristics and food consumption according to the degree of processing was evaluated, it was possible to observe, from the age of 55, a reduction in the consumption of ultra-processed foods and an increase in the consumption of foods of the *in natura* group. This result suggests a possible cohort effect in which older participants (from different generations) formed their eating habits in a period in which the *modern* dietary pattern was less pronounced and the traditional food culture was more preserved in the country, while younger subjects were more exposed to this new pattern[36]. The increase in the share of ready-to-eat food concomitantly with the decrease of the *in natura* and minimally processed foods began to be evidenced in the metropolitan areas of Brazil from the 1980s[22]. The time at which these changes began coincided with the adult life stage of the participants in the present study over the age of 50 when they had already formed their eating habits.

Between 1987-88 and 2008-09, the energy contribution from ultra-processed foods in the metropolitan areas of Brazil increased from 19 to 29%, from *in natura* or minimally processed foods decreased from 44 to 39%[7]. The expansion of ultra-processed foods can be attributed to the production and supply system concentrated by large transnational corporations (big food), to the cheapness of these products and to their characteristics, such as convenience and *longer shelf life*[5,37].

In relation to age, our results were consistent with recent research conducted in the United Kingdom in which it was found that elderly people consume less ultra-processed foods[17]. Other international studies have detected an inverse association of the consumption of ultra-processed products with age[18-20]. National studies did not indicate an association between age and food consumption according to the degree of processing, however, data from the Family Budget Survey (2008-9) revealed a more frequent consumption of fruits, vegetables and improved quality of food with increasing age[36-38].

In this study, we did not find an association between consumption according to the degree of food processing and gender, as occurred with other international studies[18-20]. In a Brazilian study with young adults (Pelotas), consumption of ultra-processed foods was directly associated with females[21].

In our research, we did not see an association between food consumption according to the degree of processing and two socioeconomic status markers (schooling and income). This subject has been little investigated in our environment[21].

In relation to schooling, only in Mexico there was an inverse association with ultra-processed consumption, but in this study only the schooling of the head of the family was used. In Brazil, the consumption of ultra-processed foods was associated with schooling only in the Pelotas cohort, being higher among individuals with higher educational levels[21].

Regarding income, in Chile a direct association was found between the consumption of ultra-processed foods and family income[18], while in the United States this association was reversed[20]. In Brazil, the association with income has not been investigated to date; however, according to national data from the Family Budget Survey (2003–9), there was an increase in energy participation from ultra-processed foods in all socioeconomic strata, more intensely among individuals with lower income levels[7].

The absence of association of food consumption with schooling and income in our study can be, at least in part, explained by the influence of factors such as access, availability[38,39] and food price[41,42]. It is also emphasized that the population of this study is formed by technical administrative staff from the same university *campus* who experience the same food environment on a daily basis[43]. In addition, approximately 60% of participants at the lowest educational level were older than 60 years, which possibly resulted in a reduction in the effect of this socioeconomic marker on our results.

A national study conducted with food acquisition data from the Family Budget Survey (2008–9) found that the *in natura*, minimally processed and culinary ingredients food group had the lowest average price per calorie (R$ 1.66/kcal) when compared to processed and ultra-processed foods (R$ 2.58/kcal), in the Southeast, however, *in natura* items, such as vegetables, fish and fresh meat, stood out with very high prices. In the same study, it was verified that the ratio between the prices paid for *in natura* and minimally processed foods, and food preparations (together) and the price paid for processed and ultra-processed foods remained stable among the different income strata, indicating a similar economic scenario[42], possibly justifying the absence of association with income in this study.

The analytical approach used here was emphasized: the SUR regression model for multiple analysis. The main advantage of this model is the inclusion of the three food groups in the same regression to estimate the association, since the caloric participation of each food group is always dependent on the participation of the other groups. In considering the correlation between the errors of the equations, the accuracy of the estimated parameters increases. In any case, our results were similar to those obtained in linear and quantile regression analyzes (results not shown). In addition, most of the studies that used the NOVA classification evaluated the relationship between effective food consumption and sociodemographic characteristics, focusing only on the consumption of ultra-processed foods, not including other food groups[18-21].

