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# Sociodemographic disparities in the consumption of ultra-processed food and drink products in Southern Brazil: a population-based study

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## Abstract

**Purpose** This study aims to describe the distribution of ultra-processed food and drink products (UPP) consumption according to sociodemographic characteristics in adults from southern Brazil, and to investigate which are the most-consumed UPP subtypes in the different social strata.

**Methods** Cross-sectional analysis of the second wave of a population-based cohort of 1720 adults. The usual caloric intake and the caloric contribution of UPP to total energy intake (%CTEI) were estimated by the application of two 24-h dietary recalls (adjusted by intra- and inter-individual variability). Data were analyzed according to gender, age, marital status, schooling, and family income. Linear regression models were used to estimate the adjusted means.

**Results** Consumption data were obtained from 1206 adults (70.1% of the original cohort). Mean UPP consumption was higher in males than females (829.6 kcal vs 694.3 kcal, $p$ value < 0.001), but the %CTEI from UPP increased in females (34.7% vs 39.3%, $p$ value < 0.001), even after adjusting for sociodemographic variables. In the full model, which included all sociodemographic variables, %CTEI from UPP was inversely associated with age (difference between extreme categories 7.1 pp., 95 CI% 7.7–6.5) and directly associated with schooling (difference between extreme categories 6.3 pp., 95 CI% 5.5–7.1). The subtypes of UPP that contributed most to the observed differences were processed breads, fast food, and ultra-processed pies and sweets.

**Conclusions** UPP account for a third of the calories normally consumed, with women, young people, and better educated individuals being the most vulnerable groups. These results can help when planning public policies to reduce UPP consumption.

**Keywords** Food habits · Nutrition · Risk factors · Population characteristics · Nutrition survey · Nutritional epidemiology

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## Introduction

Dietary pattern changes have led to an increased consumption of ultra-processed food and drink products (UPP) in the last few decades (Popkin et al. 2012; Monteiro et al. 2015). UPP are industrial formulations that usually contain high levels of sugar, saturated fats, trans fats, and/or salt, and a mixture of additives, antioxidants, stabilizers, and preservatives, while only a small proportion of natural food is present, if at all (Monteiro et al. 2017).

Diverse studies have shown an adverse relationship between UPP intake and various chronic non-communicable diseases (NCDs) (Popkin et al. 2012; WHO 2013; Moubarac et al. 2015). However, despite its deleterious health effects and reduced nutritive value compared to natural food products, UPP consumption continues to rise around the world, accounting for 21.5% (data from Brazil) to 61.7% (data from Canada) (Moubarac et al. 2014) of total calories consumed daily. The

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increasing proportion of UPP in the diet is largely explained by their high durability and palatability, facilitated accessibility, and aggressive marketing strategies (Monteiro et al. 2017).

Although larger amounts of UPP are consumed in high-income countries, dietary pattern changes have occurred most abruptly in middle-income settings (Popkin et al. 2012; Monteiro et al. 2015). In Canada, for example, family budget surveys conducted between 1938/39 and 2011 showed the share of UPP in family expenses increased from 28.7 to 61.7%, while unprocessed or minimally processed food fell from 34.3 to 25.6% (Moubarac et al. 2014). In contrast, in middle-income settings such as Brazil, there was a decrease of up to 40.5% in the share of traditional foods such as rice and beans in the short period between 2002/03 and 2008/09. Moreover, the share of UPP increased up to 39% in the same period, with products like bread, biscuits, soft drinks, and ready-to-eat meals showing the highest growth (Levy et al. 2012).

In addition to the influence of the country-specific economic level in determining the share of UPP (high-income countries, such as Canada with a share of up to 61.7%, and middle-income settings, such as Brazil, with a caloric share of 30%) (Moubarac et al. 2014; Louzada et al. 2015), individual sociodemographic characteristics also seem to determine UPP consumption. Studies in high-income countries have shown that males and younger individuals are more prone to consume UPP (Levy et al. 2012). However, the relationship with the individuals' socioeconomic status is more complex. Although traditional homemade foods are more common among people with lower incomes, these individuals also tend to consume larger amounts of some UPP subcategories with reduced nutritive value, but a better cost/benefit ratio (i.e., soft drinks, snacks, ultra-processed dinners) (Djupegot et al. 2017). In this sense, economically disadvantaged groups are at a greater risk of nutritional inadequacy, as they also have limited access to fresh products (i.e., fruits and vegetables) due to their higher cost (Aggarwal et al. 2012).

Although many low and middle-income countries are facing a rapid nutritional transition process characterized by significant increases in the prevalence of obesity and diverse NCDs (Popkin et al. 2012; WHO 2013), most of the results regarding changing population diets rely on the analysis of family budgets, which are inaccurate when estimating individuals' usual food consumption (Popkin et al. 2012; Canella et al. 2014). Therefore, it is necessary to conduct population-based studies in these country types, and use appropriate tools to investigate individuals' food intake, including the UPP subcategories most consumed, and establish whether these choices differ according to sociodemographic characteristics. Such investigations are fundamental for public health policy makers to provide information aiming to control UPP consumption and reduce the risk of obesity and NCDs (Popkin et al. 2012; WHO 2013).

