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Evolution of household availability of added sugars and their sources in Brazil: analysis of Household Budget Surveys from 2002 to 2017

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Abstract

The objective of this study was to describe the evolution of household purchase of added sugars and their main food sources in Brazil. Nationally representative data from the Household Budget Surveys from 2002–2003, 2008–2009 and 2017–2018 were used. Energy and added sugar quantities were estimated by means of per capita food quantities. The items considered as food sources were: (1) table sugar: refined sugar and other energetic sweeteners and (2) processed and ultra-processed foods with added sugar: soft drinks; other drinks; sweets, candies and chocolates; cookies; cakes and pies and other foods. The parameters estimated were: mean share of added sugar in total energy and, for food sources, the share of added sugar in total sugar intake and the impact of variations in sources of added sugar between 2008 and 2017. There was a regular share of energy from added sugar to total energy intake between 2002 and 2008 but a reduced share in 2017. Between 2008 and 2017, there was a decrease in the share of refined sugar and other sweeteners and soft drinks to total sugar intake and an increased share of all other items. High-income households had a lower share of refined sugar and other energetic sweeteners, but a higher share of soft drinks, sweets, candies and chocolates. The decrease in added sugar in 2017 was mainly due to the lower share of soft drinks. In conclusion, Brazilians' total intake of added sugar was decreased, mostly owing to reduced consumption of sugar from soft drinks.

Keywords: **Added sugar: Dietary surveys: Middle-income countries: Ultra-processed foods**

The WHO defines free sugars are composed of (1) added sugars, which include all monosaccharides and disaccharides added to food and beverages by the manufacturer, cook or consumer, including that at the table and (2) sugars naturally present in fruits, fruit juices and milk[1,2]. A high intake of these sugars is a public health concern because it is usually associated with worse nutritional quality of the diet, excessive energy intake and risk of developing obesity and non-communicable diseases[1,3].

With a focus on the prevention and control of weight gain and the prevention of dental caries, the WHO recommends reducing the intake of free sugars to less than 10 % of daily energy intake, but it suggests that, ideally, intake should be limited to less than 5 %[2]. As the problem in most of the world seems to be the fraction of added sugar, some countries[4], such as the USA, focus their recommendations particularly on such sugars.

Sources of added sugars include table sugar, a processed culinary ingredient used in culinary preparations and to sweeten foods and beverages, and sugars added to processed foods, such as canned fruit, and ultra-processed foods and beverages, such as sweets, candies, chocolate, ice cream and soft drinks[5]. The greater share of ultra-processed foods in the diet of different populations has been associated with higher consumption of free sugar[6]. Ultra-processed foods account for about 90 % of added sugar intake in the USA[7], 80 % in Spain[8] and more than 55 % in Argentina[9] and Chile[10]. In Brazil, data from metropolitan areas, assessed in the Household Budget Surveys conducted between 1987 and 2009, showed that the fraction of intake of added sugar originated from table sugar was reduced by 22 % (from 81·8 % to 64·0 % of the total amount), while the fraction of added sugars originated from processed and ultra-processed foods doubled from 18·6 % to 36·0 % of the total amount. The share of soft drinks to total added sugar intake tripled from 6·1 % to 15·5 %, while the share of cookies doubled from 2·4 % to 5·0 %[11]. Similar trends were previously identified

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when also considering only metropolitan areas, using food availability data from 1987 to 2003[12]. Additionally, analyses using food consumption data from 2008 to 2017 showed a decrease in the table sugar intake[13].

To minimise the adverse effects of sugar intake, several countries have been adopting effective measures to monitor and reduce added sugar intake, especially by levying tax on sugar-sweetened beverages[14–18]. The adoption of such measures is recommended by the Pan American Health Organization, the WHO and the Word Cancer Research Fund[19–21].

Considering the changes in Brazilians' food consumption, and with a focus on monitoring and updating analyses previous conducted by Levy *et al.*[12], the present study aimed to describe the evolution of household purchase of added sugars and its main food sources in the period 2002–2003 to 2017–2018 in Brazil, as well as identify the sources that have most contributed to potential changes.

Methods

Sampling and data collection

This study used data from the Household Budget Surveys (HBS - *Pesquisas de Orçamentos Familiares*) conducted in 2002–2003, 2008–2009 and 2017–2018 by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*) in three periods: June 2002 to July 2003, May 2008 to May 2009 and June 2017 to July 2018.

