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Food consumption according to degree of food processing, behavioral variables, and sociodemographic factors: Findings from a population-based study in Brazil

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ABSTRACT

Objectives: This study aimed to investigate the consumption levels of foods at different degrees of processing and their associations with sociodemographic and behavioral characteristics of Brazilian adults.
Methods: This is a cross-sectional, population-based study involving 976 adult individuals (ages 20 to 59 y) of both sexes, living in the municipality of Viçosa, Minas Gerais State, Brazil. Participants were selected using a probabilistic sampling technique. Consumed foods were categorized into four groups: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and ultraprocessed foods. Associations were tested using linear regression.
Results: Unprocessed and minimally processed foods accounted for 61.3% of the total energy intake and were positively associated with age and negatively associated with level of education (β = −6.86; 95% confidence interval [CI] [−10.16 to −3.57]) and sedentary behavior (β = 3.24; 95% CI [−5.88 to −0.61]). Ultraprocessed foods accounted for 23.6% of the total energy intake, and consumption was negatively associated with age and positively associated with sedentary behavior (β = 0.005; 95% CI [0.00008−0.01]) and tertiary education (β = 5.42; 95% CI [2.71−8.13]).
Conclusions: Ultraprocessed foods contribute more to the daily energy intake of younger individuals, and ultraprocessed food consumption is positively associated with sedentary activity and level of education.

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The authors declare no conflict of interest.

D.C.G.S contributed to the data collection and analyses of this study, wrote the initial draft of the manuscript, and assembled the final version. G.M.R.F. contributed to the analyses of this study, wrote the initial draft of the manuscript, and assembled the final version. A.M.B. contributed to study design, developed analyses and data analyses, and participated in the approval of the final version of the manuscript. G.G.K.V. contributed to the analyses of this study, wrote the initial draft of the manuscript, and assembled the final version. K.J.M. contributed to study design, developed analyses and data analyses, and participated in the approval of the final version of the manuscript. R.G.W. contributed to study design, developed analyses and data analyses, and participated in the approval of the final version of the manuscript. G.Z.L. contributed to the analyses of this study, wrote the initial draft of the manuscript, and assembled the final version.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects/patients were approved by the Research Ethics Committee of the Federal University of Viçosa (Official Letter 008/2012). Written informed consent was obtained from all subjects/patients.

The study was approved by Comitê de Ética em Pesquisa com Seres Humanos da Universidade Federal de Viçosa (Human Research Ethics Committee from Universidade Federal de Viçosa), under the protocol n° 008/2012. All the subjects signed an informed consent form.

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Introduction

The Dietary Guidelines for the Brazilian Population (DGBP) provide recommendations for food choice and consumption according to four categories of food processing. The first category comprises fresh foods, which are defined as foods obtained directly from plants and animals and sold for human consumption without having undergone any processing operation, and minimally processed foods, which are fresh foods that have been subjected to minimal processing. The second category includes culinary ingredients, which are industrial products extracted from fresh foods or obtained directly from nature that are commonly used in cooking and food preparation. The third category comprises processed foods, defined as food products manufactured by adding salt, sugar, or fat to fresh or minimally processed foods. The fourth category, ultraprocessed foods, includes food products resulting from several processing steps, techniques, and ingredients, many of which are used exclusively in industrial settings. DGBP's recommendation is that the consumption of ultraprocessed foods should be avoided, consumption of processed foods should be limited, processed culinary ingredients should be used sparingly in food preparations, and fresh and minimally processed foods should form the basis of the population's diet [1].

The most recent Brazilian Consumer Expenditure Survey (2017–2018) evaluated food consumption patterns and revealed that fresh and minimally processed foods are being replaced by processed and ultraprocessed foods [2]. In high-income countries, such as the United States [3], Canada [4], and the UK [5], ultraprocessed foods contribute to more than half of the daily energy intake of the population. In middle-income countries such as Brazil, Mexico, and Chile, the energy contribution from ultraprocessed foods is lower, varying from one-fifth to one-third of the total daily energy intake [6–10].

