





# Usual consumption of ultra-processed foods and its association with sex, age, physical activity, and body mass index in adults living in Brasília City, Brazil

*Consumo usual de alimentos ultraprocessados e sua associação com sexo, idade, atividade física e índice de massa corporal em adultos residentes na cidade de Brasília, Brasil*

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**ABSTRACT:** *Objective:* To evaluate the usual consumption of ultra-processed foods (UPF) and its association with body mass index (BMI), physical activity (PA), age, and sex in adults living in Brasília City, Brazil. *Methodology:* A total of 506 individuals aged  $\geq 20$  years old were interviewed. Dietary intake was assessed with two non-consecutive 24-h food recalls. The distributions of usual intakes of energy and the amount of UPF were estimated using the Iowa State University method. The association of age, BMI, PA, and sex with the proportions of UPF consumption (%Kcal and %grams) was investigated with linear regression models. *Results:* UPF represented 9.2% of the total dietary consumption (grams/day) and 25% of total energy intake. Compared to eutrophic, subjects with obesity consumed a higher percentage of UPF in grams, whereas subjects with overweight had a higher percentage of UPF in kilocalories. The share of UPF in energy intake was lower in male than female individuals, and PA and age were inversely associated with UPF consumption. *Conclusion:* Careful monitoring of intake of UPF is recommended. Its consumption should be reduced among people with overweight/obesity and sedentary individuals. Appropriate choices for methods to evaluate the usual distribution of intake will strengthen future analysis of UPF assessment.

**Keywords:** Food. Body mass index. Obesity. Overweight. Motor activity.

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**RESUMO:** *Objetivo:* Avaliar o consumo usual de alimentos ultraprocessados (AUP) e sua associação com o índice de massa corporal (IMC), a atividade física (AF), a idade e o sexo em adultos moradores de Brasília, Brasil. *Métodos:* Foram entrevistados 506 indivíduos com idade maior ou igual a 20 anos. A ingestão dietética foi avaliada utilizando dois recordatórios 24 h não consecutivos. As distribuições da ingestão usual de energia e de quantidade de AUP foram estimadas por meio do método da Universidade do Estado de Iowa, nos Estados Unidos. Empregaram-se modelos de regressão linear para verificar a associação de idade, IMC, AF e sexo com as proporções de consumo de AUP (%Kcal e %gramas). *Resultados:* A ingestão de AUP representou 9,2% do total de consumo alimentar em quantidade (gramas/dia) e 25% do total do consumo energético. Comparados com eutróficos, os sujeitos com obesidade consumiram maior percentual de AUP em gramas, e os indivíduos com sobrepeso apresentaram maior percentual de AUP em calorias. A quantidade de AUP na ingestão energética total foi menor por parte dos homens do que das mulheres, e a AF e a idade foram inversamente associadas com o consumo de AUP. *Conclusão:* Recomendam-se a monitorização da ingestão de AUP e a redução no consumo entre pessoas com sobrepeso, com obesidade e sedentárias. Métodos apropriados para avaliar a ingestão usual vão fortalecer as análises futuras de avaliação de AUP.

*Palavras-chave:* Alimentos. Índice de massa corporal. Obesidade. Sobrepeso. Atividade motora.

## INTRODUCTION

Worldwide prevalence of obesity has increased during recent years and has been in part attributed to increased consumption of ultra-processed foods (UPF)<sup>1</sup>. UPF and drinks are defined as industrial formulations manufactured from substances derived from foods or synthesized from other organic sources, with chemical additives such as color stabilizers, flavor enhancers, sugar-free sweeteners, and preservatives. They are ready to consume or ready to heat, thus requiring little or no culinary preparation and presenting excessive energy density, high free sugars, unhealthy fats and salt, and low dietary fibers<sup>1,2</sup>. The UPF category of food has been established as the NOVA conceptual framework, devised by a research team at Universidade de São Paulo (USP), in Brazil. The NOVA system classifies foods and diets according to the origin, purpose, and extent of industrial food processing, rather than in terms of nutrients and food types<sup>2</sup>.