The use of FFQ brought to the study limitations inherent in this method of assessing food consumption, such as difficulties in classifying some items according to the degree of processing due to the low level of detail of the information collected, when compared to the methods of registration and recall to feed. To minimize classification errors, we used the calorie division of some foods present in the same food item of the FFQ in different processing groups[27].

It is recommended that, in future studies with similar objectives to this work's, when evaluating food consumption according to the degree of processing, the influence of contextual factors, in addition to sociodemographic characteristics, should be considered.

CONCLUSION

This study detected an association between age and food consumption according to the degree of food processing, with important participation of ultra-processed foods in the diet, especially among younger adults. This result indicates future trends with negative implications on the health of this population. In view of this, the need for interventions that subsidize public policies aimed at stopping the progression of consumption of ultra-processed foods and promoting the consumption of *in natura*, and minimally processed foods.

ACKNOWLEDGEMENTS

PhD Prof. Carlos Augusto Monteiro and PhD Maria Laura Louzada, contributions to the classification of foods.

REFERENCES

1. Swinburn BA, Sacks G, Hall KD, McPherson K, Finegood DT, Moodie ML, et al. The global obesity pandemic: shaped by global drivers and local environments. Lancet 2011; 378(9793): 804-14. https://doi.org/10.1016/S0140-6736(11)60813-1
2. Monteiro CA, Moubarac J-C, Cannon G, Ng SW, Popkin B. Ultra-processed products are becoming dominant in the global food system. Obes Rev 2013; 14(Supl. 2): 21-8. https://doi.org/10.1111/obr.12107
3. Moodie R, Stuckler D, Monteiro CA, Sheron N, Neal B, Thamarangsi T, et al. Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. Lancet 2013; 381(9867): 670-9. https://doi.org/10.1016/S0140-6736(12)62089-3
4. Moubarac J-C, Parra DC, Cannon G, Monteiro CA. Food classification systems based on food processing: significance and implications for policies and actions: a systematic literature review and assessment. Curr Obes Rep 2014; 3(2): 256-72. https://doi.org/10.1007/s13679-014-0092-0
5. Organização Pan-Americana da Saúde. Ultra-processed food and drink products in Latin America: Trends, impact on obesity, policy implications. Washington D.C.: Organização Pan-Americana da Saúde; 2015.
6. Juul F, Hemmingsson E. Trends in consumption of ultra-processed foods and obesity in Sweden between 1960 and 2010. Public Health Nutr 2015; 18(17): 3096-107. https://doi.org/10.1017/S1368980015000506
7. Martins APB, Levy RB, Claro RM, Moubarac JC, Monteiro CA. Increased contribution of ultra-processed food products in the Brazilian diet (1987–2009). Rev Saúde Pública 2013; 47(4): 656-65. https://doi.org/10.1590/S0034-8910.2013047004968
8. Louzada MLC, Baraldi LG, Steele EM, Martins APB, Canella DS, Moubarac JC, et al. Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. Prev Med 2015; 81: 9-15. https://doi.org/10.1016/j.ypmed.2015.07.018
9. Steele EM, Baraldi LG, Louzada MLC, Moubarac JC, Mozaffarian D, Monteiro CA. Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. BMJ Open 2016; 6(3): e009892. https://doi.org/10.1136/bmjopen-2015-009892
10. Canella DS, Levy RB, Martins APB, Claro RM, Moubarac JC, Baraldi LG, et al. Ultra-processed food products and obesity in Brazilian households(2008-2009). PLoS One 2014; 9(3): e92752. https://doi.org/10.1371/journal.pone.0092752
11. Tavares LF, Fonseca SC, Rosa ML, Yokoo EM. Relationship between ultra-processed foods and metabolic syndrome in adolescents from a Brazilian Family Doctor Program. Public Health Nutr 2012; 15(1): 82-7. https://doi.org/10.1017/S1368980011001571
12. Rauber F, Campagnolo PDB, Hoffman DJ, Vitolo MR. Consumption of ultra-processed food products and its effects on children's lipid profiles: A longitudinal study. Nutr Metab Cardiovasc Dis 2015; 25(1): 116-22. https://doi.org/10.1016/j.numecd.2014.08.001