Increased consumption of ultraprocessed foods has been associated with higher waist circumference [11] and body mass index [11,12] and to the increased prevalence of obesity and other chronic non-communicable diseases observed in several countries [13–17]. Longitudinal studies found that high consumption of ultraprocessed foods is associated with increased all-cause mortality, regardless of risk factor burden [18], and with increased risks for cardiovascular, coronary, and cerebrovascular diseases, even after adjustment for other dietary quality markers (e.g., healthy dietary patterns and daily intake of saturated fat, sodium, sugar, and dietary fiber) [19]. A review article by Elizabeth et al. [20] concluded that high consumption of ultraprocessed foods is associated with adverse health outcomes and has the potential to negatively influence the overall disease burden. According to the study, ultraprocessed food consumption also seems to be associated with increased risk for all-cause mortality. In a systematic review with meta-analysis, Pagliai et al. [21] reported, for the first time, the possible association between high ultraprocessed food consumption and poor cardiometabolic risk profile (increased risk for overweight and obesity, high waist circumference, low high-density lipoprotein cholesterol, and increased risk for metabolic syndrome), all-cause mortality risk, cardiovascular disease, cerebrovascular disease, and depression.

Although international [3,4,7,8,22] and Brazilian [9,10,23] studies have examined the association between sociodemographic variables and processed/unprocessed food consumption, the results are divergent, underscoring the need for more population-based surveys. The relationship between degree of food processing and behavioral variables, such as smoking and physical activity, has been underinvestigated [10]. No studies were identified that assessed the association between food consumption according to degree of food processing and sedentary behaviors in adult populations. Given these knowledge gaps, this study aimed to analyze food consumption according to degree of food processing and investigate its relationship with sociodemographic and behavioral characteristics in a representative sample of adults living in Viçosa, Minas Gerais, Brazil.

Methods

This is a cross-sectional, population-based study with a sample of 976 adult individuals (20–59 y), of both sexes, living in the urban area of Viçosa, Minas Gerais, Brazil, between 2012 and 2014. This investigation is part of a larger research project aimed at assessing the health status of adults in Viçosa, entitled "Metabolic syndrome and associated factors: a population-based study of adults in Viçosa, Minas Gerais." Further details of the study procedures can be found in Segheto et al. [24]. The project was approved by the Research Ethics Committee of the Universidade Federal de Viçosa, Minas Gerais, Brazil (Protocol No. 008/12). Participation was voluntary, and all participants signed an informed consent form.

Data from the 2010 census indicated that the group ages 20 to 59 y comprises 43 431 individuals, representing 52% of the total population of Viçosa. The sample size was calculated assuming an unknown outcome (50%), a sampling error of 4%, and a design effect of 1.5. The sample size was increased by 10% to compensate for losses and refusals and an extra 10% to compensate for the decrease in power due to adjustment for confounding factors in the multivariate analysis.

The sample consisted of 1 065 individuals (Fig. 1), but 89 were excluded for not participating in the second stage of the study (assessment of food consumption), resulting in a final sample of 976 individuals. The sample was selected using a two-stage cluster sampling scheme. First, 30 of the 99 census tracts of Viçosa were randomly selected using a random sampling scheme without replacement. Next, a block was randomly selected and, on it, a corner was chosen as the starting point of household visits, with the field work beginning clockwise. Detailed information on the methodologic aspects of the study is described in Segheto et al. [24].

Assessment of food consumption (dependent variable)

Usual food consumption was assessed by using a quantitative food frequency questionnaire (FFQ) that was developed in a pilot project and validated for the study population [25]. The FFQ collected data on the usual frequency of consumption of 95 food items from 26 food groups during the previous 1-y period. Consumption frequencies ranged from 0 to 12 times per d, wk, mo, or y. Portions were classified as small, medium, large, and extra-large according to the 25th, 50th, 75th, and 95th percentiles, respectively, of the consumption of each food item in grams. The mean portion size was taken as the reference portion size. Portion sizes were provided in household measures and grams. The data were analyzed using Brazil-Nutri software, which was developed for the 2008–2009 Consumer Expenditure Survey [26].