Since 2002–2003, HBS is nationally representative, which is the reason to focus on these three surveys. They cover all regions, urban and rural areas, and all socio-economic strata. They used a complex, cluster-based sampling plan, involving geographic and socioeconomic stratification of all census tracts in Brazil, followed by random selection of tracts in the first stage and of households in the second stage. Data for the three surveys was collected over 12 months and evenly distributed in the strata, which are aggregates of homogeneous households in terms of socio-economic level and geographic location. This ensures representative data in the four quarters of the year. The sample consisted of 48 470 households in 2002–2003, 55 970 households in 2008–2009 and 57 920 households in 2017–2018, distributed in 443, 550 and 575 sample strata, respectively. The complex sampling procedures used in the surveys were described in detail in specific publications[22–24].

The basic data analysed in this study refers to food items purchased in each household for a period of seven consecutive days. All items were recorded daily in a booklet with an open list (containing information of the item itself and the quantity purchased) by the residents of the household or by an *Instituto Brasileiro de Geografia e Estatística* interviewer. Considering the short reference period for food availability data collecting in each household (seven days), the sample strata, which are the homogeneous aggregates of households, were used as study units.

Creation and description of the variables

The total weekly quantity (in grams) of each food item purchased was converted to express daily purchase values per individual (per capita). The total daily quantity (in grams) of each food item purchased was converted into energy (calories), using the Brazilian Food Composition Table of the University of São Paulo[25]. The amount of added sugar was determined by using the US Department of Agriculture (USDA) National Nutrient Database for Standard Reference – version 23[26], since this information was not available in the Brazilian Table for several food items, e.g. those that were ultra-processed. Subsequently, these values were converted into energy from added sugar.

Added sugar was considered as the sum of table sugar added by individuals to recipes or at the table with all sugars added by the industry to processed and ultra-processed foods. Although brown sugar hard candy, molasses, honey and other energetic sweeteners account for a small proportion of the total amount of sugar purchased by Brazilian families, they were considered for the calculation of the total energy from sugars (grouped with table sugar). As part of the added sugar definition, sugars naturally present in foods, such as fruit sugar (fructose) and milk sugar (lactose), were not considered as energy from sugar in the USDA composition table.

The indicators used in the present study were (1) energy share of added sugars in the total energy purchased by households (hereinafter called % of added sugar energy in total energy); and (2) energy share of added sugar from different sources in total sugar energy purchased by Brazilian households (hereinafter called fraction of available added sugar).

The following foods were grouped as sources of added sugar: (1) table sugar: refined sugar and other energetic sweeteners and (2) processed and ultra-processed foods and beverages containing added sugar: soft drinks; other drinks (artificial juices and other non-alcoholic beverages); sweets, candies and chocolates; cookies; cakes and pies and other food items (ice cream, breakfast cereal, bread, meals).

Additionally, the following variables were used in the study: Region (North, Northeast, Southeast and South, Central-West), household situation (urban, rural) and per capita household income (expressed in quintiles).

Data analysis

Data from the HBS 2002–2003, 2008–2009 and 2017–2018 was used to estimate the means and respective 95 % CI of the share of added sugar energy in the total energy available in the Brazilian households for the country as a whole, for the five regions, urban and rural areas and quintiles of per capita income. The comparison between 95 % CI values was used to identify significant differences. The absence of overlap between the intervals was assumed as a significant difference, considering the level of significance of 5 %.

For each of the food sources of added sugar, the means (and respective 95 % CI) of available fraction of added sugar purchased by households were estimated for the three years. A linear regression model was used to evaluate the evolution of the sources of added sugar; the outcome was the available fraction of each of the food sources and the exposure was the year of the study; P values less than 0·05 were considered significant for the linear trend. Also, Equiplots were generated to present an available fraction of added sugar from the food

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sources according to quintiles of per capita income for each study year (www.equidade.org/equiplot).

In addition, to identify the sources that contributed the most to potential changes in the share of energy from added sugar in the total energy available in households, the impact of variations in food sources on the total purchase of added sugar was estimated, by calculating predicted values for the share of sugar, using linear regression models.

All analyses were performed using the Stata/SE statistical package version 15·1 (*Stata Corp.*), in the *survey module,* which considers the effects of complex sampling and allows extrapolation of results to the Brazilian population.