Following the growth in obesity rates, worldwide sales of UPF increased by 43.7% between 2000 and 2013<sup>1</sup>. In Brazil, an increase in the caloric share of UPF in the diet was observed from 1987 to 2009 and was found in all socioeconomic strata<sup>3</sup>.

In developed countries, a higher consumption of UPF was independently associated with males<sup>4,5</sup>, lower income<sup>5</sup>, few physical activity<sup>6,7</sup>, and overweight or obesity<sup>5,6</sup>. In Brazil, studies identify an association between higher consumption of UPF and females<sup>8</sup>, higher income<sup>8,9</sup>, and overweight or obesity<sup>8</sup>.

Many studies that evaluate the consumption of UPF are based in short-term instruments and consider the mean of two or three days or only one day 24-h food recall<sup>5,6,10-12</sup>. These dietary assessment methods are known to be highly affected by day-to-day or within-person variation in dietary intake, resulting in misleading estimates on the prevalence of low or high intakes, which is not sufficient to reproduce the usual food intake<sup>13</sup>. In fact,

usual intake is defined as the long-run average daily intake over a period. Considering that administering several 24-h recalls per individual in large epidemiological studies is difficult due to time, cost, and burden involved for respondents participation, statistical methods were developed to remove the within-person random error and to estimate the usual intake with a second 24-h recall for at least a subsample of the study population<sup>14</sup>. Only one study that used the usual intake to estimate the consumption of UPF could be found<sup>15</sup>.

Considering the relation between the consumption of UPF and overweight/obesity and the lack of studies that considered the usual intake to evaluate the consumption of UPF, the present study provides information related to the usual consumption of UPF and factors associated in a specific population. Among the 27 Brazilian states, the Federal District is the state with the highest *per capita* income and education level<sup>16</sup>. Hence, the aim of this study was to evaluate the usual consumption of UPF and its association with nutritional status, physical activity (PA), age, and sex in mostly middle to high class adults living in Brasília City, Federal District, Brazil.

## METHODS

### STUDY DESIGN AND PARTICIPANTS

This is a cross-sectional survey, designed to assess adult dietary intake and physical activity behavior. The sample unit are residents from Brasília central area. Residents were chosen through a random selection of the household addresses registered at the Energy Company of Brasília (*Companhia Energética de Brasília - CEB*), which serves 100% of the households in the city ( $n = 93,605$ ). Sample size was based on an alpha error of 5%, a confidence level of 95%, and assumed a homogenous distribution (80/20) for the practice of 150 min of PA per week. The ratio came from the Vigitel study (2012), in which 12.6% (95%CI 10.5 – 14.7) practiced more than 150 min of PA<sup>17</sup>. Total sample size was calculated to be 250 households; the final sample was 500 individuals, assuming two adults per household. A stratified sample according to the size of the four sanitary regions of central Brasília<sup>18</sup> (Figure 1) was used.

The field collection period lasted from 2016–2017. Two trained interviewers visited each selected household and completed a questionnaire to collect data about sociodemographic characteristics, dietary intake, and anthropometry. Sociodemographic characteristics included age, gender, socioeconomic status, schooling years, and physical activity. Further details can be assessed from Sousa and Costa (2018)<sup>18</sup>. Inclusion criteria were: residing in the selected household, being 20 or older, and agreeing to participate in the study. Exclusion criteria were: being pregnant, nursing mothers, individuals with special needs, and disabled or mentally handicapped persons.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki. All procedures involving human subjects/patients were approved by the Research Ethics Committee of Universidade de Brasília, School of Health Sciences. Written informed consent was obtained from all subjects.

