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# Association between the consumption of sugar-sweetened beverages and food markers: National Dietary Survey 2008-2009

## Associação entre o consumo de bebidas adoçadas e marcadores da alimentação: Inquérito Nacional de Alimentação 2008-2009

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**Abstract** *We aimed to analyze the association between sugar-sweetened beverage (SSB) consumption with healthy food markers (HFM) and unhealthy food markers (UFM) as well as their impact on these markers in the Brazilian population's diet. Food consumption during two nonconsecutive days of food records of individuals aged ten years or over were investigated in the National Dietary Survey 2008-2009 (n = 32,900) and the caloric contributions of HFM and UFM were distributed according to the categories of SSB consumption. Multiple linear regression was applied to analyze the associations between the consumption of SSB and the impact of a 50% reduction in portion size and dietary markers. The contribution of energy from HFM was higher among individuals who did not consume SSB. A 50% reduction in the average portion of SSB in the population would imply a 6% decrease in energy contribution to the diet and 12% decrease in total energy from added sugar. It would increase the consumption of HFM and dietary fiber by 7g and 4g, respectively. A 50% reduction in SSB serving size is a strategy that could improve the quality of the diet, increase the consumption of HFM and fiber and reduce the consumption of sugar and UFM.*

**Key words** *Eating, Food and beverages, Diet survey, Healthy diet*

**Resumo** *Analisar a associação entre o consumo de bebidas adoçadas (BA) e marcadores da alimentação saudável (MAS) e não saudável (MANS), bem como seu impacto sobre esses marcadores na dieta da população brasileira. Os dados de consumo alimentar foram analisados por meio de registros alimentares de dois dias não consecutivos em indivíduos com 10 anos ou mais de idade investigados no Inquérito Nacional de Alimentação (INA) de 2008-2009 (n = 32.900). As BA, as contribuições calóricas dos MAS e MANS foram distribuídas de acordo com as categorias de consumo das BA. A regressão linear múltipla foi aplicada para analisar associações entre o consumo de BA e o impacto de uma redução de 50% no tamanho da porção e marcadores da alimentação. A contribuição da energia dos MAS foi maior entre os indivíduos que não consumiam BA. A redução de 50% na porção média das BA na população implicaria uma diminuição de 6% na contribuição de energia da dieta, de 12% na energia total do açúcar de adição e teria um aumento no consumo de MAS e fibra alimentar em 7g e 4g, respectivamente. A redução de 50% no tamanho da porção das BA seria uma estratégia para melhorar a qualidade da dieta, aumentar o consumo de MAS e fibra e reduzir o consumo de açúcar e MANS.*

**Palavras-chave** *Ingestão de alimentos, Alimentos e bebidas, Inquéritos sobre dietas, Dieta saudável*

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## Introduction

It has been observed that high levels of consumption of ultra-processed foods of low nutritional value, containing high levels of saturated and trans fats, sugars, and sodium, persists in the Brazilian population[1,2]. Moreover, there has been an increase in food consumption away from home, mainly in urban areas[3,4], with traditional homemade foods often being replaced by quick meals[5].

These changes in the consumption patterns in Brazil as a whole demonstrate a significant reduction in the consumption of foods that are indicators of healthy eating, such as a decrease in the consumption of beans between 2008 and 2017 from 73% to 60%, decreases in the consumption of food with high nutritional value and traditional Brazilian staple food, and reductions in the consumption of vegetables and fruits. The consumption of these foods remains below the recommendations[6].

On the other hand, data from national surveys have demonstrated a significant increase in the consumption of unhealthy foods, such as fruit juices (33%), soft drinks (15%), cakes (11%), cookies (10%), salted fried foods (10%) and sweets (4%). In addition, the consumption of sandwiches increased from 8% to 14% in the National Dietary Survey[6]. Additionally, Claro et al.[7], using data from the National Health Survey, called attention to the population's high consumption of meat with visible fat, soft drinks, and sweets.

Low diet quality is associated with the development and mortality of chronic noncommunicable diseases[8]. Specifically, regarding sugar-sweetened beverages (SSB), international studies have described their consumption as being related to the risk of developing diabetes mellitus, hypertension, metabolic syndrome, and other health problems[9-11]. Moreover, an increased intake of vegetables, fish, fruits, nuts, and whole grains decreases the risk of all-cause mortality. Increasing the intake of SSB increased the risk of all-cause mortality by 7% among short follow-up studies conducted in the United States; for other studies, the findings were not conclusive[12].

In general, SSB has low nutritional value, is low in fiber and high in energy content, and provides low satiety[13-16]. It is speculated that Brazilians, in addition to their excessive consumption of SSB[17-20], have replaced the consumption of soft drinks with similar beverages of low cost and with natural fruit juices[21], remembering that even pure fruit juices (100% fruit) contain high levels of simple sugars in the form of fructose and have a low fiber content[16]. Moreover, there are gaps concerning the association between the consumption of SSB and dietary markers and the impact of these same marker son the Brazilian population's diet.

Therefore, the study objective was to analyze diet quality based on healthy food markers (HFM) and unhealthy food markers (UFM) according to SSB consumption in the Brazilian population.