Results

Over the study period, there was a stable purchase of added sugar between 2002–2003 and 2008–2009 and a small reduction in 2017–2018, compared with previous years. Nevertheless, in the three periods, the mean share of added sugars in the Brazilian diet was greater than 10 %, in Brazil as a whole and in all strata analysed. There was little variation in the mean share of sugar between urban and rural areas and family income quintiles. It is noteworthy that the Southeast region had the greatest share of sugar in total energy, except in 2017–2018, when it presented the same mean value as the South region, as opposed to the North region, which presented the lowest share in all years (Table 1).

In addition to variation in the share of added sugar in Brazilians' diet between 2008–2009 and 2017–2018, there were changes in the share of food sources for total added sugar purchases. Between 2002–2003 and 2017–2018, there was a decrease of 11 % (76·4 % to 67·8 %) in the share of refined sugar and other energetic sweeteners in the total amount of sugar purchases. Although intake of soft drinks was stable between 2002–2003 and 2008–2009, there was an 18 % reduction in their share between 2008–2009 and 2017–2018 (from 10·3 % to 8·4 %). For all other food sources (other drinks; sweets, candies and chocolates; cookies; cakes and pies and other foods), there was a significant increase in their share of total added sugar. Importantly, in 2017–2018, the share of sweets, candies and chocolates almost equated with the share of soft drinks (Table 2).

Regarding the share of added sugar from the food sources in total household sugar purchases according to income, for the three study periods, there was a different relationship for table sugar and other energetic sweeteners and processed and ultra-processed foods and beverages with added sugar. The major differences according to income quintiles were found for refined sugar and other energetic sweeteners, soft drinks and sweets, candies and chocolates. Based on the year 2017–2018, the share of refined sugar and other energetic sweeteners was 82·6 % (95 % CI 81·0, 84·2) for the 1st quintile (Q1 – lower-income households) and 54·7 % (95 % CI 51·0, 58·4) for the 5th quintile (Q5 – highest income households), i.e. a difference of 34 %, while for soft drinks, the share ranged from 4·4 % (95 % CI 3·8, 4·9) to 11·2 % (95 % CI 9·9, 12·5), and for sweets, candies and chocolates, the share ranged from 3·4 % (95 % CI 3·0, 3·8) to 12·9 % (95 % CI 11·4, 14·4). When Q1 and Q5 are compared, there are differences of 155 % and 279 %, respectively. Particularly for soft drinks, over the study period (between 2002–2003 and 2017–2018), the difference between Q1 and Q5 decreased from 11·7 % (2002–2003: 3·8 % *v.* 15·5 %) to 6·8 % (2017–2018: 4·4 % *v.* 11·2 %) (Fig. 1).

There was a reduction in added sugar purchases from the sources 'refined sugar and other energetic sweeteners' and 'soft drinks' in 2017–2018. Considering that and using linear regression models with the share of added sugar energy in the total energy purchased as the outcome and the share of each of the two sources as the exposure variable, the predictive share of added sugars was calculated for 2017–2018 using the mean values of 2008–2009 of share of 'refined sugar and other energetic sweeteners' (scenario 1) and 'share of soft drinks' (scenario 2), i.e. simulating that their share was stable between 2008–2009 and 2017–2018.

By looking at the difference between the real values and the predicted values for each of these sugar sources, it has been found that added sugar purchases fell between 2008–2009 and 2017–2018, mainly owing to the reduced intake of sugar from soft drinks (Table 3). Despite their lower share to total added sugar intake, between 2008–2009 and 2017–2018, the share of soft drinks was higher than that of refined sugar and other energetic sweeteners (Table 2). If the share of soft drinks had remained at the level of 2008–2009, the energy share of added sugars would hardly have changed in 2017–2018 (Scenario 2). On the other hand, the change in refined sugar and other energetic sweeteners between 2008–2009 and 2017–2018 seems to have hardly influenced the lower share of added sugars in total energy consumption in 2017–2018 (Scenario 1) (Tables 1 and 3).

Discussion

Based on nationally representative data on household food purchases, there was a stable energy share of added sugar in Brazil in total energy purchased between 2002–2003 and 2008–2009, but a reduction in 2017–2018. In all strata, availability estimates were considered high, since they exceeded the maximum limit of 10 % of the total energy value, recommended by the WHO for the consumption of free sugars, which includes added sugars[2]. In addition, there were changes in food sources of sugar in the study period, with a decrease in the share of refined sugar and other energetic sweeteners and soft drinks in total sugar purchases and an increase in the share of other processed and ultra-processed items.

Using data from 2002–2003 of this same study, it was found that the increase of 1·00 kJ (0·24 kcal) in the purchase of sugar (whether refined sugar or sugar added to ultra-processed foods) corresponded to an increase of 3·64 kJ (0·87 kcal) in total energy purchase[27].