First, all food items were classified according to their degree of processing into one of the following groups: fresh or minimally processed foods, processed culinary ingredients, processed foods, and ultraprocessed foods [27]. After this initial

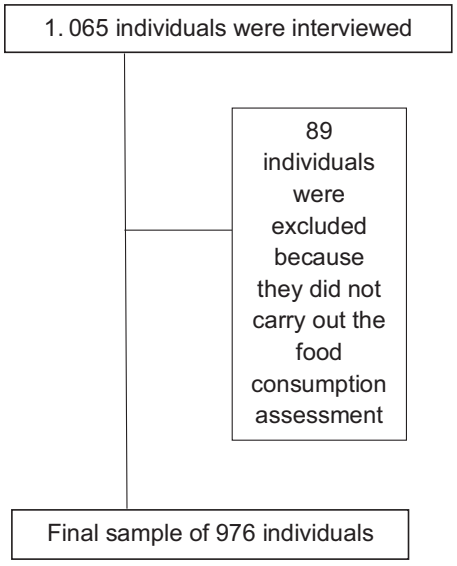

Fig. 1. Sample selection flowchart.

step, groups were rearranged into three categories. The first category, labeled FF/MPF/FP (Fresh foods, minimally processed foods, and food preparations), comprised fresh and minimally processed foods as well as food preparations based on one or more fresh or minimally processed ingredients (with or without other basic culinary ingredients, such as salt, sugar, vinegar, and cooking oil) [1,12,27]. Because the questionnaire evaluated only a few processed culinary ingredients, these items were included in the first category [9,12]. The second and third categories contained processed and ultraprocessed foods, respectively [12]. Culinary preparations or food combinations made from ingredients that were not classified as fresh, minimally processed, or processed culinary ingredients were classified according to their main constituent [5,22]; these items represented only 7.5% of FFQ items.

Processing degree classification was performed by joint discussion between three researchers. Subsequently, one of the researchers revised the classification. Any inconsistencies were discussed among six researchers until consensus was reached. Given that it was not possible to evaluate the ingredients list, we adopted a conservative criterion during all stages of classification [28] (i.e., in the case of uncertainty as to which category a food item belongs, we chose to place it in the least processed category).

Food consumption data are presented as the contribution of each food item or degree of processing category to daily energy intake (continuous dependent variable).

Independent variables

The sociodemographic variables assessed in this study were sex (men and women), age group (20–29, 30–39, 40–49, and 50–59 y), ethnic group (White and non-White), and socioeconomic level (determined according to criteria from the Brazilian Association of Research Companies [29] and categorized into classes A and B, high; class C, middle; and classes D and E, low).

Behavioral variables included smoking status (smoker, former smoker, and non-smoker), level of physical activity, and sedentary behavior. Physical activity level was assessed using a short version of the International Physical Activity Questionnaire validated for the Brazilian population. International Physical Activity Questionnaire scores were converted to metabolic equivalent task minutes per week and classified as low, moderate, and high [30]. Sedentary behavior was calculated as the sum of the time spent watching television and the time spent using a computer on weekdays and weekends (categorized into <120, 120–240, and ≥240 min) [31].

Statistical analysis

Data quality was assessed by administering the questionnaire to 10% of the sample via a telephone survey with double pass data entry by previously trained typists. After the data were tested for consistency, and statistical analyses were performed using Stata version 14.1, STATA Corporation [32]. Design effects were accounted for by using the svy commands. Sample weights for sex, age, and level of education were calculated to standardize sociodemographic differences between the study sample and the adult population of Viçosa according to the 2010 census [33].

The dependent variable (mean percentage contribution of each food item or processing category to the daily energy intake) was analyzed continuously, as the data satisfied all normality assumptions. Descriptive analysis was performed for the population as a whole and according to sociodemographic and behavioral variables. Statistical differences were identified by analyzing 95% confidence intervals (CI). Multiple linear regression was used to examine associations of the dependent variable with independent variables. All independent variables with $P \leq 0.20$ in the unadjusted models were included in the adjusted model. Then, the variable that contributed the least to the dependent variable (highest P value) was excluded from the model, and this procedure was repeated until only variables statistically associated with the dependent variable remained ($P \leq 0.05$). Finally, variables excluded in the previous steps were reintroduced into the model and tested for significance. All independent variables associated with the outcome ($P < 0.20$) were treated as possible confounders and tested in the multiple linear regression model.