## Methods

Data from the 2008-2009 First National Dietary Survey were used in this study. It was carried out as a module of the 2008-2009 Household Budget Survey (HBS), developed by the Brazilian Institute of Geography and Statistics (IBGE, *Instituto Brasileiro de Geografia e Estatística*). The household selection was based on a two-stage cluster sampling design. In the first stage, the census sectors were stratified geographically and according to the income of the heads of the families. The census sectors were selected by probabilistic sampling proportional to the number of households in each sector, the demographic basis of the 2000 Demographic Census. In the second stage, permanent households were selected by simple random sampling without replacement in each census sector. A subsample of 24.3% of these households, 13,569 families, was selected to provide the food intake data. This subsample included all residents ten years or over, totaling 34,003 individuals. In the present analysis, the individuals who filled out the two days of food records, totaling 32,900 individuals, were assessed after excluding 1,103 who reported only one day of food records[17].

Data on food intake were obtained through food records from two nonconsecutive days. It instructed individuals to register the consumption of all foods and beverages: type of preparation amounts with homemade measurements, time, and place of meals (at home or away from home). A question on the use of sugar and/or sweetener to sweeten food and beverages was included, where a fixed percentage of sugar was added: 10% for those who answered they used only sugar and 5% for those who answered they used sugar and/or other sweetener, following the methodology applied in the Household Budget Survey.

The quantities of consumed food in household measures were converted into grams or milliliters based on the Table of Referenced Mea-

sures for Foods Consumed in Brazil of the POF 2008-2009[22]. In addition, tables were specifically compiled to analyze the data against the national Table of Nutritional Composition of Foods Consumed[23] to estimate the total intake (grams and kcal) of macronutrients, nutrients, sugar, and energy. Details of the sampling and food intake assessment were published by the IBGE[17].

The following food markers were considered: i) healthy food markers (HFM): legumes, vegetables, and fruits and their respective preparations and dietary fiber density; and ii) unhealthy food markers (UFM): sweets, cakes and cookies, crackers, snacks, fast food and added sugar[24,25]. The sugar-sweetened beverages (SSB) comprised fruit drinks, fruit juices, soft drinks, and milk-based sugary drinks[26]. The sociodemographic variables considered in this study were gender, age classified into three age groups: adolescents (from 10 to 19), adults (20 to 59) and elderly (60 and over), *per capita* family income (R$), level of schooling (years of study), household area (urban or rural) and macroregions of the country (North, Northeast, Midwest, Southeast, and South).

The proportions of energy from HFM, UFM, added sugar and dietary fiber density (g/1,000 kcal) were calculated. Means and 95% confidence intervals were estimated for food consumption and nutrient intake based on the mean of two days of records according to the categories of sociodemographic variables. The most frequently consumed food groups were classified into SSB, HFM, and UFM according to sex and age groups.

Individuals were categorized as nonconsumers or consumers of SSB. The consumers of SSB were ranked into tertiles of energy (lower, middle, and upper) obtained from these beverages. Means and 95% confidence intervals were estimated for the consumption of diet quality markers adjusted for total energy, country regions, household area, income, and level of schooling according to the categories of consumption of SSB.

To analyze how the consumption of SSB was associated with the quality of the diet, multivariate linear regression models were applied, where the consumption of SSB (mL) was considered exposure and the consumption of dietary quality markers [added sugar (% kcal), dietary fiber (g), HFM and UFM (g)] were considered the outcome. The models were adjusted for total energy consumption (except for % energy from added sugar), country regions, household area, income, and education. To assess the effect of SSB consumption on the quality of the diet, we estimated the mean change in the consumption of the diet quality markers with a 50% reduction in the consumption of SSB for each age group and gender. The actual average was considered SSB consumption, and a hypothetical average was considered a 50% reduction in consumption for each age group and gender. This hypothetical consumption average was multiplied by the regression coefficients estimated in the specific regression models for each marker of diet quality. Based on the standard errors of the regression coefficients multiplied by the observed difference, 95% confidence intervals were obtained.

All of the estimates were calculated using the Statistical Analysis software System (SAS), a free and online software version of Demand for Academics, taking into account expansion factors of the 2008-2009 HBS and the complexity of the sample design and considering that the mean difference was statistically significant when the 95% CI did not overlap.

The Ethics Committee approved this Institute of Social Medicine research by the University of the State of Rio de Janeiro and its research protocol (CAAE 0011.0.259.000-11).

## Results

The SSB contributed, on average, approximately 8% of the total energy intake, with no difference between the sexes. The energy contribution of SSB consumption was higher among individuals living in urban areas and lower among the elderly. The energy contribution of added sugar was higher among females, adolescents, and individuals residing in urban areas. A more significant percentage contribution of UFM was observed among females and adolescents. In contrast, the percentage contribution of HFM was higher in males, the elderly, and residents of rural areas. The dietary fiber density was higher among the elderly and residents of rural areas and lower in the north region (Table 1). Adolescent and adult males consumed more beans and legumes than adolescent and adult females. Adult and older women consumed more fruits than males in the same group. Except for sweets, there was no difference in UFM and SSB consumption among adolescents by gender (Table 2).