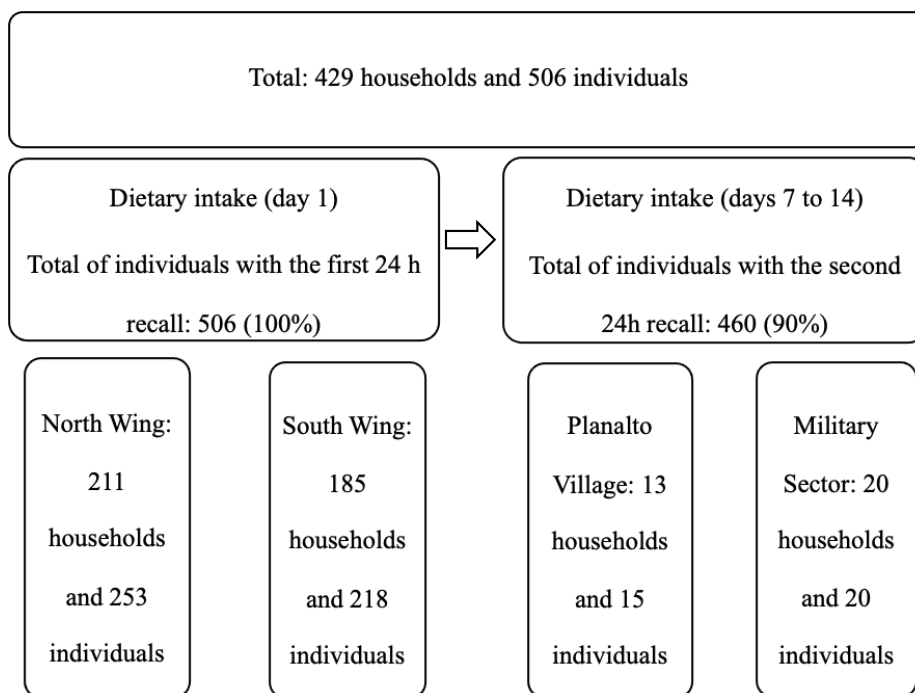


Figure 1. Flowchart of the sample. Brazilian adults  $\geq 20$  years old ( $n = 506$ ), 2016–2017.

## ANTHROPOMETRY, DIETARY INTAKE, AND PHYSICAL ACTIVITY

Body weight was measured using a platform-type digital electronic scale, with a capacity of 150 kg and accuracy of 100 g (WISO, Brazil). Height was measured with portable vertical stadiometer with a precision of 0.5 cm and maximum height of 2.1 m (Personal Caprice Sanny, Brazil). Body mass index (BMI) was obtained and classified according to the World Health Organization<sup>19</sup>.

Dietary intake was assessed using two non-consecutive 24-h food recalls, following the five-step multiple pass method<sup>20</sup>. In order to assist respondents when describing the amount of food and beverages consumed, and estimate the portion size, real tableware and a food photography booklet were offered<sup>21</sup>. The first 24-h recall was conducted in person, and the second was conducted by telephone after seven to 14 days and in a different weekday from the first in-person interview. A paper registration form was adopted. All 506 individuals provided the first 24-h recall; 460 (90% of the total sample) provided the second 24-h recall (Figure 1).

To estimate energy and nutrient intake, the Nutrition Data System for Research, version 2016 (NDSR) (Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, USA) was used. Since this software is based on food data from the United States Department of Agriculture (USDA), Brazilian foods were included in the program database or adapted from a food of the same value according to national information. Each food portion was converted to grams or milliliters using a standardized conversion table<sup>22</sup>.

The IPAQ (International Physical Activity Questionnaire) short version was used to obtain weekly time and frequency of moderate, vigorous, and 10 min continuous walking. The weekly amount of time spent in these activities was calculated as the sum of minutes of moderate activity (including fast and moderately fast walking) plus twice the minutes of vigorous activity<sup>23</sup>. To be considered physically active, the individual must perform more than 150 min per week of PA.

## **CLASSIFICATION OF ULTRA-PROCESSED FOOD CONSUMPTION**

All foods recorded by the subjects were analyzed. UPF were identified based on the extent and purpose of industrial processing according to the NOVA classification<sup>2</sup>. NOVA classifies all foods and food products, including the individual items of culinary preparations obtained from recipes, into the following four groups:

- Unprocessed or minimally processed foods;
- Processed culinary ingredients;
- Processed foods;
- Ultra-processed foods and drink products<sup>2</sup>.