Results

Of the 976 study participants, 50.1% were men, 26.3% were ages 30 to 39 y, 65.4% were of middle socioeconomic level, and 38.5% were self-declared White. Regarding behavioral variables, 67.4% of participants were non-smokers, 73.4% had a low physical activity level, and 54.2% spent more than 240 min/wk on sedentary activities (watching television or using a computer).

The mean energy intake was 2 552.01 kcal/d. FF/MPF/FP contributed the most to daily energy intake (61.3%), followed by ultraprocessed foods (23.6%) and processed foods (15.1%) (Table 1). Of all FF/MPF/FP, rice made the largest contribution to daily energy intake (10.55%), followed by beef and pork (9.14%), beans (5.42%), fruits (4.99%), and milk (4.18%). Among processed foods, bread had the largest contribution (6.70%). Of ultraprocessed foods, cookies, sweets, and dairy products contributed the most to energy intake at 3.35%, 2.25%, and 2.12%, respectively (Table 1).

Table 2 shows the means and 95% CI values for the energy contribution of food processing categories stratified by sociodemographic and behavioral characteristics. A higher consumption of FF/MPF/FP was observed in older adults, individuals with a low education level, former smokers, non-Whites, and participants with less sedentary behavior. Ultraprocessed food consumption was negatively associated with age and positively associated with sedentary behavior and education level.

Results were adjusted for confounding variables, as shown in Table 3. According to the model for FF/MPF/FP, in which variables were adjusted for each other, consumption was positively associated with the age groups 30 to 39 y (β = 2.96; 95% CI [0.53–5.41]); 40 to 49 y (β = 5.04; 95% CI [2.62–7.45]); and 50 to 59 y (β = 6.81; 95% CI [3.68–9.94]). However, level of education (β = −6.86; 95% CI [−10.16 to −3.57]) and sedentary behavior (β = 3.24; 95% CI [−5.88 to −0.61]) showed a negative association with FF/MPF/FP consumption. We also observed that FF/MPF/FP consumption was higher in non-White individuals (β = 2.25; 95% CI [0.08–4.42]) and lower in smokers (β = −3.55; 95% CI [−6.92 to −0.18]. After adjusting for age, we observed that women had a lower consumption of processed foods (β = −3.01; 95% CI [−4.73 to −1.28]) (Table 3). According to the smoking status-adjusted model, ultraprocessed food consumption was negatively associated with age and positively associated with sedentary behavior (β = 0.005; 95% CI [0.00008–0.01]) and tertiary education (β = 5.42; 95% CI [2.71–8.13]). Ultraprocessed food consumption was higher in women (β = 1.54; 95% CI [0.16–2.91]) than in men (Table 3).

Discussion

This study investigated the consumption of foods at different degrees of processing and its association with sociodemographic and behavioral characteristics in a representative sample of adults living in Viçosa, Brazil. Ultraprocessed foods accounted for about one-fourth (23.6%) of the daily energy intake of the study population. Such a high consumption does not comply with the recommendations of the DGBP, according to which ultraprocessed foods should be avoided [1]. A similarly high intake of ultraprocessed foods (20–30%) was reported in Hungary, Lithuania, Slovakia, and Spain [6]. In high-income countries such as the UK, Canada, and the United States, the contribution of ultraprocessed foods to daily energy intake was even greater, ranging from 47% to 59% [3,4,22]. In middle-income American countries, such as Mexico [7] and Chile [8], as well as in cities such as Rio de Janeiro, São Paulo, Minas Gerais, Bahia, Rio Grande do Sul, and Espírito Santo states, Brazil [9,10], ultraprocessed foods accounted for 24% to 30% of the daily energy intake. The most recent Brazilian Consumer Expenditure Survey (2017–2018), which provides data on food consumption, revealed that ultraprocessed foods accounted for less than 20% of the daily energy intake of the Brazilian population [2]. High ultraprocessed food consumption may be related to the high palatability, convenience, and durability of such products and their being produced mainly by large food companies [13,34].