Thus, the present study aims to describe the prevalence of UPP consumption and the UPP subcategories more consumed by adults, as well as UPP distribution according to sociodemographic characteristics. To achieve this objective, we used data from a population-based cohort study in Southern Brazil, and two 24-h dietary recalls (24HR) combined to estimate usual dietary intake.

## Methods

We carried out a cross-sectional analysis of the second wave (2012) of the EpiFloripa study, a population-based cohort including a representative sample of adults (20–59 years of age) living in Florianópolis, a state capital in Southern Brazil. In 2010, the city had an estimated population of 249,530 adults, the third-highest human development index (HDI) of all Brazilian municipalities (0.847), an illiteracy rate of 1.6%, and life expectancy of 75.8 years (IBGE 2011).

### Sample

A random sampling process was carried out in two stages at baseline (2009). Firstly, ten census tracts in each decile of family income were systematically selected (63/420 census tracts in the city). Secondly, 18 households in each of these sectors (total 1134/16,755 households) were methodically chosen. To achieve the required sample size ($n = 1720$), all adults living in these households were considered eligible. Further methodological details of the cohort have been published elsewhere (Boing et al. 2014).

### Data collection

In both waves of the cohort, data were collected at the house of the participants through face-to-face interviews, performed by trained researchers. Data on sociodemographic variables, general and oral health, anthropometric measurements, and blood pressure were registered on personal digital assistants (PDAs). Quality control was conducted through telephone interviews with a random sample of 15% of respondents in 2009 and 10% in 2012, using a small survey with key questions (kappa = 0.7 for behavioural variables and marital status).

### Dietary intake

The study outcome (UPP consumption) was evaluated in 2012 using two 24HRs, including one weekday and one weekend day. The first 24HR was administered to all participants during the face-to-face interview, while the second 24HR was carried out by telephone, in a 40% subsample, selected by systematic sampling from the respondents to the first 24HR. The multiple pass method was used to stimulate the participants' memory. Collected data were registered in the Nutrition Data System for Research software (NDSR), Grad Pack 2011 (University of Minnesota, USA), following

standardized procedures (Fisberg and Marchioni 2012). As the NDSR is mainly based on the food composition table of the United States Department of Agriculture (USDA), the Brazilian Table of Food Composition (TACO) (NEPA — Núcleo de Estudos e Pesquisas em Alimentação 2011) was used to verify compatibility and select equivalent food items when necessary. Preparations not available in the NDSR were manually registered using standardized recipes (Benzecry et al. 2001; Bombem et al. 2012). Home measurements were converted into grams using national reference tables (Benzecry et al. 2001; Fisberg and Marchioni 2012).

After checking for data consistency, food items were grouped according to their processing level (Monteiro et al. 2017). A list of 450 UPP was identified and further divided into 12 subcategories: 1) ultra-processed breads (industrialized packaged breads, pre-made and frozen breads), 2) cold cuts and sausages, 3) margarine, 4) fast food (burgers and sandwiches, French fries, pizzas, industrialized empanadas, and *calzone*), 5) salty snacks (crackers, packed snacks), 6) ready-to-eat meals (frozen products such as pizzas, "*pão de queijo*" (which is a frozen Brazilian bread cheese imitation), lasagne, pastas, frozen and ready-to-heat burgers and sandwiches, instant soups, instant noodles), 7) ultra-processed cakes and sweets (candies, chocolates, ice cream, packaged cakes, cake mixes, industrialized pies), 8) packaged cookies and breakfast cereals (packaged sweet cookies with or without filling, breakfast cereals, industrialized granola), 9) soft drinks (regular, diet, or light), 10) juices and teas (juices, teas, energy drinks), 11) sweetened dairy drinks (yogurts and milk drinks), and 12) other UPP (four products that did not fit in any of the 11 subcategories: ready-to-eat *farofas* (processed manioc flour), *sustacal* (milk-based oral supplement), shake mixtures for weight loss, and baby food).

Total energy intake (TEI), total caloric value from UPP (TCV$_{UPP}$), and the caloric value for each of the 12 UPP subcategories were estimated using the NDSR. Datasets were exported to Stata 13.0 (Stata Corp, College Station, TX, United States) for data analysis. Data from the two 24HRs were used to adjust the variables for intra- and inter-individual variability, so as to represent the individual's usual food intake (Dodd et al. 2006; Willett 2013). The Iowa State University (ISU) method (Dodd et al. 2006) was used for symmetrical food/nutrients variables without zeros in their distribution (TEI and TCV$_{UPP}$), and the National Cancer Institute method (NCI) (Dodd et al. 2006) was used for variables with a non-normal distribution and/or occasionally consumed UPP subcategories.