13. Fiolet T, Srour B, Sellem L, Kesse-Guyot E, Allès B, Mejéan C, et al. Consumption of ultra-processed foods and cancer risk: results from NutriNet-Santé prospective cohort. BMJ 2018; 360: k322. https://doi.org/10.1136/bmj.k322
14. Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Guia alimentar para a população brasileira. 2ª ed. Brasília: Ministério da Saúde; 2014. 156 p.
15. Monteiro CA, Cannon G, Levy R, Moubarac JC, Jaime PC, Martins AP, et al. The star shines bright. World Nutrition 2016; 7(1-3): 28-38.
16. Food and Agriculture Organization of the United Nations. Guidelines on the collection of information on food processing through food consumption surveys. Rome: Food and Agriculture Organization of the United Nations; 2015.
17. Adams J, White M. Characterisation of UK diets according to degree of food processing and associations with socio-demographics and obesity: cross-sectional analysis of UK National Diet and Nutrition Survey (2008–12). Int J Behav Nutri Phys Act 2015; 12: 160. https://doi.org/10.1186/s12966-015-0317-y
18. Cediel G, Reyes M, Louzada MLC, Martinez Steele E, Monteiro CA, Corvalán C, et al. Ultra-processed foods and added sugars in the Chilean diet (2010). Public Health Nutr 2018; 21(1): 125-33. https://doi.org/10.1017/S1368980017001161
19. Marrón-Ponce J, Sánchez-Pimienta T, Louzada M, Batis C. Energy contribution of NOVA food groups and sociodemographic determinants of ultra-processed food consumption in the Mexican population. Public Health Nutr 2018; 21(1): 87-93. https://doi.org/10.1017/S1368980017002129
20. Baraldi LG, Martinez Steele E, Canella DS, Monteiro CA. Consumption of ultra-processed foods and associated sociodemographic factors in the USA between 2007 and 2012: evidence from a nationally representative cross-sectional study. BMJ Open 2018; 8(3): e020574. https://doi.org/10.1136/bmjopen-2017-020574
21. Bielemann RM, Motta JVS, Minten GC, Horta BL, Gigante DP. Consumption of ultra-processed foods and their impact on the diet of young adults. Rev Saúde Pública 2015; 49: 28.
22. Monteiro CA, Levy RB, Claro RM, Castro IRR, Cannon G. Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. Public Health Nutr 2010; 14(1): 5-13. https://doi.org/10.1017/S1368980010003241
23. Faerstein E, Chor D, Lopes CS, Werneck GL. Estudo Pró-Saúde: características gerais e aspectos metodológicos. Rev Bras Epidemiol 2005; 8(4): 454-66. http://dx.doi.org/10.1590/S1415-790X2005000400014
24. Sichieri R, Everhart J. Validity of a Brazilian food frequency questionnaire against dietary recalls and estimated energy intake. Nutr Res 1998; 18(10): 1649-59. https://doi.org/10.1016/S0271-5317(98)00151-1
25. United States Department of Agriculture. Agricultural Research Service. USDA National Nutrient Database for Standard Reference. Release, 15. Beltsville: United States Department of Agriculture; 2002.
26. Universidade Estadual de Campinas. Núcleo de Estudos e Pesquisas em Alimentação. Tabela Brasileira de Composição de Alimentos – TACO. Campinas: Núcleo de Estudos e Pesquisas em Alimentação / Universidade Estadual de Campinas; 2004.
27. Louzada MLC, Martins APB, Canella DS, Baraldi LG, Levy RB, Claro RM, et al. Ultra-processed foods and the nutritional dietary profile in Brazil. Rev Saúde Pública 2015; 49: 38. https://doi.org/10.1590/S0034-8910.2015049006132
28. Levy RB, Claro RM, Mondini L, Sichieri R, Monteiro CA. Regional and socioeconomic distribution of household food availability in Brazil, in 2008-2009. Rev Saúde Pública 2012; 46(1): 6-15. https://doi.org/10.1590/s0034-89102011005000088
29. Parker RN, Fenwick R. The Pareto Curve and its utility for open-ended income distributions in survey research. Soc Forces 1983; 61(3): 872-85. https://doi.org/10.2307/2578140
30. Anyaegbu G. Using the OECD equivalence scale in taxes and benefits analysis. Econ Lab Market Rev 2010; 4(1): 49-54. https://doi.org/10.1057/elmr.2010.
31. Zellner A. An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias. J Am Stat Assoc 1962; 57(298): 348-68.
32. Keshavarzi S, Ayatollahi SM, Zare N, Sharif F. Quality of life of childbearing age women and its associated factors: an application of seemingly unrelated regression (SUR) models. Qual Life Res 2013; 22(6): 1255-63. https://doi.org/10.1007/s11136-012-0250-3
33. Jahanshad N, Nir TM, Toga AW, Jack CR Jr., Bernstein MA, Weiner MW, et al. Seemingly Unrelated Regression empowers detection of network failure in dementia. Neurobiol Aging 2015; 36(Supl. 1): S103-12. https://doi.org/10.1016/j.neurobiolaging.2014.02.032
34. StataCorp. Stata Statistical Software: Release 13. Collede Station: StataCorpLP; 2013.
35. Moubarac J-C, Batal M, Louzada ML, Martinez Steele E, Monteiro CA. Consumption of ultra-processed foods predicts diet quality in Canada. Appetite 2017; 108: 512-20. https://doi.org/10.1016/j.appet.2016.11.006
36. Jaime PC, Monteiro CA. Fruit and vegetable intake by Brazilian adults. Cad Saúde Pública 2005; 21(Supl.): 19-24. https://doi.org//S0102-311X2005000700003