In the UK, in 2014–2016, it was reported that intake of added and free sugars accounted for 7 % to 13 % of total energy intake[28], respectively. Data from Portugal, from 2015 to 2016, show that the contribution of total sugar to total energy intake was 18·5 %, with 6·8 % added sugar and 7·5 % free sugar[29]. In both cases, the values of added sugar were lower than those found in Brazil. However, both countries had a higher

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Table 1. Evolution of energy share of added sugar purchased by Brazilian households by region, household situation and per capita household income. Brazil, 2002–2003, 2008–2009 and 2017–2018

	% of energy share of added sugars in the total energy purchased					
	2002–2003		2008–2009		2017–2018	
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI
Regions						
North	12·2	11·4, 13·1	13·8	13·0, 14·5	12·0	11·3, 12·7
Northeast	15·9	15·3, 16·5	15·2	14·7, 15·7	13·2	12·8, 13·5
Southeast	17·0	16·0, 17·9	16·6	15·9, 17·3	14·5	13·9, 15·0
South	15·7	15·0, 16·4	15·6	15·1, 16·0	14·6	14·0, 15·3
Central-West	16·0	15·3, 16·8	15·5	14·8, 16·3	13·2	12·2, 14·1
Household situation						
Rural	15·8	15·0, 16·6	16·9	16·0, 17·7	13·7	13·4, 14·1
Urban	16·2	15·6, 16·9	15·6	15·2, 16·0	14·8	14·3, 15·4
Income quintiles						
1st	15·6	14·8, 16·4	15·8	15·1, 16·6	13·3	12·7, 13·9
2nd	16·2	15·2, 17·2	15·9	15·2, 16·7	13·7	13·2, 14·2
3rd	17·5	15·8, 19·3	15·9	15·0, 16·9	14·7	14·0, 15·3
4th	15·7	15·0, 16·4	16·4	15·7, 17·0	14·4	13·7, 15·0
5th	15·6	15·0, 16·3	15·0	14·3, 15·6	13·3	12·6, 14·0
Brazil	16·1	15·6, 16·7	15·8	15·4, 16·2	13·9	13·6, 14·2

Table 2. Distribution of energy share of added sugar from different sources in total sugar energy purchased by Brazilian households, by year of the survey. Brazil, 2002–2003, 2008–2009 and 2017–2018

	Available fraction of added sugar (%)					
	2002–2003		2008–2009		2017–2018	
Food sources of sugar	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI
Refined sugar and other energetic sweeteners	76·4	74·4, 78·4	71·7	69·9, 73·4	67·8	66·1, 69·5*
Soft drinks	9·5	8·6, 10·4	10·3	9·6, 11·0	8·4	7·9, 9·0*
Other ultra-processed drinks†	0·3	0·3, 0·4	0·8	0·7, 0·9	1·2	1·1, 1·4*
Sweets, candies and chocolates	5·0	4·3, 5·6	6·8	6·1, 7·4	8·7	8·1, 9·4*
Cookies	4·3	4·0, 4·6	4·5	4·2, 4·7	5·3	5·1, 5·6*
Cakes and pies	1·9	1·7, 2·1	2·8	2·5, 3·1	4·1	3·8, 4·4*
Other foods‡	2·9	2·6, 3·2	4·0	3·7, 4·3	5·6	5·1, 6·0*