Of the evaluated ultraprocessed foods, cookies (with and without filling), sweets (ice-cream, popsicles, sundaes, candy, gum, açaí with toppings, chocolate, chocolate milk mix), and dairy products (fermented products, soy milk, light and normal *requeijão*) had the highest contribution to energy intake at 3.35%, 2.25%, and 2.12%,

Table 1
Means and 95% CI for the relative consumption of foods according to their degree of processing among adults (n = 976) living in Viçosa, Minas Gerais, Brazil, 2012–2014

Degree of food processing category and food items	Contribution to daily energy intake (%)	95% CI
Fresh foods, minimally processed foods, and food preparations	61.36	59.05–63.67
Rice	10.55	9.25–11.85
Beef, pork	9.14	8.35–9.92
Fruits	4.99	4.52–5.46
Chicken meat	4.29	4.03–4.56
Coffee, tea	4.26	3.69–4.83
Milk	4.18	3.89–4.48
Soup	2.75	2.27–3.22
Whole fruit juice, pulp juice, sugarcane juice	2.24	1.94–2.53
Cake, cornmeal cake	1.97	1.65–2.30
Fats (cooking oil, butter)	1.54	1.32–1.74
Vegetables	1.34	1.25–1.43
Eggs (boiled, fried, omelet)	1.12	0.96–1.29
Beef Milanese, parmigiana, or stroganoff	0.96	0.80–1.13
Pasta (spaghetti, ravioli, tortellini, gnocchi, lasagna)	0.91	0.81–0.99
Flour, farofa[*]	0.87	0.72–1.01
Angu[†], polenta	0.77	0.56–0.97
Fish (stewed, boiled, fried)	0.74	0.61–0.87
Roots and tubers (boiled, fried, baked)	0.56	0.49–0.62
Salad dressing (vinegar, lemon juice, garlic paste)	0.47	0.40–0.54
Oatmeal, granola	0.35	0.23–0.48
Sweet rice, pudding, flan	0.25	0.19–0.31
Popcorn	0.18	0.15–0.21
Vinaigrette	0.13	0.11–0.16
Brown sugar, rapadura[‡], refined sugar, honey	0.13	0.07–0.20
Processed foods	15.03	14.21–15.90
Bread (sliced, French, toast)	6.70	6.12–7.28
Fermented alcoholic beverages (beer, wine)	2.85	2.31–3.39
Cheese	2.66	2.25–3.07
Cheese bread	1.24	1.01–1.47
Scratchings/bacon	1.01	0.86–1.15
Fruit jams (coconut, guava, fig, peach)	0.38	0.32–0.43
Canned foods (corn, olives)	0.19	0.17–0.21
Ultraprocessed foods	23.58	21.61–25.54
Cookies (with and without filling)	3.35	2.85–3.85
Sweets (ice-cream, popsicles, sundae, candy, gum, açaí with toppings, chocolate, chocolate milk mix)	2.25	1.94–2.57
Dairy products (fermented products, soy milk, light and normal requeijão[§])	2.12	1.76–2.48
Burgers, ham sandwich	1.96	1.59–2.32
Whole grain bread, whole grain biscuit	1.71	1.16–2.26
Soft drinks and juices	1.70	1.47–1.92
Margarine (normal and light)	1.62	1.33–1.90
Sausages	1.57	1.40–1.74
Pizza	1.55	1.24–1.85
Fried or baked finger foods (coxinha[‖], sfiha, croquette, pastel)	1.45	1.27–1.63
Bakery products (breads, sweet goods)	1.08	0.85–1.31
Fried tubers (potato, cassava)	0.61	0.54–0.68
Mayonnaise (normal, light, plant-based)	0.58	0.50–0.66
Distilled beverages	0.43	0.25–0.61
Feijão tropeiro[¶], feijoada[#]	0.40	0.34–0.47
Instant noodles	0.36	0.27–0.45
Processed meat (meatballs, nuggets, beef burger)	0.30	0.24–0.37
Cereal bar	0.28	0.19–0.38
Sauces and seasonings (salad dressing, ketchup, mustard, broth powder)	0.16	0.14–0.18

CI, confidence interval
[*]Toasted cassava flour.
[†]Cornmeal-based dish.
[‡]Sweet prepared by boiling and evaporating sugarcane juice.
[§]Spreadable processed cheese.
[‖]Shredded chicken meat covered in dough, battered, and fried.
[¶]Typical dish made of beans, cassava flour, bacon, eggs, and seasonings.
[#]Stew of beans, beef, and pork.

respectively. In the 2017–2018 Brazilian Consumer Expenditure Survey, cookies ranked fourth in contribution to energy intake (1.7%), behind only margarine, crackers, snack foods, and breads. However, sweets and dairy beverages ranked sixth and ninth in energy contribution at 1.4% and 1.1%, respectively [2]. It is noteworthy that the three most frequent ultraprocessed foods and food categories identified here are among the 10 most frequent foods reported in the 2017–2018 Brazilian Consumer Expenditure Survey.