HFM consumption was higher among adults and adolescents who did not consume SSB. The dietary fiber density was higher among female adolescents who were nonconsumers of SSB and adults of both genders. As expected, there was a direct association between the energy contribu-

tion of added sugar and the consumption of SSB among adolescents and adults of both sexes (Table 3).

A reduction in SSB consumption by 50% would decrease energy intake by 182 kcal and 128 kcal for male and female adolescents, respectively, and 135 kcal and 126 kcal for male and female adults, respectively. On average, a reduction in SSB consumption would have an impact of 2.4% and 1.9% reduction in total energy from added sugar among female and male adolescents, respectively, and an increase of 19g and 26g of HFM and 0.9 g and 1.2g of dietary fiber for these individuals, respectively. For UFM, a reduction in SSB would imply a decrease, respectively, of 3.4g and 2.9g for male adults and adolescents, and 2.5g and 2.6g for female adults and adolescents. We observed that consumption of UFM would increase among elderly males with a reduction in the consumption of SSB (Table 4).

## Discussion

SSB consumption was positively associated with UFM and added sugar consumption and inversely related to the HFM of the Brazilian population's diet. Beans and legumes were the main foods in the HFM, and juices were consumed at higher levels than soft drinks in the population. We observed that a partial reduction (50%) of the average consumption of SSB would result in an increase in HFM in the population's diet and a decrease in total energy consumption by 116 kcal or more among adults and adolescents, being close to 200 kcal in male adolescents. These results are similar to those from other international studies, which observed an association between a low-quality diet and the consumption of SSB by adolescents, adults, and the elderly[27-31].

According to a study conducted in the United States, the quality of the diet was lowest among women who consumed SSB[27]. Leung et al.[28] found

**Table 1**. Mean and 95% confidence interval (95%CI) of energy intake, energy from sugar-sweetened beverages (SSB)*, added sugar, unhealthy food markers (UFM)†, healthy food markers (HFM)‡ and dietary fiber density according to sociodemographic characteristics of the Brazilian population. First National Dietary Survey 2008-2009 (n = 32,900).

| Variables | n | Energy | | | | | | | | | | Dietary fiber (g/1.000 kcal) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total (kcal) | | SSB (%) | | Added sugar (%) | | UFM (%) | | HFM (%) | | | |
| | | Mean 95%IC | | | | | | | | | | | |
| Total | 32,900 | 1,913 | 1,893; 1,933 | 9.9 | 9.7; 10.1 | 13.4 | 13.2; 13.6 | 13.3 | 12.9; 13.6 | 14.7 | 14.4; 15.0 | 11.2 | 11.0; 11.3 |
| Sex | | | | | | | | | | | | | |
| Male | 15,160 | 2,120 | 2,093; 2,148 | 7.6 | 7.3; 7.9 | 12.6 | 12.3; 12.9 | 12.2 | 11.7; 12.6 | 15.4 | 15.0; 15.8 | 11.3 | 11.1; 11.5 |
| Female | 17,740 | 1,721 | 1,701; 1,741 | 8.0 | 7.7; 8.3 | 14.1 | 13.4; 14.4 | 14.2 | 13.8; 14.7 | 14.1 | 13.8; 14.4 | 11.1 | 10.9; 11.2 |
| Age Range | | | | | | | | | | | | | |
| Adolescent | 7,342 | 2,054 | 2,017; 2,091 | 9.7 | 9.2; 10.1 | 15.1 | 14.7; 15.5 | 17.9 | 17.2; 18.7 | 13.4 | 12.9; 13.9 | 10.4 | 10.2; 10.6 |
| Adult | 21,354 | 1,924 | 1,902; 1,947 | 7.8 | 7.6; 8.1 | 13.3 | 13.0; 13.5 | 12.3 | 11.8; 12.7 | 14.8 | 14.4; 15.1 | 11.2 | 11.1; 11.4 |
| Elderly | 4,204 | 1,632 | 1,597; 1,667 | 4.9 | 4.4; 5.4 | 11.3 | 10.8; 11.8 | 10.6 | 9.8; 11.4 | 16.7 | 16.0; 17.4 | 12.2 | 11.9; 12.6 |
| Region of the country | | | | | | | | | | | | | |
| North | 5,128 | 2,101 | 2,046; 2,158 | 7.0 | 6.6; 7.5 | 11.5 | 11.1; 11.9 | 10.1 | 9.3; 10.8 | 13.6 | 12.8; 14.3 | 10.3 | 10.1; 10.6 |
| Northeast | 12,152 | 1,884 | 1,853; 1,915 | 6.7 | 6.4; 7.0 | 12.8 | 12.4; 13.1 | 14.0 | 13.5; 14.6 | 14.4 | 13.9; 14.9 | 11.0 | 10.8; 11.2 |
| Southeast | 7,048 | 1,909 | 1,872; 1,946 | 8.4 | 7.9; 8.9 | 13.7 | 13.3; 14.1 | 12.9 | 12.2; 13.6 | 15.8 | 15.3; 16.3 | 11.2 | 11.0; 11.4 |
| South | 4,061 | 1,896 | 1,849; 1,943 | 8.5 | 7.9; 9.0 | 14.9 | 14.4; 15.4 | 14.6 | 13.8; 15.5 | 12.5 | 12.0; 13.1 | 11.8 | 11.4; 12.2 |
| Midwest | 4,511 | 1,884 | 1,829; 1,940 | 8.3 | 7.7; 8.8 | 12.7 | 12.3; 13.2 | 12.8 | 12.3; 13.2 | 15.5 | 14.8; 16.3 | 11.2 | 10.9; 11.5 |
| Household area | | | | | | | | | | | | | |
| Urban | 24,852 | 1,910 | 1,887; 1,932 | 8.3 | 8.1; 8.6 | 13.6 | 13.4; 13.9 | 13.4 | 13.0; 13.9 | 14.2 | 13.8; 14.5 | 10.9 | 10.8; 11.1 |
| Rural | 8,048 | 1,930 | 1,889; 1,971 | 5.3 | 4.9; 5.7 | 12.1 | 11.7; 12.6 | 12.4 | 11.7; 13.1 | 17.6 | 16.9; 18.3 | 12.4 | 12.0; 12.7 |