UPF identified were: cookies, pastries, cakes, breakfast cereals, breads with added emulsifiers and energy bars; margarines and spreads; ready to heat dishes (pies, pasta, pizza); sweet or savory packaged snacks; ice-cream, chocolate, and candies; carbonated and energy drinks; dairy drinks, yogurts with sugar or artificial sweeteners, fruit drinks, and cocoa drinks; meat and chicken extracts, and 'instant' sauces; 'nuggets', sausages, burgers, and hot dogs; infant formulas; powdered and packaged 'instant' soups, noodles and desserts; and alcoholic drinks produced by distillation.

All types of cheese were classified as processed food, except cream cheese, which was categorized as UPF due to the amount of stabilizers and preservatives. Moreover, all types of cakes were considered UPF because the volunteers were not asked if the cake was home-made or industrialized. UPF were then grouped according to their characteristics, based on the source and content of sugar and fat.

## **STATISTICS**

Dietary intake analysis was performed by implementing the Iowa State University (ISU) method, using PC Software for Intake Distribution Estimation (PC-SIDE version 2.0, 2017; Department of Statistics, Iowa State University, Ames, IA, USA) to estimate the distributions of usual intake of energy and the amount of UPF. This method allows initial adjustments for confounding factors, such as day of the week, month, interview mode, or interview sequence, and uses a power transformation to bring the distribution of the observed data closer to normality<sup>24</sup>.

UPF and energy intake were stratified by sex, PA, and BMI. Within-person variation was removed from total grams and total kilocalories, as well as from UPFgrams and UPFKcal. The PC-Side analysis included order of recall and sampling weight as covariates<sup>25</sup>. The ratio of UPFgrams and UPFKcal was calculated from the usual distributions, reflecting the ratio of usual intake<sup>25</sup>. The usual ratio of energy (%Kcal) and weight (%grams) of UPF in the diet was computed for each individual.

The usual mean dietary share of UPF (%Kcal and %grams) was calculated according to sex, PA, and BMI. Individual sample weight was included to obtain the usual intakes and their errors. The percentiles of UPF intake in grams and Kcal are also presented by BMI classes.

A total of 5.6% (n = 54 out of 966 recalls) of individuals recorded zero consumption of UPF in either one or two days of the 24-h-food recalls. Only six individuals (0.8%) recall no UPF consumption on both days. An asymmetric distribution does not allow the ISU method to converge. Therefore, an adjustment to the UPFgrams and UPFKcal distributions were implemented in R software<sup>24</sup>. An addition of a small quantity of UPF was added to the 54 zeros values in the distribution, following a normal distribution of mean zero and 0.5 standard deviation (SD), and absolute values generated. Absolute values obtained for the mean and SD differ only in the decimal cases for grams and Kcal of UPF after the addition of zeros. Mean and SD before zeros adjustment for grams and Kcal are 301.33 g  $\pm$  315.35 g; 499.71 Kcal  $\pm$  469.86 Kcal. Mean and SD after zeros adjustment for grams and Kcal are 301.68 g  $\pm$  315.02 g; 499.84 Kcal  $\pm$  469.79 Kcal, respectively.

The assessment of usual intake was estimated from two nonconsecutive 24-h recall. Nonetheless, UPF was grouped according to similar nutritional characteristics, using only data obtained in the first 24-h recall. The mean intake of each group was obtained in grams and energy. The percentage of energy and grams intake of each UPF group was calculated, and then the mean was obtained.

The association of personal characteristics (age, sex, PA, and BMI, as independent variables) with the proportions of UPF intake (%Kcal and %grams, as dependent variables) was investigated with linear regression. Variables such as schooling and sample weight were used as covariates in the regression. The normality assumptions for variables and residuals from the regression was verified with Shapiro-Wilks test. Percentage grams of UPF did not pass the normality test and were log transformed for the linear regression analysis. All analysis were performed in R program, using the R Studio (Version 1.1.383 – © 2009-2017 RStudio, Inc.). The level of significance adopted was 5%.