FF/MPF/FP accounted for 61.3% of the daily energy intake, in agreement with reports from 13 European countries [6]. Different from that observed in the present study, however, was that in these countries, processed culinary ingredients had an important contribution to energy intake, ranging from 15.2% to 28.0% [6].

Table 2
Means and CI for the relative consumption of foods at different processing degrees according to sociodemographic characteristics in an adult population (n = 976) in Viçosa, Minas Gerais, Brazil, 2012–2014

Variable	Fresh foods, minimally processed foods, and food preparations		Processed foods		Ultraprocessed foods	
	Mean (%)	95% CI	Mean (%)	95% CI	Mean (%)	95% CI
Total	61.36	59.05–63.67	15.05	14.21–15.90	23.57	21.61–25.54
Sex						
Women	62.71	60.02–65.41	13.45	12.50–14.41	23.82	21.66–25.98
Men	60.02	57.55–62.49	16.64	15.18–18.09	23.33	21.21–25.45
Age group (y)						
20–29	54.80	53.08–56.52	16.15	15.10–17.20	29.04	27.56–30.52
30–39	61.07	58.57–63.57	14.34	13.24–15.45	24.57	22.39–26.75
40–49	64.31	61.70–66.93	14.39	13.22–15.57	21.28	19.06–23.50
50–59	66.28	62.98–69.58	15.39	12.64–18.14	18.31	15.83–20.80
Level of education						
Primary	67.56	64.73–70.39	13.83	12.04–15.62	18.59	15.98–21.21
Secondary	62.28	60.12–64.44	14.73	13.43–16.02	22.98	21.17–24.79
Tertiary	56.59	55.07–58.12	16.06	15.21–16.90	27.34	25.96–28.71
Smoking status						
Non-smoker	60.71	58.37–63.05	14.88	13.95–15.81	24.39	22.67–26.12
Smoker	59.34	55.93–62.75	18.13	14.08–22.17	22.52	19.22–25.82
Former smoker	64.76	60.56–68.96	13.73	12.28–15.18	21.49	17.61–25.38
Ethnic group						
White	58.96	56.71–61.21	16.31	14.94–17.67	24.72	22.35–27.08
Non-White	62.95	60.39–65.51	14.22	13.30–15.15	22.82	20.66–24.97
Sedentary behavior (min/wk)						
≤120	66.95	63.67–70.24	13.90	12.29–15.51	19.14	16.70–21.58
120–240	64.31	61.67–66.95	14.29	12.51–16.07	21.39	18.45–24.34
≥240	57.99	55.88–60.09	15.86	14.95–16.78	26.14	24.36–27.92

CI, confidence interval

Table 3
Associations between food consumption by degree of processing and sociodemographic characteristics among adults (n = 976) living in Viçosa, Minas Gerais, Brazil, 2012–2014