* SSB: fruit drinks, fruit juices, soft drinks and milk-based sugary drinks were considered. † UFM: sweets, cakes and cookies, crackers, snacks and fast food were considered. ‡ HFM: legumes, vegetables, fruits and their respective preparations were considered.

Source: Authors.

**Table 2.** Frequency (%) and 95% confidence interval (95% CI) of healthy and unhealthy food markers and sugar-sweetened beverages according to sex and age. First National Dietary Survey 2008-2009 (n = 32,900).

| | Total | Adolescents* | | Adults* | | Elderly* | |
|---|---|---|---|---|---|---|---|
| | | Male | Female | Male | Female | Male | Female |
| | % (95%CI) | % (95%CI) | | % (95%CI) | | % (95%CI) | |
| Healthy Food Markers | | | | | | | |
| Beans and legumes | 74,0 (72,8; 75,1) | 76,4 (74,0; 78,7) | 70,1 (67,5; 72,6) | 78,5 (77,1; 80,0) | 70,7 (69,2; 72,2) | 75,2 (71,6; 78,7) | 70,8 (67,5; 74,1) |
| Vegetables | 41,6 (40,3; 42,8) | 26,1 (23,6; 28,6) | 30,6 (28,0; 33,2) | 42,8 (41,1; 44,5) | 44,6 (43,0; 46,3) | 49,0 (45,2; 52,8) | 54,1 (50,7; 57,5) |
| Fruits | 33,5 (32,3; 34,7) | 25,2 (22,6; 27,8) | 30,3 (27,6; 32,5) | 29,0 (27,4; 30,7) | 37,3 (35,5; 39,0) | 38,0 (34,3; 41,7) | 49,0 (45,6; 52,4) |
| Unhealthy Food Markers | | | | | | | |
| Sweets | 26,7 (25,7; 27,8) | 30,0 (27,7; 32,4) | 36,2 (33,6; 38,9) | 23,0 (21,6; 24,4) | 28,0 (26,6; 29,5) | 20,2 (17,5; 22,9) | 23,5 (20,9; 26,1) |
| Cakes and cookies | 25,1 (24,1; 26,1) | 30,3 (27,7; 33,0) | 33,6 (30,9; 36,3) | 19,7 (18,3; 21,0) | 26,4 (25,0; 27,8) | 22,2 (19,0; 25,4) | 25,0 (22,0; 28,1) |
| Crackers | 15,1 (14,3; 15,8) | 12,6 (10,8; 14,4) | 16,5 (14,2; 18,9) | 11,6 (10,5; 12,6) | 17,7 (16,5; 18,9) | 14,3 (11,5; 17,1) | 19,9 (17,2; 22,5) |
| Snacks and fast food | 23,1 (21,0; 23,2) | 25,8 (23,2; 28,5) | 30,9 (28,3; 33,6) | 23,8 (22,3; 25,4) | 21,0 (19,7; 22,3) | 11,8 (9,0; 14,7) | 10,2 (8,0; 12,4) |
| Sugar-sweetened beverages | | | | | | | |
| Soft drinks | 24,7 (23,5; 25,9) | 29,1 (26,2; 32,0) | 31,0 (28,4; 33,5) | 27,2 (25,5; 28,9) | 23,4 (21,9; 25,0) | 14,9 (11,6; 18,2) | 12,7 (10,1; 15,4) |
| Juices | 38,4 (37,1; 39,6) | 39,7 (36,9; 42,4) | 41,2 (38,4; 43,9) | 39,0 (37,3; 40,8) | 39,8 (38,3; 41,3) | 31,4 (27,6; 35,2) | 28,9 (25,7; 32,1) |
| Flavored dairy drinks | 7,6 (6,9; 8,3) | 15,7 (13,1; 18,3) | 13,6 (11,5; 15,7) | 5,8 (4,8; 6,8) | 6,8 (6,0; 7,7) | 2,1 (1,1; 3,1) | 2,7 (1,3; 4,2) |

*Adolescents: (10 to 19 years), adults (20 to 59 years), elderly (≥ 60 years).