## RESULTS

The mean age of the sample was 40 years old (SD = 15.6 years), 87% had completed higher education (> 15 schooling years), and 76% had high/medium socioeconomic status (monthly personal income > US\$ 2,102.94 or BRL 7,799.5) (data not shown). Overall, UPF represented 9.2% of the total amount of foods consumed (3,411 g  $\pm$  897.24 g), and 25% of total energy intake (2,000 Kcal,  $\pm$  576 Kcal) (Table 1).

Table 1. Dietary share of ultra-processed foods (% grams and % daily energy intake), according to characteristics of respondents. Brazilian adults  $\geq 20$  years old (n = 506), 2016–2017.

Variables	Total		%GramsUPF		%KcalUPF	
	N	%	Mean	SD	Mean	SD
All	506	100	9.2	5.5	25	9.6
Sex						
Female	290	57.3	8.8	4.7	27	8.8
Male	216	42.7	9.6	6	23	10
Body Mass Index						
Eutrophic	267	52.8	7.9	4.1	24	8.9
Overweight	166	32.8	10	6.4	26	10.9
Obese	73	14.4	12.1	6.6	28	10.4
Physical Activity (min/week)						
< 150	119	23.5	12	7	30	10.2
$\geq 150$	387	76.5	8.4	5	24	9.3

UPF: ultra-processed foods; SD: standard deviation.

People with overweight or obesity, and inactive individuals (< 150 min/week of PA) presented higher percentage in grams and Kcal of UPF intake than eutrophic and active individuals. In relation to sex, a higher percentage of UPF consumption (%GramsUPF) was noted for males than females, and the opposite occurred for percentage of UPF energy intake (%KcalUPF) (Table 1).

Age was negatively associated with the proportion of UPF in grams and energy. For each year of increase in age, there was a reduction of 0.07% of kilocalorie from UPF. The interpretation is limited to percentage of UPF in grams, as the units were log transformed. Compared to eutrophic, the percentage of UPF in grams from total amount of food was positively associated with obesity, whereas overweight was positively associated with percentage of UPF in Kcal from total energy intake. Overweight was associated with a usual intake of 3.5% more Kcal of UPF when compared to eutrophic individuals (Table 2). Although not reaching the predefined 5% statistical significance level ( $p = 0.09$ ), obesity was associated with a 3% more energy intake of UPF than eutrophic was. The share of UPF in energy intake was lower in males than females ( $p < 0.0001$ ), but was not statistically significant if considered the amount of UPF in grams ( $p = 0.15$ ). The ratio of UPF in grams and energy was negatively associated with more weekly time of PA (active individuals) when compared to fewer weekly time of PA (< 150 min/week) (Table 2).

For percentiles of UPF consumption, when analyzed by BMI status, the higher the UPF consumption, the greater the discrepancy between groups. In the 25<sup>th</sup> percentile, subjects with overweight and obesity had a consumption about 5% more than those eutrophic. However, the distance doubled between overweight and eutrophic for the 95<sup>th</sup> distribution percentile (Figure 2A). This accounted for 240 g of UPF intake (data not shown). Individuals

Table 2. Association of age, sex, body mass index (BMI), and physical activity (PA) with usual proportion of daily energy and grams intake of ultra-processed foods (UPF) in Brazilian adults  $\geq 20$  years old ( $n = 506$ ), 2016–2017\*.

Parameter	%GramsUPF*				%KcalUPF			
	Coefficient	SE	t value	Pr >  t	Coefficient	SE	t value	Pr >  t
Intercept	2.47	0.13	18	< 0.001	31.98	2.04	16	<0.0001
Age	-0.006	0.002	-1.4	0.031	-0.07	0.04	-2	0.047
Sex								
Male	-0.12	0.08	-1.4	0.152	-5.75	1.22	-4.7	< 0.0001
BMI								
Overweight	0.1	0.09	1.1	0.253	3.46	1.36	2.5	0.012
Obese	0.24	0.12	2	0.04	3.05	1.8	1.7	0.092
PA								
$\geq 150$	-0.29	0.09	-3.2	0.002	-3.37	1.43	-2.4	0.019

#Reference data (coefficient = 0): Female, eutrophic, PA < 150; BMI: body mass index; PA: physical activity (minutes/week);

\*units were log transformed. Linear regression with schooling and sample weight as covariates. Significance p-value < 0.05.

with obesity presented an increase of grams of UPF consumption like those eutrophic and maintained the increment pattern along the curve (Figure 2A).