The generated variables were used to estimate total contribution of UPP to the TEI and expressed as a percentage (%CTEI$_{UPP}$ = [TCV$_{UPP}$*100]/TEI). The same equation was used for the caloric value of the UPP subcategories.

## Sociodemographic variables

Information on gender (male/female), age (collected as a continuous variable, and categorized for analysis as 20–29, 30–49, or 50+ years), and attained educational level (collected as a discrete variable, and categorized as 0–8, 9–11, 12+ more years of schooling) was obtained at the baseline. Marital status (single, married, widowed, or divorced) and total family income (per capita, divided into tertiles: 1st tertile = < R\$ 766.7; 2nd tertile = R\$ 766.7–1800; 3rd tertile= > R\$ 1800; 1 USD = R\$ 1.75 in 2009) were defined based on data collected in 2012.

## Data analysis

TCV$_{UPP}$ and total %CTEI$_{UPP}$ were presented as means with their respective 95% confidence interval (95% CI). *T*-test or ANOVA (heterogeneity or trend) were used to tests the bivariate associations with sociodemographic variables. To obtain unbiased results, a multiple linear regression model was used to estimate the adjusted predicted means of the total %CTEI$_{UPP}$. All sociodemographic variables were mutually adjusted in the regression model, regardless of the level of statistical significance in the association with the bivariate analysis. Collinearity between variables was analysed by the variance inflation factor (VIF). Gender, age, and schooling were tested as possible sources of heterogeneity in associations.

The average consumption within the 12 UPP subcategories was presented in separate tables for those variables associated with total %CTEI$_{UPP}$ in adjusted analysis (gender, age, and education level). Due to the asymmetry of these outcomes, results were shown as medians with their respective interquartile ranges (p25 –75). Differences in the consumption of all UPP across categories of the independent variables were tested using the Mann–Whitney or Kruskal–Wallis tests.

Data analysis was conducted using the statistical software Stata 13.0 (Stata Corp, College Station, TX, USA), taking into account sampling weights (probability of selection in 2009 and probability of location in 2012) and the survey design. The EpiFloripa study was approved by the Ethics Committee on Human Research at the Federal University of Santa Catarina (protocol numbers 351/08 and 1772/11), and all participants signed a consent form in both waves.

## Results

Of the 1720 adults evaluated in 2009, data on food consumption were obtained for 70.1% of the sample in 2012 (*n* = 1206). Of these, 455 answered the second 24HR (98.9% of those selected for this purpose). In 2009, the median of education level in the sample was 11 years (p25−p75 = 9–11 years) and the age mean was 40.6 years (SD = 11.7 years).

Table 1 shows the distribution of the sample according to sociodemographic characteristics at baseline and 2012. The education level of those located in 2012 was similar to the original cohort, but there was a lower percentage of men,

**Table 1** Comparison of sample at baseline (2009) and follow-up (2012) according to sociodemographic characteristics

|  | 2009 ($n = 1720$) | 2012 ($n = 1206$) | P value* |
|---|---|---|---|
| Gender |  |  | 0.030 |
| Male | 44.9% | 43.1% |  |
| Female | 55.1% | 56.9% |  |
| Age group in years |  |  | < 0.001 |
| 20–29 | 33.4% | 28.5% |  |
| 30–49 | 47.2% | 50.2% |  |
| 50+ | 19.4% | 21.3% |  |
| Marital status |  |  | < 0.001 |
| Married | 59.7% | 63.3% |  |
| Single | 30.3% | 26.7% |  |
| Divorced/widowed | 10.0% | 10.0% |  |
| Education level |  |  | 0.307 |
| 0–8 years | 22.9% | 22.2% |  |
| 9–11 years | 34.1% | 33.4% |  |
| 12+ years | 43.0% | 44.4% |  |

\* p value for comparison between those located and losses to follow-up in 2012 (chi-squared test)

younger individuals, and singles among those interviewed in the follow-up. Nevertheless, differences in these categories compared to the baseline distribution were lower than five percentage points.

The TEI mean was 2380.3 kcal (95% CI 2352.0 − 2408.7 kcal) in men and 1763.4 kcal (95% CI 1740.9–785.8 kcal) in women. The $TCV_{UPP}$ mean in the sample was 752.6 kcal, which represents 37.3% of the TEI (95 CI% 36.8–37.9). Ultra-processed breads were the UPP subcategory with highest %CTEI (9.9%; p25 −75 = 8.2–11.7; data not shown in tables).