Source: Authors.

an inverse association between consuming vegetables, fruits, beans, whole grains, and SSB intake in American adolescents. The consumption of dietary fiber was also inversely associated with SSB consumption among Irish adults[31]. Analyses carried out with data obtained through the *National Health and Nutrition Examination Survey* (NHANES) from 1999 to 2016 showed an association of SSB consumption with a low intake of fruits, vegetables, and whole grains among young Americans[29] and with higher levels of total sugar and added sugar in all age groups[30]. In addition, the quality of the diet evaluated according to the *Healthy Eating Index 2015* was higher among nonconsumers of SSB[30].

In addition, a study conducted by AN in 2015[32] with American adults found that high consumption of SSB was associated with lower consumption of fruits. According to Hendrick et al.[33], when evaluating the changes in the diet of American adults after a reduction in the consumption of SSB, the authors observed that the group with the lowest consumption of these beverages had the highest consumption of vegetables when compared to the control group.

Other than our findings, no other publications have correlated the consumption of dietary food markers with SSB intake in a representative sample of the Brazilian population. However, national studies carried out with data from population-based studies allowed the establishment of this association, albeit indirectly, by observing the high consumption of SSB in recent years, in parallel with the low consumption of fruits and vegetables, both in adults and adolescents[17,34]. Additionally, diet items recognized as UFM, such as sweets, cookies, deep-fried and baked snacks, and soft drinks and juices, appeared among Brazil's most often consumed items, mainly by adolescents[17,19,35,20].

**Table 3.** Mean* and 95% confidence interval (95%CI) of the percentage contribution of energy from unhealthy food markers (UFM)†, added sugar, healthy food markers (HFM)‡ and dietary fiber density according to energy consumption from sugar-sweetened beverages. First National Dietary Survey 2008-2009 (n = 32,900).