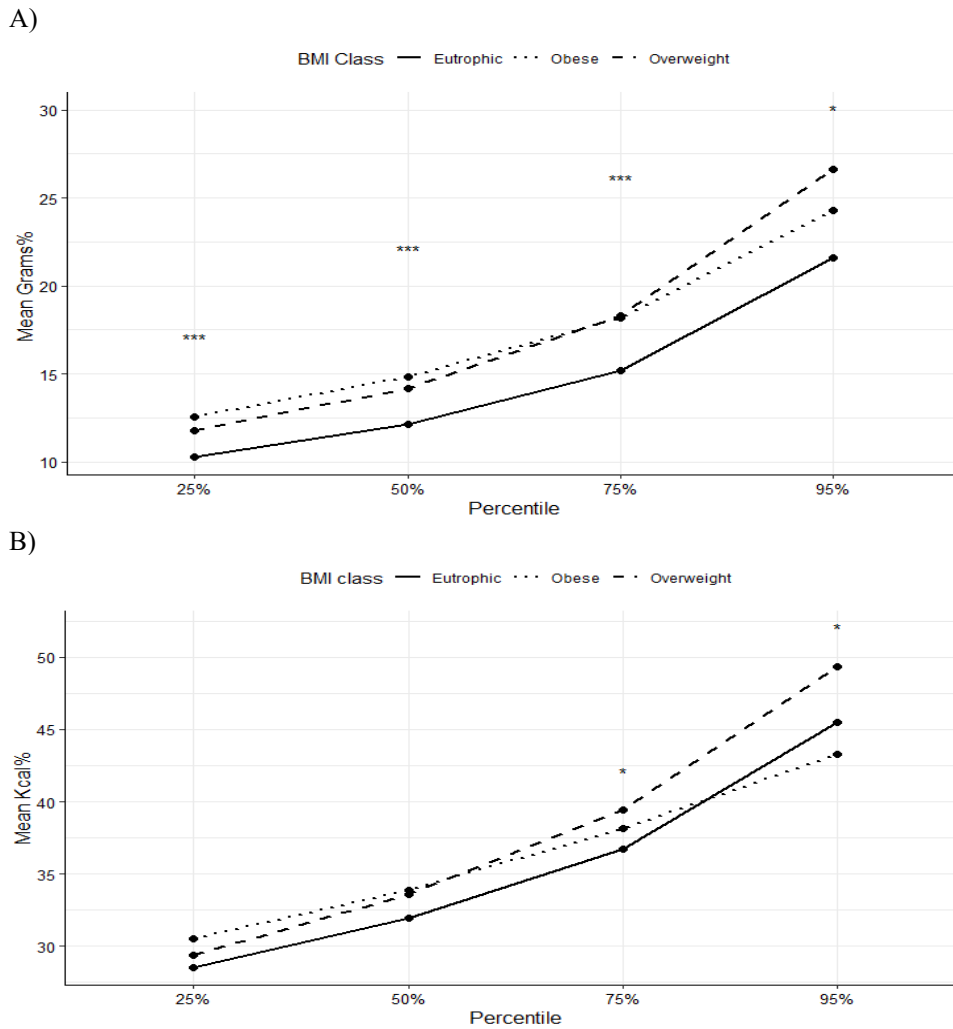
The proportion of UPF consumption in Kcal was close among overweight and eutrophic in the 25<sup>th</sup> percentile (Figure 2B). However, this difference substantially and significantly increased after the 75<sup>th</sup> percentile, reaching more than 200 Kcal in the 95<sup>th</sup> percentile (data not shown). Subjects with obesity consumed similar energy of UPF until the 50<sup>th</sup> percentile and reduced the trend in the 95<sup>th</sup> percentile, when contrasted with the other BMI categories (Figure 2B).