Table 2 shows the $TCV_{UPP}$ and total %$CTEI_{UPP}$ according to sociodemographic characteristics. Men showed a higher $TCV_{UPP}$ mean, but the %$CTEI_{UPP}$ was greater in women. Taking into account the other sociodemographic variables, both outcomes showed higher means among singles and younger individuals, and those with higher education level or higher family income. After mutual adjustment, the %$CTEI_{UPP}$ remained higher in women, younger individuals, and those with a better education level. Combined, these three variables explained 48% of the outcome variability (determination coefficient $r^2 = 0.48$).

**Table 2** Distribution of UPP mean energy value and UPP crude and adjusted caloric contribution to TEI (in %) according to sociodemographic variables

|  | N | Total caloric value from UPP (kcal) | | Crude %$CTEI_{UPP}$ (from VCT) | | | Adjusted %$CTEI_{UPP}$ (from VCT)[1] | | |
|---|---|---|---|---|---|---|---|---|---|
|  |  | Mean | 95CI% | Mean | 95CI% | | Mean | 95CI% | |
| Gender |  | p < 0.001* | | p < 0.001* | | | p < 0.001* | | |
| Male | 511 | 829.6 | 809.1 | 850.1 | 34.7 | 34.1 | 35.3 | 34.6 | 34.3 | 34.9 |
| Female | 695 | 694.3 | 679.7 | 708.9 | 39.3 | 38.8 | 39.9 | 39.5 | 39.2 | 39.8 |
| Marital status[†] |  | p < 0.001** | | p <0.001** | | | p = 0.218** | | |
| Married | 805 | 740.2 | 723.0 | 757.4 | 36.9 | 36.6 | 37.4 | 37.5 | 37.2 | 37.8 |
| Single | 261 | 838.7 | 813.1 | 864.3 | 39.5 | 38.6 | 40.4 | 37.4 | 36.7 | 38.1 |
| Divorced/widowed | 128 | 659.6 | 635.9 | 683.4 | 36.1 | 35.2 | 36.9 | 36.9 | 36.4 | 37.5 |
| Age group in years |  | p < 0.001*** | | p < 0.001*** | | | p < 0.001*** | | |
| 20–29 | 288 | 907.2 | 889.2 | 925.3 | 42.2 | 41.4 | 42.9 | 41.5 | 40.9 | 42.2 |
| 30–49 | 601 | 743.7 | 726.9 | 760.4 | 36.8 | 36.4 | 37.2 | 36.9 | 36.6 | 37.3 |
| 50+ | 316 | 612.3 | 595.3 | 629.4 | 33.5 | 32.9 | 34.1 | 34.1 | 33.7 | 34.5 |
| Family income (R$)[†] |  | p < 0.001*** | | p = 0.001*** | | | p = 0.470*** | | |
| 1° tertile (lower) | 416 | 714.8 | 694.1 | 735.5 | 36.1 | 35.5 | 36.7 | 37.4 | 37.0 | 37.8 |
| 2° tertile | 372 | 764.5 | 742.5 | 786.5 | 37.9 | 37.1 | 38.7 | 37.6 | 37.2 | 38.0 |
| 3° tertile (upper) | 387 | 781.3 | 756.1 | 806.5 | 38.2 | 37.2 | 39.2 | 37.2 | 36.6 | 37.8 |
| Education level [†] |  | p < 0.001*** | | p < 0.001*** | | | p < 0.001*** | | |
| 0–8 years | 278 | 796.5 | 781.6 | 811.3 | 30.7 | 29.7 | 31.8 | 32.2 | 31.3 | 33.2 |
| 9–11 years | 394 | 641.6 | 625.3 | 658.0 | 33.2 | 32.3 | 34.0 | 33.7 | 32.9 | 34.4 |
| 12+ years | 531 | 517.8 | 497.9 | 537.7 | 38.8 | 38.3 | 39.3 | 38.6 | 38.4 | 38.9 |
| Total | 1206 | 752.6 | 735.8 | 769.3 | 37.3 | 36.8 | 37.9 | – | – | – |

UPP = ultra-processed food and drink products; %CTEI = percentage of caloric contribution to usual total energy intake (TEI); Kcal = kilocalories

[1] Adjusted predicted means considering mutual adjustment between gender, age, marital status, family income, and education level

[†] Variable with missing < 3%

\* t-test; ** ANOVA heterogeneity test; *** ANOVA test for trend

Marital status and family income were no longer associated with the outcome after adjustment. There was no evidence of collinearity between the variables (average VIF = 1.68). No evidence of effect modification of the associations was identified according to gender, age, or education level ($p$ value for interaction > 0.10 in all cases).

Tables 3, 4 and 5 show the %CTEI of the 12 UPP subcategories according to gender, age and education level, respectively. Table 3 shows that the %CTEI of most UPP subcategories was higher in women, but that the %CTEI of soft drinks was higher in men. Additionally, only the %CTEI of cold cuts and sausages was similar in both genders.

Table 4 shows that younger participants consumed higher amounts of UPP in nine of the 12 subcategories evaluated. Only the %CTEIs for ultra-processed breads and margarines were higher among older participants, while the %CTEI of other UPP was slightly higher among middle-aged individuals.