Variable	Fresh foods, minimally processed foods, and food preparations		Processed foods		Ultraprocessed foods	
	Crude β (95% CI)	Adjusted β* (95% CI)	Crude β (95% CI)	Adjusted β† (95% CI)	Crude β (95% CI)	Adjusted β‡ (95% CI)
Sex						
Female	2.69 (0.44–4.93)	–	−3.18 (−4.95 to −1.41)	−3.01 (−4.73 to −1.28)	0.49 (−1.23 to 2.21)	1.54 (0.16–2.91)
Age group (y)						
30–39	6.27 (3.70–8.84)	2.96 (0.53–5.41)	−1.80 (−3.26 to −0.33)	−0.94 (−2.29 to 0.42)	−4.46 (−6.77 to −2.16)	−2.37 (−4.70 to −0.02)
40–49	9.51 (6.78–12.25)	5.04 (2.62–7.45)	−1.75 (−3.17 to −0.33)	−0.28 (−1.70 to 1.15)	−7.76 (−10.36 to −5.15)	−4.74 (−7.03 to −2.44)
50–59	11.48 (8.00–14.95)	6.81 (3.68–9.94)	−0.75 (−3.65 to 2.14)	0.74 (−1.68 to 3.17)	−10.72 (−13.24 to −8.20)	−7.14 (−9.86 to −4.42)
Level of education						
Secondary	−5.28 (−8.12 to −2.43)	−3.97 (−6.53 to −1.41)	0.89 (−1.13 to 2.92)	1.15 (−0.78 to 3.09)	4.38 (1.77–6.99)	3.19 (0.76–5.63)
Tertiary	−10.96 (−14.25 to −7.68)	−6.86 (−10.16 to −3.57)	2.22 (0.17–4.27)	2.21 (0.22–4.19)	8.74 (5.85–11.63)	5.42 (2.71–8.13)
Ethnic group						
Non-White	3.98 (1.43–6.48)	2.25 (0.08–4.42)	−2.08 (−3.74 to −0.43)	–	−1.90 (−4.38 to 0.58)	–
Smoking status						
Smoker	−1.37 (−4.95 to 2.21)	−3.55 (−6.92 to −0.18)	3.24 (−1.07 to 7.57)	–	−1.87 (−4.60 to 0.85)	0.26 (−1.78 to 2.30)
Former smoker	4.05 (−0.28 to −8.39)	−0.93 (−4.55 to 2.69)	−1.15 (−2.92 to 0.61)	–	−2.89 (−6.64 to 0.84)	1.64 (−1.56 to 4.84)
Sedentary behavior (min/wk)						
120–240	−2.64 (−6.22 to 0.94)	−1.78 (−4.68 to 1.12)	0.39 (−1.91 to 2.69)	–	2.24 (−1.18 to 5.68)	0.05 (0.00008–0.01)
≥240	−8.96 (−11.78 to −6.14)	−3.24 (−5.88 to −0.61)	1.96 (0.42–3.51)	–	7.00 (4.61–9.38)	–

CI, confidence interval
*Variables adjusted for each other.
†Adjusted for age.
‡Adjusted for smoking status.

Here, because of their low representativeness, processed culinary ingredients were included in FF/MPF/FP. Our findings were also similar to those of studies conducted in Mexico [7] and Brazil [2,9,10], in which FF/MPF/FP accounted for 53% to 65% of the daily energy intake. In Chile, the contribution of FF/MPF/FP was lower than 45% [8]. The high contribution of FF/MPF/FP to energy intake is in line with national recommendations to base diets on fresh foods, minimally processed foods, and food preparations [1]. This positive result may be related to the importance of traditional Brazilian foods, such as rice and beans, which together accounted for more than 15% of the daily energy intake. Of note, the consumption of rice and beans decreased by 8% from 2008–2009 to 2017–2018, according to the Brazilian Consumer Expenditure Survey [2].

A significant difference between the sexes was only observed in the adjusted analysis; processed and ultraprocessed food consumption was significantly lower and higher, respectively, among female participants. These results differ from those reported in studies conducted in Brazil [9] and in other countries [3,7,8], which observed no differences between the sexes. A study carried out in Pelotas, Rio Grande do Sul, Brazil, also identified a higher consumption of ultraprocessed foods by female participants. The lower consumption of processed foods by women, as also reported in the 2017–2018 Consumer Expenditure Survey [2], may be related to the higher consumption of alcoholic beverages, such as wine and beer (classified as processed foods by NOVA), by men [2].

Even after adjusting for age, we observed that FF/MPF/FP consumption increased and ultraprocessed food consumption decreased with age. This finding is consistent with international studies showing that ultraprocessed food consumption is negatively associated with age [3,7,8]. The 2017–2018 Consumer Expenditure Survey reported that younger individuals consume more ultraprocessed food products [2], which may be because children and adolescents born in the late twentieth and early twenty-first centuries were more exposed to packaged foods during the formation of eating habits than older generations [35]. This aspect is relevant because it suggests that these children and adolescents may maintain high levels of ultraprocessed food consumption as they grow older.