Most individuals (98.2%) consumed some type of UPF. The UPF group with the highest contribution to energy intake was cakes, cookies, breakfast cereals, and commercial breads, followed by sugary products, and pizzas, sandwiches, and ready-to-eat dishes. Considering the amount of UPF consumed major contributors were soft drinks and industrialized juices (Table 3).

## DISCUSSION

To the best of our knowledge, the present study is the first to evaluate the usual consumption of UPF in a Brazilian population sample. In the scientific literature, only one study that evaluated the usual consumption of UPF was found, which was conducted in Belgium<sup>15</sup>. The ratios of usual intakes were calculated for %GramsUPF and %KcalUPF, which reflects the long-term ratio of UPF intake<sup>25</sup>. The long-term consumption of UPF is what should be associated with health measures and outcomes. The literature published is somewhat limited because it reflects the distribution of the reported one-day value<sup>14</sup>.





#BMI group difference from Kruskal-Wallis test for each percentile level. P values are for Mean Gram % (Panel A): 25<sup>th</sup> percentile: 0.001(\*\*\*); 50<sup>th</sup>: 0.0003 (\*\*); 75<sup>th</sup>: 0.0001 (\*\*\*); 95<sup>th</sup>: 0.021 (\*\*). P values are for Mean Kcal % (Panel B): 25<sup>th</sup> percentile: 0.10; 50<sup>th</sup>: 0.08; 75<sup>th</sup>: 0.03 (\*); 95<sup>th</sup>: 0.03 (\*).

Figure 2. Dietary share of ultra-processed foods (UPF) in the diet according to percentiles of consumption in each classification of body mass index (BMI). Brazilian adults  $\geq 20$  years old (n = 506), 2016–2017#.

The contribution of UPF consumption to energy intake was equal to one fourth of the total energy intake and approximately 5% higher than the results observed in some Brazilian studies, which analyzed only one day of intake<sup>9,11</sup>. Another Brazilian study observed a higher contribution of UPF consumption equal to one third of the total energy intake<sup>8</sup>. In most of these Brazilian studies, samples comprised adults and children above 10 years old<sup>9,11</sup>. This difference and the fact that they did not adopted usual intake mitigates comparison with the present study.

Table 3. Energy and weight mean and percentage contribution of ultra-processed foods (UPF) groups, obtained from the first 24h recall of Brazilian adults  $\geq 20$  years old (n = 506), 2016–2017.

Groups of UPF	Kcal	%Kcal	Grams	%Grams
Commercial sauce*	17	0.8	7.7	0.2
Dairy drinks and flavored yogurts†	26	1.3	23.6	0.7
Industrialized beverages‡	61	2.9	143.0	4.5
Reconstituted meat or fish products§	63	3.0	25.8	0.8
Pizzas, sandwiches, and ready-to-eat dishes	96	4.4	35.6	1.2
Sugary products¶	97	4.6	29.0	0.9
Cakes, biscuits, cereals, commercial breads	133	7.1	41.3	1.3
Total	494	24.0	306	9.8

\*Including dressing for salads, ketchup, bouillon, commercial mayonnaise, pâté, commercial peanut butter, cream cheese, and margarine; †including soft drinks, juices, cappuccino, cocoa or hot chocolate, coconut milk, drinks mixtures, and ready-to-drink rice beverage or soy milk; ‡including artificial sweetener, vanilla extract, guarana, energy drinks, carbonated water sweetened, ready-to-drink tea, vodka, and liqueur; §including ham, pepperoni, salami, bacon, and textured vegetable protein; |including snacks, commercially popcorn, and instant noodles; ¶including glazed cakes, chocolate, filled bars and cookies, candies, frosted or glazed cakes, ice-cream, desserts, donuts, gelatin, and jams, preserves, or jelly.

When comparing the results herein to that of studies in other countries, the contribution of UPF to total energy intake was 10% lower than results found in France<sup>5</sup> and Belgium<sup>15</sup>, 20% lower than a study from Canada<sup>10</sup>, and 30% less than adults from United States (USA)<sup>7</sup> and United Kingdom (UK)<sup>4</sup>. Few studies evaluated the contribution of UPF to the amount of food ingested<sup>5,12</sup>, showing roughly 50% higher grams of UPF consumed per total food consumption than the present study.