With regard to education level (Table 5), those with fewer years of schooling had higher %CTEIs for ultra-processed bread, margarine, and juices/teas. Among the most educated participants, there was a greater %CTEIs for fast food, ultra-processed cakes and sweets, packaged cookies and breakfast cereals, and sweetened dairy drinks. The %CTEIs for soft drinks was slightly larger among those with an intermediate education level, while the %CTEIs for the remaining subcategories (cold cuts and sausages, salty snacks, ready-to-eat meals) were not associated with this variable.

## Discussion

This paper evaluated the distribution of UPP consumption according to sociodemographic characteristics in a population-based sample in a middle-income country, using direct 24HR instead of family budget data. Five main findings can be highlighted. First, UPP account for over a third of the calories consumed by adults in Florianópolis, Southern Brazil. Second, although in absolute terms women had a lower UPP consumption, they showed higher %CTEI$_{UPP}$ than men. Third, the inverse relationship between age and total %CTEI$_{UPP}$ was explained by a higher consumption of almost all UPP subcategories among young people, with only the consumption of ultra-processed bread and margarine being higher among older individuals. Fourth, despite the direct relationship between the education level and total %CTEI$_{UPP}$, less educated individuals showed a bigger consumption of only three UPP subcategories (ultra-processed bread, margarine, and juices/teas). Finally, neither income nor marital status influenced UPP consumption.

**Table 3** Distribution of caloric contribution to TEI (%CTEI) from 12 subcategories of UPP according to gender

| | Male | | Female | | P value* |
|---|---|---|---|---|---|
| | Median | p25–p75 | Median | p25–p75 | |
| Breads and accompaniments | | | | | |
| %CTEI ultra-processed breads | 9.5 | 7.8–11.2 | 10.3 | 8.5–12.0 | 0.001 |
| %CTEI cold cuts and sausages | 1.6 | 1.3–2.2 | 1.5 | 1.3–2.1 | 0.184 |
| %CTEI margarine | 1.3 | 0.9–2.9 | 1.5 | 1.0–3.1 | < 0.001 |
| Convenience food products | | | | | |
| %CTEI fast food | 4.0 | 3.0–5.3 | 4.7 | 3.6–5.9 | < 0.001 |
| %CTEI salty snacks | 1.4 | 1.2–1.8 | 1.9 | 1.5–2.5 | < 0.001 |
| %CTEI ready-to-eat meals | 0.6 | 0.3–1.1 | 1.0 | 0.5–1.7 | < 0.001 |
| Cakes, desserts and sweets | | | | | |
| %CTEI ultra-processed cakes and sweets | 5.7 | 4.3–7.2 | 7.1 | 5.7–8.8 | < 0.001 |
| %CTEI packaged cookies and breakfast cereals | 1.1 | 0.9–1.8 | 1.5 | 1.2–2.2 | < 0.001 |
| Sweetened beverages | | | | | |
| %CTEI soft drinks | 2.6 | 1.6–4.3 | 2.1 | 1.5–3.4 | < 0.001 |
| %CTEI juices and teas | 1.1 | 0.8–1.6 | 2.1 | 1.5–3.4 | < 0.001 |
| %CTEI sweetened dairy drinks | 0.7 | 0.5–1.1 | 1.1 | 0.8–1.9 | < 0.001 |
| %CTEI other UPP[†] | 1.0 | 0.8–1.5 | 1.1 | 0.8–1.9 | 0.031 |

UPP = ultra-processed food and drink products; %CTEI = percentage of caloric contribution of UPP to total energy intake (TEI)

* Mann–Whitney test

[†] Four products that did not fit into any other subcategory: ready-to-eat *farofas* (processed manioc flour), *sustacal* (milk-based oral supplement), shake mixtures for weight loss, and ready-to-eat baby food