FF/MPF/FP and ultraprocessed food consumption was higher and lower, respectively, in individuals with low education levels; these associations were observed both in adjusted and unadjusted analyses. Similar results were reported by other Brazilian studies [10,23], but a negative relationship between these variables was observed in Canada [4] and Mexico [7]. In high-income countries such as the United States, the relationship between income and ultraprocessed food consumption was found to be negative [3], whereas in Chile, a middle-income country, the relationship was positive [8].

Non-White individuals had a higher consumption of FF/MPF/FP, whereas White individuals had a higher consumption of ultraprocessed foods. Adjusted analysis, however, showed that the relationship between ethnic groups and food consumption was only significant for FF/MPF/FP. Our results agree with those of studies assessing ultraprocessed food consumption in Brazil [10] and the UK [22]. Given the historical development patterns of Brazil, the non-White population of the country is socially and economically vulnerable [36]. In view of this, a parallel can be drawn between the results found for education level and ethnic group. According to a systematic review [37] and a study developed in the United States [38], there is a stereotypical view of low-income individuals and food consumption: this population group is considered the largest consumer of ultraprocessed foods because of their low price, although “junk food” is not necessarily cheaper than meals prepared using fresh foods and minimally processed foods. In Brazil, it has been demonstrated that fresh and minimally processed foods have a lower price per calorie than other food items, suggesting an economic advantage in preparing meals at home compared with consuming ultraprocessed foods [39].

In analyzing behavioral variables, we found that non-smokers had a higher consumption of ultraprocessed foods. Adjusted analysis revealed that FF/MPF/FP consumption was lower in smokers and higher in individuals with less-sedentary behavior. For ultraprocessed food consumption, the opposite was observed: individuals with high sedentary behavior consumed more of these food products. Another Brazilian study identified, using an unadjusted analysis, that non-smokers had a high consumption of ultraprocessed foods [10], possibly related to such foods being highly palatable [13]. It is possible that individuals consume ultraprocessed foods to relax or as a reward (as these foods do not require prior preparation), a habit that is likely replaced by smoking in individuals who smoke. The low consumption of FF/MPF/FP in smokers may be explained by the association between poor quality of life and the onset of smoking [40].

Another behavioral variable associated with high ultraprocessed food consumption was sedentary behavior. No studies associating ultraprocessed food consumption and sedentary behavior in adults were found in the literature, only those that associate consumption and physical exercise. We highlight that sedentary behavior and physical exercise are not equivalent and may coexist. For instance, a physically active person can have high sedentary behavior. Sedentary behavior represents the time spent on activities that require low energy expenditure, such as watching television, playing video games, and driving to work [41]. Ultraprocessed foods are designed precisely to facilitate consumption by eliminating the need to prepare and share meals; they may be consumed alone, at any given moment, while watching television, using a computer, or driving [1]. A Brazilian study identified that 61% of food advertisements aired on public television are related to ultraprocessed foods and only 7% to fresh and minimally processed foods [42].

The strengths of the present study include its population-based nature and the use of an FFQ validated for the study population. An FFQ provides information on the habitual consumption of individuals, which may reflect the dietary pattern of a population, and is different from other methods of food consumption assessment (24-h recall and food records) that consider only current consumption. Unlike the present study, most studies that used the NOVA classification to evaluate food consumption and sociodemographic characteristics focused only on ultraprocessed foods, did not adjust for sociodemographic variables, or both. Studies investigating sedentary behaviors with a similar objective were not identified.

However, some difficulties, in addition to limitations inherent to the method, were observed regarding the use of FFQ. The preestablished list of foods was not designed while considering the NOVA classification; thus, it was difficult to classify food preparations, since in a single preparation it is possible to find ingredients from all NOVA food groups. We opted to classify preparations according to the category of the major ingredient [5,22], which may have led to underestimation of ultraprocessed food consumption or overestimation of FF/MPF/FP. Nevertheless, our findings are consistent with the results of national surveys [9,10,12]. It is also noteworthy that the methodologic differences between the present study and those included in this section may affect their comparability. Future research should investigate other behavioral, sociodemographic, and contextual variables that might influence food consumption in Brazil as well as in other countries.

Conclusion

The results suggest that ultraprocessed foods contribute more to the daily energy intake of younger individuals and that ultraprocessed food consumption is positively associated with sedentary behavior and level of education.

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