37. Gehlhar M, Regmi A. Factors shaping global food markets. In: Regmi A, Gehlhar M, eds. New Directions in Global Food Markets. Agriculture Information Bulletin 794. Washington , D.C.: United States Department of Agriculture; 2005. p. 5-17.
38. Ramalho AA, Dalamaria T, Souza OF. Regular consumption of fruits and vegetables by university students in Rio Branco, Acre, Brazil: prevalence and associated factors. Cad Saúde Pública 2012; 28(7): 1405-13.
39. Vedovato GM, Trude ACB, Kharmats AY, Martins PA. Degree of food processing of household acquisition patterns in a Brazilian urban area is related to food buying preferences and perceived food environment. Appetite 2015; 87: 296-302. https://doi.org/10.1016/j.appet.2014.12.229
40. Duran AC, Almeida SL, Lattore MC, Jaime PC. The role of the local retail food environment in fruit, vegetable and sugar-sweetened beverage consumption in Brazil. Public Health Nutr 2016; 19(6): 1903-102. https://doi.org/10.1017/S1368980015001524
41. Monteiro CA, Cannon G, Moubarac JC, Martins APB, Martins CA, Garzillo J, et al. Dietary guidelines to nourish humanity ant the planet in the twenty- first century. A blueprint from Brazil. Public Health Nutr 2015; 18(13): 2311-22. https://doi.org/10.1017/S1368980015002165
42. Claro RM, Maia EG, Costa BVL, Diniz DP. Food prices in Brazil: prefer cooking to ultra-processed foods. Cad Saúde Pública 2016; 32(8): e00104715. https://doi.org/10.1590/0102-311X00104715
43. Franco A da S. Ambiente alimentar universitário: caracterização, qualidade da medida e mudança no tempo [tese]. Rio de Janeiro: Universidade do Estado do Rio de Janeiro; 2016.

Received on: 06/14/2017
Final version presented on 06/16/2018
Approved on: 07/13/2018

Authors' contributions: Conception and design of the study: Talita Lelis Berti and Eduardo Faerstein. Data analysis and interpretation: Talita Lelis Berti, Thalita Fialho da Rocha, Cíntia Chaves Curioni, Eliseu Verly Junior, Daniela Silva Canella and Eduardo Faerstein. All authors reviewed and approved the final version of the article.

© 2019 Associação Brasileira de Saúde Coletiva
This is an open access article distributed under the terms of the Creative Commons license.