| Males | Quality of diet | Energy from sugar-sweetened beverages (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Non consumers | | 1nd tertile | | 2nd tertile | | 3rd tertile | |
| | | Mean | 95%CI | Mean | 95%CI | Mean | 95%CI | Mean | 95%IC |
| Adolescents | | **(n = 1,418)** | | **(n = 739)** | | **(n = 719)** | | **(n = 716)** | |
| | Cutoff points of tertiles | **0%** | | **≤ 9.0%** | | **> 9.0% - ≤ 16.5%** | | **> 16.5%** | |
| | Energy from UFM (%) | 13.2 | 11.9; 14.5 | 18.3 | 16.1; 20.6 | 18.4 | 16.1; 20.7 | 14.9 | 13.4; 16.5 |
| | Energy from added sugar (%) | 9.40 | 8.70; 10.0 | 13.7 | 13.0; 14.5 | 15.8 | 15.0; 16.5 | 19.8 | 18.9; 20.7 |
| | Energy from HFM (%) | 17.1 | 15.9; 18.2 | 14.6 | 13.4; 15.8 | 13.1 | 12.0; 14.2 | 11.1 | 10.1; 12.0 |
| | Dietary fiber (g/1,000 kcal) | 12.1 | 11.6; 12.6 | 11.1 | 10.6; 11.7 | 10.1 | 9.60; 10.6 | 9.40 | 8.90; 9.80 |
| Adults | | **(n = 4,308)** | | **(n = 1,772)** | | **(n = 1,802)** | | **(n = 1,749)** | |
| | Cutoff points of tertiles | **0%** | | **≤ 8.1%** | | **> 8.1% - ≤ 14.4%** | | **> 14.4%** | |
| | Energy from UFM (%) | 8.40 | 7.60; 9.10 | 11.2 | 9.90; 12.6 | 10.5 | 9.30; 11.8 | 9.80 | 8.70; 11.0 |
| | Energy from added sugar (%) | 7.80 | 7.50; 8.20 | 11.0 | 10.5; 11.6 | 14.3 | 13.7; 14.8 | 18.4 | 17.6; 19.2 |
| | Energy from HFM (%) | 18.2 | 17.5; 18.8 | 16.2 | 15.4; 17.1 | 14.1 | 13.4; 14.8 | 12.4 | 11.6; 13.2 |
| | Dietary fiber (g/1,000 kcal) | 12.7 | 12.3; 13.1 | 11.7 | 11.3; 12.1 | 10.9 | 10.5; 11.3 | 10.1 | 9.60; 10.5 |
| Elderly | | **(n = 1,207)** | | **(n = 259)** | | **(n = 243)** | | **(n = 228)** | |
| | Cutoff points of tertiles | **0%** | | **≤ 7.5%** | | **> 7.5% - ≤ 13.5%** | | **> 13.5%** | |
| | Energy from UFM (%) | 9.60 | 8.40; 10.8 | 10.8 | 6.80; 14.9 | 7.60 | 5.60; 9.50 | 9.0 | 6.20; 11.8 |
| | Energy from added sugar (%) | 8.60 | 7.90; 9.30 | 11.1 | 9.70; 12.5 | 12.8 | 11.2; 14.4 | 17.0 | 15.1; 18.9 |
| | Energy from HFM (%) | 18.0 | 16.8; 19.1 | 16.1 | 14.1; 18.1 | 14.9 | 12.9; 16.9 | 12.6 | 10.0; 15.3 |
| | Dietary fiber (g/1,000 kcal) | 12.6 | 12.1; 13.2 | 11.1 | 10.2; 12.0 | 11.2 | 10.0; 12.4 | 10.5 | 8.90; 12.1 |
| **Females** | **Quality of diet** | **Non consumers** | | **1st tertile** | | **2nd tertile** | | **3rd tertile** | |
| | | **Mean** | **95%CI** | **Mean** | **95%CI** | **Mean** | **95%CI** | **Mean** | **95%CI** |
| | | **(n = 1,356)** | | **(n = 813)** | | **(n = 806)** | | **(n = 775)** | |
| Adolescents | Cutoff points of tertiles | **0%** | | **≤ 9.3%** | | **> 9.3% - ≤ 17.0%** | | **> 17.0%** | |
| | Energy from UFM (%) | 16.0 | 14.6; 17.3 | 21.1 | 19.0; 23.2 | 20.9 | 18.3; 23.4 | 19.5 | 17.6; 21.5 |
| | Energy from added sugar (%) | 10.5 | 9.8; 11.2 | 15.1 | 14.1; 16.1 | 17.6 | 16.7; 18.6 | 21.5 | 20.5; 22.4 |
| | Energy from HFM (%) | 15.5 | 14.5; 16.6 | 12.1 | 11.0; 13.2 | 11.4 | 10.3; 12.5 | 8.80 | 7.6; 10.0 |
| | Dietary fiber (g/1,000 kcal) | 11.3 | 10.9; 11.8 | 10.2 | 9.7; 10.7 | 9.50 | 9.0; 10.0 | 8.70 | 8.2; 9.2 |
| Adults | | **(n = 5,249)** | | **(n = 2,144)** | | **(n = 2,167)** | | **(n = 2,163)** | |
| | Cutoff points of tertiles | **0%** | | **≤ 8.9%** | | **> 8.9% - ≤ 15.7%** | | **> 15.7%** | |
| | Energy from UFM (%) | 12.6 | 11.9; 13.3 | 16.5 | 15.1; 17.9 | 14.0 | 12.9; 15.2 | 13.5 | 12.5; 14.5 |
| | Energy from added sugar (%) | 10.2 | 9.8; 10.6 | 13.8 | 13.1; 14.4 | 15.7 | 15.1; 16.3 | 19.5 | 18.8; 20.2 |
| | Energy from HFM (%) | 16.2 | 15.7; 16.8 | 13.6 | 12.9; 14.2 | 12.2 | 11.6; 12.9 | 10.9 | 10.2; 11.6 |
| | Dietary fiber (g/1,000 kcal) | 11.9 | 11.7; 12.2 | 10.9 | 10.5; 11.2 | 9.90 | 9.6; 10.2 | 9.70 | 9.4; 10.0 |
| Elderly | | **(n = 1,375)** | | **(n = 271)** | | **(n = 318)** | | **(n = 303)** | |
| | Cutoff points of tertiles | **0%** | | **≤ 7.2%** | | **> 7.2% - ≤ 13.7%** | | **> 13.7%** | |
| | Energy from UFM (%) | 12.2 | 11.1; 13.3 | 15.0 | 11.1; 18.8 | 11.7 | 9.0; 13.5 | 12.4 | 10.2; 14.6 |
| | Energy from added sugar (%) | 9.50 | 8.7; 10.2 | 12.7 | 11.2; 14.1 | 12.5 | 11.1; 13.9 | 17.6 | 16.2; 19.0 |
| | Energy from HFM (%) | 17.1 | 15.9; 18.2 | 14.9 | 13.0; 16.7 | 15.5 | 13.6; 17.4 | 11.5 | 9.0; 13.5 |
| | Dietary fiber (g/1,000 kcal) | 12.1 | 11.6; 12.5 | 1 1.4 | 10.5; 12.3 | 11.4 | 10.6; 12.2 | 10.0 | 9.0; 10.8 |

* The models were estimated for each age group and sex and adjusted for total energy intake. Regions of the country (North, Northeast, Southeast, South, and Midwest). Household area (urban or rural). *Per capita* household income (R$) and schooling (years of study). † UFM: unhealthy food markers. ‡ HFM: healthy food markers.

Source: Authors.