**Table 4** Distribution of caloric contribution to TEI (%CTEI) from 12 subcategories of UPP according to age group

| | Age group (in years) | | | | | | P value |
|---|---|---|---|---|---|---|---|
| | 20–29 | | 30–49 | | 50+ | | |
| | Median | p25–p75 | Median | p25–p75 | Median | p25–p75 | |
| Breads and accompaniments | | | | | | | |
| %CTEI ultra-processed breads | 9.1 | 7.5–10.9 | 9.9 | 8.2–11.6 | 10.5 | 8.8–12.7 | < 0.001* |
| %CTEI cold cuts and sausages | 1.7 | 1.3–2.3 | 1.7 | 1.4–2.3 | 1.3 | 1.1–1.8 | < 0.001** |
| %CTEI margarine | 1.1 | 0.9–2.9 | 1.5 | 1.0–3.2 | 1.5 | 1.0–2.8 | < 0.001** |
| Convenience food products | | | | | | | |
| %CTEI fast food | 6.0 | 5.0–7.1 | 4.4 | 3.4–5.4 | 3.2 | 2.6–4.0 | < 0.001* |
| %CTEI salty snacks | 1.9 | 1.6–2.6 | 1.6 | 1.2–2.1 | 1.7 | 1.4–2.2 | < 0.001** |
| %CTEI ready-to-eat meals | 1.0 | 0.5–1.7 | 0.8 | 0.4–1.4 | 0.6 | 0.4–1.2 | < 0.001* |
| Cakes, desserts and sweets | | | | | | | |
| %CTEI ultra-processed cakes and sweets | 7.3 | 5.7–8.8 | 6.6 | 5.2–8.2 | 5.6 | 4.4–7.1 | < 0.001* |
| %CTEI packaged cookies and breakfast cereals | 2.0 | 1.6–3.6 | 1.3 | 1.0–1.7 | 1.1 | 1.0–1.5 | < 0.001* |
| Sweetened beverages | | | | | | | |
| %CTEI soft drinks | 3.2 | 2.2–5.1 | 2.3 | 1.6–3.8 | 1.6 | 1.2–2.5 | < 0.001* |
| %CTEI juices and teas | 1.4 | 1.0–2.0 | 1.3 | 1.0–1.8 | 1.3 | 0.9–1.8 | 0.004** |
| %CTEI sweetened dairy drinks | 1.0 | 0.7–2.0 | 0.9 | 0.6–1.5 | 0.8 | 0.6–1.1 | < 0.001* |
| %CTEI other UPP[†] | 1.0 | 0.8–1.6 | 1.1 | 0.9–1.6 | 0.8 | 0.7–1.2 | < 0.001** |

UPP = ultra-processed food and drink products; %CTEI = percentage of caloric contribution of UPP to total energy intake (TEI)

* Kruskal–Wallis test for trend ** Kruskal–Wallis test for heterogeneity

[†] Four products that did not fit into any other subcategory: ready-to-eat *farofas* (processed manioc flour), *sustacal* (milk-based oral supplement), shake mixtures for weight loss, and ready-to-eat baby food

According to the family budget data from a survey held in 2008–09 that used the same classification system as in this article, the percentage of caloric contribution of UPP to family expenditure on food was 25.5% in Brazil (Canella et al. 2014). However, another Brazilian national survey conducted in the same year using 24HR pointed to a %CTEI$_{UPP}$ prevalence of 30.0 (Louzada et al. 2015). These data illustrate the discrepancy in estimates when evaluating food expenditures and actual food consumption. Nevertheless, our results showed a %CTEI$_{UPP}$ that was 23% higher than the 2008–09 national survey. Since the regional economic development level is associated with the nutrition transition process (higher consumption of UPP, obesity, and NCDs in more developed areas) (Popkin et al. 2012), the higher HDI of the target population in this study could explain the higher %CTEI$_{UPP}$ found in our study. On the other hand, family budget surveys in the United States (Martínez Steele et al. 2017), Canada (Moubarac et al. 2014) and the United Kingdom (Moubarac et al. 2013) show that UPP represent at least 60% of food expenditure. Therefore, our results suggest Florianópolis is at an intermediate level of food transition in relation to that observed in regions with low or middle economic development and high-income settings.

UPP have shown to be increasingly present in the daily diet of individuals as a result of product characteristics such as hyperpalatability, durability, affordability, accessibility, practicality, and environmental factors such as those of a physical, economic, political, and/or sociocultural nature (Popkin et al. 2012; Martínez Steele et al. 2017). The impact of UPP consumption on health status has been the subject of extensive discussions between industry and scientists, but the present study data are consistent with the scientific literature, showing that diets with a higher UPP consumption are rich in added sugar, sodium, saturated fats, and trans fats, but poor in dietary fibre (Martínez Steele et al. 2017 — Supplementary Table 1). The increase in the share of UPP is even more worrying in middle-income countries due to the rapid epidemiological transition processes that they are facing (Popkin et al. 2012; WHO 2013). Brazil, for example, is one of the ten countries with highest number of overweight people in the world, and has the third greatest increase in the absolute number of obese people over the last 30 years (20 million), only behind the United States (56 million) and China (42 million) (Stevens et al. 2012). The evidence regarding the impact of an unhealthy diet on NCDs has increased over the past decade, and currently seven food consumption behaviours are among the top 25 risk factors for the global burden of disease, namely low consumption of fruits, whole grains, vegetables, nuts and seeds, omega-3, and fibre, as well as high sodium consumption. Furthermore, four other metabolic disorders directly related to