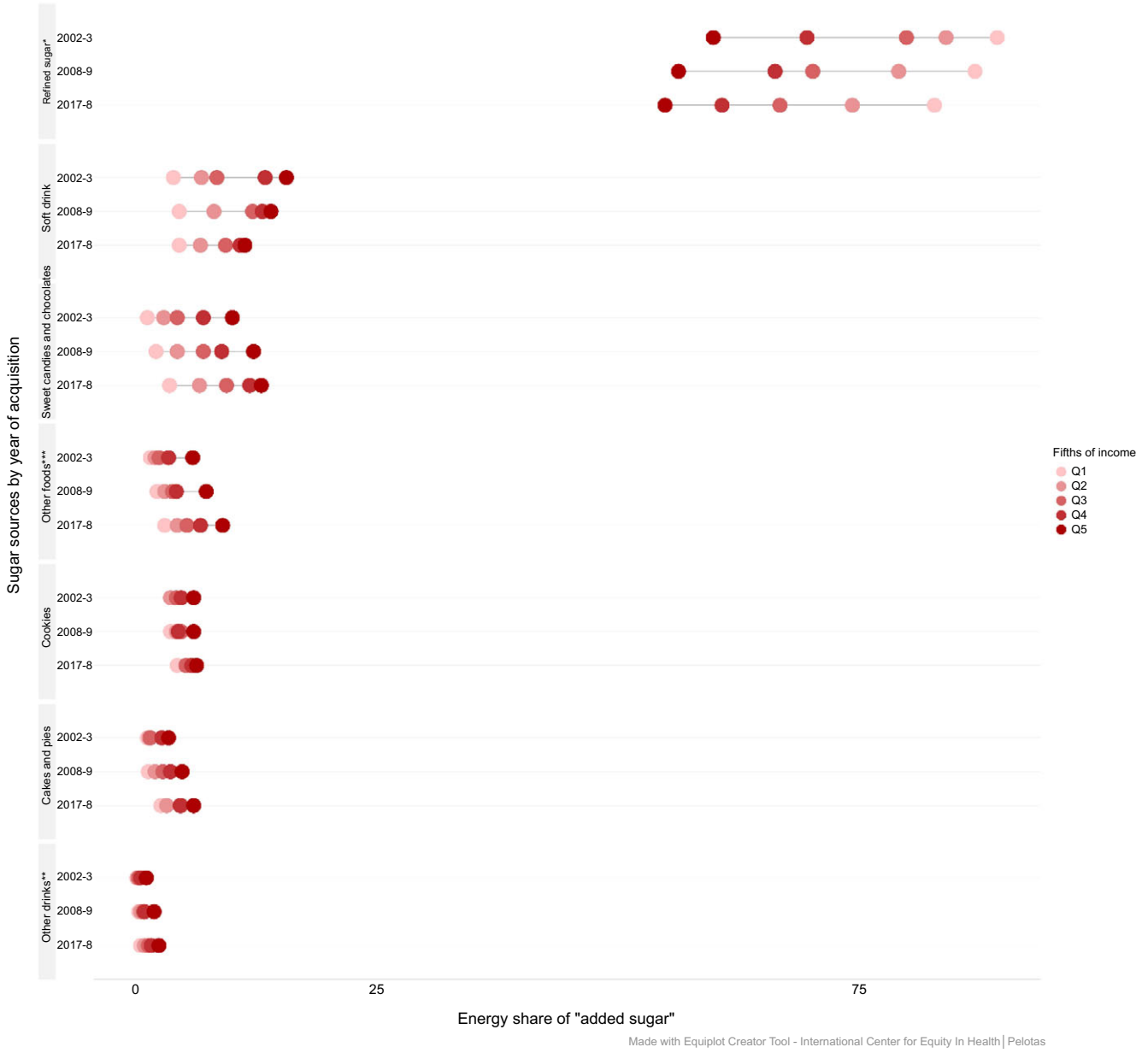
* *P* significant (≤ 0·05) for the linear trend.
† Artificial juices and other non-alcoholic beverages.
‡ Ice cream, breakfast cereal, breads and meals.

consumption of ultra-processed foods compared with Brazil[6]. Considering the increase in the consumption of ultra-processed foods in Brazil[30], the decrease observed in added sugar may be not maintained.

Between 2008–2009 and 2017–2018, Brazilian data indicate a decrease in the energy share of total sugar purchases for refined sugar and other energetic sweeteners and soft drinks. On the other hand, there was an increase in other drinks (artificial juices and other non-alcoholic beverages); sweets, candies and chocolates, cookies, cakes and pies and other foods (ice cream, breakfast cereal, bread, meals), i.e. the share of ultra-processed foods has been increasing. Also, it was found that income is related to the source of sugar purchases: in high-income households, there was a lower share of refined sugar and other energetic sweeteners, but a greater share of soft drinks, sweets, candies and chocolate. Data on the British population (2014–2017) reinforce these income-related differences[31], which can imply in the need of different interventions for different populational groups.

Based on consumption trend data for children and adolescents, an open cohort study conducted in Germany (1985–2016) showed an increase between 1985 and 2005 in the energy share of free sugar, with a decrease from 2006 onwards. This change seems to be due to the reduction in the consumption of sugar, sugar-sweetened beverages, sweets and milk products[32]. Another study involving this same age group, with data from the National Health and Nutrition Examination Survey 2001–2018 for North Americans, points to a decrease in the percentage of added sugar, especially because of significant decreases in sugar from sugar-sweetened beverages[33]. The results of these two studies, showing changes in sugar sources over the time, are crucial for identifying priorities for interventions and public policies. In addition to describing the evolution of sugar sources, another important step is to assess the impact of source changes in added sugar consumption, as conducted in this article.