A lower UPF Kcal intake was observed in males rather than females, following previous results from Brazil<sup>8</sup>. However, in developed countries<sup>4,5</sup>, males consumed higher amounts and energy of UPF than females. This result can be attributed to different lifestyles between sex, in part because they have different exposures to health-related demands and coping strategies<sup>26</sup>.

One of the results of the present study was the association between overweight and obesity with UPF consumption. Similar results were found in European<sup>5,6</sup> and Brazilian<sup>8</sup> research. Compared to eutrophic individuals, those with obesity consumed higher percentage of UPF in grams but not in kilocalories. Although the type of UPF consumed in each BMI category was not assessed, this result may indicate that individuals with obesity consumed a higher amount of diet beverages, which contain low kilocalorie in a large volume. In addition, because people with obesity normally tend to misreport, they could have misreported the high energy density food, which are mainly UPF.

Another alarming result about weight in excess is that subjects classified as overweight had a major consumption of UPF in grams and kilocalories, and presented an elevated trend according to the percentile of intake, reaching more than 200 Kcal and 240 g of UPF in the last percentile, compared to normal weight. This discrepancy between subjects not only increases the amount of energy intake in subjects with overweight and obesity but also

other components such as sugar, saturated fat, and sodium, providing in addition to weight excess, potential risks for diabetes and cardiovascular diseases.

According to the PA level, those who are inactive ( $< 150$  min/week) had a higher UPF consumption than those who are active ( $\geq 150$  min/week). International research supported what was found in the present study, resulting in higher UPF consumption among sedentary subjects<sup>6</sup>. In fact, habitually active individuals appear to have increased sensitivity to the energy density of foods in comparison with inactive ones<sup>27</sup>.

Another finding in the present study was the inverse association between the consumption of UPF (grams and energy) and age. The same result has been found in many other studies<sup>4,5,9,15</sup> and may reflect the awareness about health as people grow older.

The highest contribution of UPF consumption in amount of food intake observed was the beverages group, such as soft drinks and industrialized juices, although they only contributed to 2.86% of total energy intake. This result, for caloric intake in the beverages group, occurred because several of them contain artificial sweeteners, which allow them to have a low energy per amount of UPF. In the literature, we found only two studies that evaluated the contribution of UPF to the total amount of food<sup>5,12</sup>.

Limitations of the present analysis were: some foods and beverages reported in the 24-h food recalls were not detailed enough to correctly classify them into the UPF group; NOVA uses terms that are not precisely defined and sometimes contradict the UPF definition. For example, the term “artisanal bread”, even if they were not industrialized, may contain ingredients typically used in UPF. Among industrialized products, the classification could vary according to ingredients used in each brand and product; dishes according to ingredients were not divided, and some had UPF and other food groups in the same recipe. In this case, food was classified according to the major ingredient. The study was a cross-sectional survey, which prevents directional conclusions or causality, being impossible to determine if UPF intake caused weight gain. Moreover, the self-reported dietary recalls are prone to misreporting, and UPF intake could be higher.

Despite these limitations, the present study has a relevant strength as the first study to estimate individual usual intake of UPF in Brazil. This method is important because it removes the within-person and day-to-day error, and describes the long-term average daily intake. In addition, because the sample was constituted of people who lived in the state with the highest income in Brazil, UPF consumption could be analyzed in a population without limited purchase power.

In conclusion, the percentage of UPFgrams consumption was found to be positively associated with obesity, whereas the percentage of UPFkcal consumption was positively associated with overweight subjects. The percentage of UPF consumption in grams and energy was negatively associated with age, and with more than 150 minutes of PA per week. Males presented lower UPFkcal intake than females, however the consumption of UPF grams did not differ between sex. Defining these characteristics is important to direct public policies to groups with risk factors for UPF consumption, considering that this behavior may aggravate obesity and related diseases. Further research should be conducted using the methodology which evaluates the usual consumption of UPF.

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