**Table 5** Distribution of caloric contribution to TEI (%CTEI) from 12 subcategories of UPP according to education level

| | Education level (years of study) | | | | | | P value |
|---|---|---|---|---|---|---|---|
| | 0–8 | | 9–11 | | 12 or more | | |
| | Median | p25–p75 | Median | p25–p75 | Median | p25–p75 | |
| Breads and accompaniments | | | | | | | |
| %CTEI ultra-processed breads | 12.1 | 9.3–13.9 | 10.1 | 7.9–12.2 | 9.6 | 8.1–11.3 | < 0.001* |
| %CTEI cold cuts and sausages | 1.6 | 1.4–1.9 | 1.6 | 1.3–2.2 | 1.6 | 1.3–2.1 | 0.051** |
| %CTEI margarine | 2.2 | 1.5–4.2 | 1.7 | 1.3–3.8 | 1.2 | 0.9–2.7 | < 0.001* |
| Convenience food products | | | | | | | |
| %CTEI fast food | 2.4 | 2.1–2.6 | 3.3 | 2.9–3.8 | 4.9 | 3.9–6.0 | < 0.001* |
| %CTEI salty snacks | 1.8 | 1.5–2.2 | 1.7 | 1.3–2.2 | 1.7 | 1.3–2.3 | 0.571** |
| %CTEI ready-to-eat meals | 0.6 | 0.4–1.2 | 0.9 | 0.4–1.4 | 0.8 | 0.4–1.5 | 0.179** |
| Cakes, desserts and sweets | | | | | | | |
| %CTEI ultra-processed cakes and sweets | 4.6 | 3.7–5.4 | 5.5 | 4.4–7.0 | 7.0 | 5.5–8.6 | < 0.001* |
| %CTEI packaged cookies and breakfast cereals | 1.2 | 1.0–1.4 | 1.1 | 0.8–1.3 | 1.5 | 1.1–2.3 | < 0.001** |
| Sweetened beverages | | | | | | | |
| %CTEI soft drinks | 2.1 | 1.4–3.1 | 2.7 | 1.8–4.4 | 2.3 | 1.5–3.7 | 0.002** |
| %CTEI juices and teas | 1.4 | 1.1–1.9 | 1.3 | 1.1–1.9 | 1.3 | 1.0–1.8 | 0.033** |
| %CTEI sweetened dairy drinks | 0.6 | 0.5–0.7 | 0.7 | 0.5–0.9 | 1.0 | 0.7–1.9 | < 0.001* |
| %CTEI other UPP[†] | 1.1 | 0.9–1.6 | 0.8 | 0.7–1.3 | 1.0 | 0.8–1.5 | < 0.001** |

UPP = ultra-processed food and drink products; %CTEI = percentage of caloric contribution of UPP to total energy intake (TEI)

* Kruskal–Wallis test for trend ** Kruskal–Wallis test for heterogeneity

[†] Four products that did not fit into any other subcategory: ready-to-eat *farofas* (processed manioc flour), *sustacal* (milk-based oral supplement), shake mixtures for weight loss, loss and ready-to-eat baby food

unhealthy dietary habits are also included in that list — high blood pressure, overweight, hyperglycaemia, and hypercholesterolemia (GBD 2015 Risk Factors Collaborators 2016).

According to the scientific literature, women from low and middle-income countries are affected by the nutritional and epidemiological transition sooner than men (Kanter and Caballero 2012). This hypothesis is consistent with the findings of our study, which not only revealed that %CTEI$_{UPP}$ was five percentage points higher among females, but that they also showed a higher consumption of saturated fats (+7.2 g), trans fats (+0.3 g) and added sugar (+10.5 g), as well as a lower fibre intake (−3.1 g), than males (adjusted for age, education level and TEI — unpublished results). Therefore, our results could help to explain the higher prevalence of obesity among Brazilian women (16.9% compared to 12.5% in men) (BRASIL 2010). Among the UPP subcategories, the biggest differences between males and females were for the consumption of ultra-processed cakes and sweets, and juices/teas (1.4 and 1.0 percentage points higher in women respectively). Results of a systematic review published in 2012 regarding global gender disparities in food preferences and obesity pointed in the same direction (Kanter and Caballero 2012), and showed that women have a greater preference for sweet foods (i.e., chocolates, cookies, ice cream), even when they

are also more likely to report intention to consume "healthier" products compared to men.

More important than gender differences were the association between age and UPP consumption, since this variable accounted for 18% of the variability in the %CTEI$_{UPP}$. Not only did younger individuals show a %CTEI$_{UPP}$ 7.4 percentage points higher than older participants, their usual diet also included more trans fats (+0.1 g) and added sugar (+10.2 g), and less fibre (−2.5 g) (results adjusted for gender, education level, and TEI — unpublished results). In absolute terms, the main UPP subcategories responsible for these differences were fast food, ultra-processed cakes and sweets, and soft drinks, which represented a difference of 6.1 percentage points in median %CTEI$_{UPP}$ between the top and bottom age categories. A study conducted in Germany in 2009 also showed the consumption of "highly processed" convenience products was more common among younger people. The authors of that study justified these results because older people have more available time and the necessary skills to prepare their own meals, using fresh food. Additionally, these differences have been explained as a consequence of a cohort effect in younger individuals in the form of early and constant exposure to an increasing variety of UPP and social pressures in adolescents and youth to consume UPP (Gonçalves et al.