**Table 4.** The estimated effect of the hypothetical reduction in 50% sugar-sweetened beverage (SSB) consumption on diet quality. First National Dietary Survey 2008-2009 (n = 32,900).

| Mean consumption of SSB (ml) | | Changes in diet quality with 50% of SSB reduction * | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Energy (kcal) | | Energy from added sugar (%) | | Unhealthy food markers (g) | | Healthy food markers (g) | | Dietary fiber (g) | |
| | | †Diff | 95%CI | | | | | †Diff | 95%CI | | |
| Adolescents (10 to 19 years) | | | | | | | | | | | |
| Male | 354 | -182 | -181.95;-181.65 | -1.9 | -1.94;-1.94 | -2.9 | -2,97;-2.91 | 26 | 25.62;25.72 | 1.2 | 1.16;1.17 |
| Female | 317 | -128 | -128.27;-128.02 | -2.4 | -2.35;-2.35 | - 2.5 | -2.56;-2.50 | 19 | 19.35;19.42 | 0.9 | 0.88;0.89 |
| Adults (20 to 59 years) | | | | | | | | | | | |
| Male | 288 | -135 | -135.4;-135.19 | -1.8 | -1.76;-1.76 | -3.4 | -3.41;-3.37 | 25 | 24.58;24.64 | 0.9 | 0.92;0.92 |
| Female | 235 | -116 | -116.0;-115.83 | -1.6 | -1.58;-1.58 | -2.6 | -2.63;-2.58 | 21 | 20.68;20.74 | 0.8 | 0.82;0.83 |
| Elderly (≥ 60 years) | | | | | | | | | | | |
| Male | 151 | -60 | -59.75;-59.32 | -1.0 | -0.96;-0.96 | 1.8 | 1.77; 1.84 | 21 | 21.38;21.58 | 0.5 | 0.51;0.52 |
| Female | 138 | -63 | -62.96;-62.57 | -0.9 | -0.91;-0.90 | -0.5 | -0.50;-0.44 | 12 | 12.08;12.24 | 0.4 | 0.38 0.38 |

* Change in diet quality was estimated by multiple linear regression. SSB consumption was the independent variable, and the consumption of markers of diet quality was the dependent variable. The models were estimated for each age group and gender and adjusted by the regions of the country (North, Northeast, Southeast, South, and Midwest), household area (urban or rural), *per capita* household income (R$), schooling (years of study) and total energy intake (this last variable was not considered in the model analyzed for the percentage of energy from added sugar). † The mean difference in food consumption and diet quality markers between real sugar-sweetened beverage consumption and the hypothetical reduction of 50% according to age group and gender. The mean difference was multiplied by the regression coefficients estimated in the specific regression models for each marker of diet quality. The regression coefficients' standard errors were used to estimate the 95% confidence intervals.

Source: Authors.

The increase in SSB consumption observed in this study is consistent with a trend toward an increase in total energy intake and added sugar shown in the existing scientific literature[9,27,28]. The estimated percentage of energy from added sugar was higher than 17% for both genders and among all age groups in the 3rd tertile of SSB consumers. According to Leung et al.[28], there was a direct association between the consumption of SSB and total energy consumption. Moreover, the study conducted by Gamba et al.[27], based on NHANES data between 1999 and 2006, evaluated 1,154 pregnant women and showed that the additional consumption of SSB was associated with an increase of 124 calories per day in the diet. A cross-sectional study by Bilici et al.[36] with 352 adults aged between 18 and 58 years verified that SSB consumption contributed 134 calories per day to the total caloric intake. In a systematic review, Daniels and Popkin[37], to compare the effects of consuming water vs. SSB on energy intake, found an increase of 7.8% in the total energy when consuming these drinks instead of water. The present study also found a significant 10% reduction in calories in the Brazilian population's diet due to a hypothetical decrease of SSB consumption by 50%.

Comparing the data obtained from the National Dietary Survey between 2008/2009 and 2017/2018, there was a reduction in the consumption of soft drinks during this period. The data also showed a significant increase in the consumption of raw salads and sandwiches and, to a lesser extent, in the consumption of juices by the Brazilian population. However, the reduction in the consumption of soft drinks can be considered small, from 23% to 15%, and the per capita consumption of 28 ml/day in the decade between the studies. It is noteworthy that this reduction was more significant in the lowest quartile of income, from 31% to 18%. It was smaller in the first quartile of income, from 14% to 12%, showing that even in a favorable scenario for reducing consumption of these beverages individuals with lower incomes remain more vulnerable to consuming foods that are markers of unhealthy eating. Furthermore, the consumption of SSB was related to high average energy, saturated and trans fat, and reduced fiber[6], suggesting that the consumption of SSB can contribute to an increased consumption of UFM.

The scientific literature shows that one of the reasons for such an increase in the total dietary energy, in addition to the fact that these bever-

ages provide additional calories to the diet, is the incomplete energy compensation at meals and the low satiety provided by these beverages when compared to solid foods[38]. If SSB are used as energy sources, other studies have also pointed out the lack of or absence of nutrients and dietary fiber[13,15], which generally characterizes these beverages as just energy sources.

The SSB composition is predominantly based on free sugars[39]. There is evidence of their contribution to the development of overweight and comorbidities[40,41], such as diabetes mellitus, metabolic syndrome, and cardiovascular diseases[9,10,42]. Recently, a population-based study on adults from ten countries in Europe found a direct association between soft drink consumption and the risk of premature death, which increased among individuals with a body mass index 30 or higher[43].

The World Health Organization (WHO) recommends that energy intake from free sugars should not exceed 10%. It emphasizes that sugar limited to 5% of dietary consumption could provide even more significant health benefits. The free sugars mentioned in this recommendation include all types of sugars, those added and those naturally present in food and drinks[26]. Added sugar in this study refers to sugars and syrups added to foods during their processing and/or the preparation of foods and beverages, not including naturally occurring ones, such as monosaccharides and disaccharides (milk lactose and fruit fructose)[44]. Our results may be underestimating the observed levels of added sugar in this population.

In this context, our results revealed that just over half of the Brazilian female population consumed at least one SSB on one of the days of the food record and that SSB contributed, on average, to approximately 8% of their total energy intake. This indicates that the added sugar from these beverages would exceed the WHO recommendations of 5% among SSB consumers and almost reached the 10% recommendation. Similar results were found in a US population[45,46], where approximately half of the population consumed SSB on any given day. However, the average caloric contribution of these drinks was 6.5%, slightly lower than that found in Brazil.

It is also worth noting that the average contribution of energy provided by SSB varies according to the age groups, being lower among the elderly (5%) and higher among adolescents (10%). This result was similar to that observed by Rosinger et al.[45], who investigated elderly Americans and observed an average of a 4% increase in the total energy contribution. In a study conducted in Mexico, SSB contributed an average of 10% of the total daily energy intake in all age groups[10].

The highest consumption of UFM among consumers of SSB described in the present study is consistent with other studies that associated the consumption of snacks and foods rich in fat[47,48] with the consumption of juices and soft drinks. Kovalsky et al.[49], in a multicenter study carried out in Latin America, found that approximately 70% of the studied population consumed SSB, and only 7% meet the WHO recommendation for the consumption of fruits and vegetables. The authors showed that the younger population consumed fewer fruits and vegetables and more sugar-sweetened beverages than the elderly.

There are some limitations in the present study related to the method used to evaluate food consumption, data analysis, and the interpretation of the results found. Like any other self-reported dietary assessment method, the food record used in the present study may have errors related to the individual's report, the conduction of the interviews, and the method itself. The instrument used in the present study has been evaluated. For its validity, an average of 32% underreporting was observed in terms of energy consumption compared to double-labeled water[50]. The observed underreporting was possibly related to individuals changing their diets on the days when they were filling out the food register. A strategy used to minimize the errors associated with underreporting was to estimate the nutrients and food consumption by energy density and to correct the estimates of the averages by energy[51]. It is believed that the observed associations would be even higher in the absence of that error.

Another limitation was that we chose to use some food items and some specific nutrients to comprise the food markers to assess the quality of the diet. Therefore, it did not evaluate the quality of the Brazilian diet globally. The choice for this analysis approach was an attempt to simplify the interpretation of results and facilitate the recommendations for the population. Furthermore, it was not possible to distinguish between natural and artificial juices. Finally, it is essential to say that in the data analyses, beverage sugar was added. That addition was not based on the actual consumption but instead on a question about the use of sugar to sweeten food and drinks. First, this 5% and 10% standardization may not reflect

the added amount. It is believed that there is a significant portion of the population that uses more sugar, considering that Brazil is one of the countries that consumes the highest amounts of sugar worldwide (in the absence of this limitation, there would possibly be an even more significant association) and second, the standardized addition reduces variability between individuals (in the absence of this limitation, there would perhaps be more significant differences in the association between individuals).Furthermore, we did not use a correction of food consumption by intraindividual variability since the results are limited to showing population averages and not estimates of inadequate consumption. It is already recognized that average food consumption, based on one or a few days of dietary assessment in large enough population samples, represents very close estimates to those corrected by intra-individual variability[52].

It is also worth noting that SSB represents an essential portion of all ultra-processed foods. In 2014, SSB represented one-third of the total energy from all ultra-processed foods, and most of the free sugars present in these foods corresponded to soft drinks, juices, and other SSB. In addition, the sales forecast for 2015-2019 of SSB grew by 9.6%, 133 kcal *per capita*/day, and specifically in Brazil, the sale of these drinks grew more than that of other ultra-processed foods[53].

In order to curb the excessive consumption of SSB, taxation can be a means to reduce the intake of these beverages and, consequently, reduce the health costs of the population[54]. In a systematic review, Escobar et al.[55] reported that an increase in the price of SSBs is associated with lower consumption of soft drinks, juices, and other SSBs. In Mexico, in 2014, the federal government implemented a tax of approximately 10%, based on a weight per liter of SSB consumption. In December of the same year, the purchase of the taxed beverages was reduced by 12%. During the same period, there was an average increase of 4% in the sale of water and a collection of more than two billion dollars in the first two years after the tax implementation[56].

Recently, a Brazilian study evaluated whether placing a 20% tax on SSB would reduce the consumption of these beverages by more than 20%. If there are taxes of 35% and 50%, the impact is even more significant and may reduce by more than half the amount consumed and increase water consumption. Moreover, the revenues from this new tax would be more than four billion reais per year[57].

In this regard, our results reinforce the need to regulate the supply of and reduce SSB consumption, especially among adolescents, as a strategy aimed at reducing free sugar intake and UFM and increasing HFM intake.

## Collaborations

MEMT Mastrangelo, MC Araujo and MBT Castro contributed to the study's design, analysis, data interpretation, and manuscript drafting. All authors read and approved the final manuscript.

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