2012). Moreover, the lower UPP consumption among older adults could also be due to the increase of NCDs with advancing age (reverse causality). However, previous results from the EpiFloripa study showed no differences in food intake between subjects with or without NCDs (Ozcariz et al. 2015).

Two different indicators of socioeconomic status were used in this study, of which only increased education was associated with higher consumption of UPP. Vlismas and collaborators (Vlismas et al. 2009) concluded in a review of literature that education is the best predictor of socioeconomic habits and health conditions, more so than income or occupation. The loss of the effect of family income after adjustment for other socioeconomic variables can be attributed to collinearity problems, which seems unlikely in our case, considering the low value of VIF and the small magnitude of effect in the crude analysis compared with education level. The influence of education on food intake seems to be linked more to access to food than knowledge of what constitutes a healthy diet. Although individuals with higher education show higher consumption of fruits and vegetables (Brug 2009), they also had the highest consumption of UPP in this study. It is unlikely that this result is a consequence of reporting bias (socially desirable reporting bias) (Vlismas et al. 2009), as a smaller reporting of UPP consumption would have been expected among the more educated. Moreover, a prior publication using data from this cohort revealed that the prevalence of abdominal obesity is inversely associated with schooling (Sousa et al. 2011), suggesting that the type of UPP consumed, the involvement of other dietary components, and the level of physical activity (best educated are more active) (Silva et al. 2013) would act together in determining a better nutritional status among the more educated. This combination of factors explains the increased consumption of saturated fats (2.7 g) among those with higher education, as well as lower consumption of trans fats (−0.4 g) and added sugar (−3.0 g), and increased fibre intake (+2.1 g) compared with less educated (adjusted results for age, gender, and total calories — unpublished data).

Among the subgroups of UPP evaluated, ultra-processed breads constituted the highest caloric participation in the diet, contributing to almost 10% of TEI. Their consumption was most common among women, older individuals, and those less educated. Its high caloric participation in the diet can be explained by regional cultural characteristics (Brug 2009; Levy et al. 2012), which would limit the effect of interventions that seek to reduce their consumption. However, initiatives focused on introducing whole-grain breads with higher concentrations of fibre and monounsaturated and polyunsaturated fats, and less saturated fats, trans fats, and salt, could have beneficial effects on health at the population level (Gonzalez-Anton et al. 2017).

Other UPP with a higher %CTEI$_{UPP}$ were fast food and ultra-processed cakes and sweets, especially among women, younger people, and the better educated. Interventions aiming to reduce the consumption of these foods need to provide not only healthier options, but foods that are also available outside the home and accessible in economic terms. In this regard, restaurants serving homemade foods have been shown as an appropriate option, since they help in maintaining/recovering local food habits, favour fruit and vegetable consumption, have a lower energy density, and improve nutritional status indicators (Mehta and Chang 2008; Larson et al. 2011).

Despite the methodological strengths of this study, some limitations must be recognized. Firstly, the use of two 24HRs does not fully evaluate all variations in the diet, nor the usual consumption. Additionally, this method depends on the participants' memory, which can compromise information quality. As far as possible, these potential limitations were overcome in data collection (i.e., use of the multiple pass method, interviewer training), data entry (use of a specific software for assessing food intake, data entry standardization, use of national food composition tables) and analysis (adjustment for intra- and inter-individual variability). Still, underreporting of food consumption is a frequent source of information bias (Vlismas et al. 2009), and in this study the TEI was on average 12% less than the energy requirements (estimated needs based on the gender, age, weight, and level of physical activity of the participants). However, underreporting was similar in all age, family income, and education level categories, and was only six percentage points higher among men.

In conclusion, UPP accounted for over a third of the calories consumed by adults, which when compared with national data and those of high-income countries, suggests that regional economic development favours the nutritional transition process. The more consumed UPP subcategories were processed breads, fast food, and ultra-processed cakes and sweets. The distribution among sociodemographic characteristics showed that women, young people, and those with a better education level consumed more UPP than their peers, but that associations also varied depending on the UPP subcategories being analysed. This information can be useful when planning public policies that seek to reduce UPP consumption, as well as for the prevention of obesity and various NCDs associated with food intake.

**Author contribution** Author Silvia Giselle Ibarra Ozcariz has participated in the research planning process, field and data entry supervision,

conducted the statistical analyses, written, and led this article. Katia Jakovljevic Pudla has participated in the study design and data entry and contributed in revising this article. Ana Paula Bortoletto Martins has contributed to classifying the food groups and revising this article. Marco Peres led the EpiFloripa research and contributed to the revision of this article. David González-Chica contributed to the study design, statistical analysis, writing, and revision of the article.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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