The impact of variations in food sources on the total acquisition of added sugar was assessed using data from 2008–2009 to 2017–2018. It was found that, despite the reduction



*Artificial juices and other non-alcoholic beverages. ** Ice cream, breakfast cereal, breads, meals.

Fig. 1. Distribution of energy share of added sugar from different sources in total sugar energy purchased by Brazilian households, by per capita household income quintiles and year of the survey. Brazil, 2002–2003, 2008–2009 and 2017–2018.

in the purchase of table sugar and soft drinks, the latter was the main cause for the lower energy share of added sugars in 2017–2018. The relationship between intake of sugar-sweetened beverages and sugar sources by different populations has been evidenced in the literature[28,29,32–34]. Considering the findings of the present study and the relationship of sugar-sweetened drinks – mostly soft drinks – with added sugar intake, we believe that the consumption of these beverages should be the focus of public health to minimise the effects of excessive intake of added sugar. This focus is in line with the Strategic Action Plan to Tackle non-communicable diseases in Brazil 2021–2030, which aims to reduce the intake of sugar-sweetened beverages by 30 %[35], and with the Dietary Guidelines for the Brazilian Population, which recommends that ultra-processed foods, including sugar-sweetened beverages, should be avoided. However, policies should also focus on the amount of processed culinary ingredients[36], including table sugar, used in culinary preparations. The Brazilian Dietary Guidelines also have messages related to this topic, which should be considered and applied within various contexts.

Evidence points out that, between 2007 and 2019, there was increased availability of added sugar in non-alcoholic beverages in low- and middle-income countries (13–40 %) and in packaged foods worldwide (9 %)[37]. In this sense, because we have used

Table 3. Real share and predictive share in the total energy purchased by Brazilian households, according to refined sugar and other energetic sweeteners and soft drinks availability scenarios. Brazil, 2008–2009 and 2017–2018

Sources of added sugar that have been reduced between 2008–2009 and 2017–2018	Real share of added sugar in the total energy (%), considering the 2017–2018 distribution of sources		Predictive share* of added sugar in the total energy (%), considering the 2008–2009 distribution of sources that had a reduction		Difference between real and predicted values	
	Mean	95 % CI	Mean	95 % CI	Mean	95 % CI
Refined sugar and other energetic sweeteners (Scenario 1)	13·9	13·6, 14·2	14·4	14·1, 14·6	–0·5	–0·7, –0·3
Soft drinks (Scenario 2)	13·9	13·6, 14·2	15·9	15·9, 15·9	–2·0	–2·3, –1·7

* Predicted values for linear regression models using data from 2017–2018, having as the outcome the share of added sugar in the total energy purchased and as the exposure variable the energy share of refined sugar and other energetic sweeteners (Scenario 1) and soft drinks (Scenario 2) in the year of 2008–2009.

the same sugar composition table for every study year, our results for the availability of added sugar from ultra-processed foods are possibly underestimated for the last year of research (2017–2018), compared with previous years.

Considering the current scenario, a set of effective regulatory measures should be implemented for these beverages to further reduce their consumption in Brazil. One of the central measures to be taken, advocated by international bodies[19–21], is levying tax on sugar-sweetened beverages, especially soft drinks. Countries in Latin America, such as Mexico and Chile, have achieved satisfactory results for reduced consumption owing to taxation[38–40] on these beverages. The regulation of the supply of ultra-processed foods and beverages in schools is also an important item on the agenda for promoting an adequate and healthy diet and needs to advance in Brazil[41,42]. Another crucial measure is to adopt front-of-pack nutrition labelling with simple, clear information on food quality, and with adequate cut-off points, thus helping consumers to make informed decisions[43–45]. In Brazil, a front-of-pack nutrition labelling model, which includes the phrase 'high in added sugar', was approved and came into force in October 2022[46]. Although it is a step forward, the approved model is not considered the most efficient[47] and does not warn consumers about the use of additives and sweeteners, which are often used in these beverages[48].

The present study has limitations. The results refer only to the purchase of food and beverages for household consumption. In Brazil, food and beverages purchased for household consumption account for most of the energy consumed daily. Between 2008–2009 and 2017–2018, the frequency of out-of-home consumption decreased by 8·8 % and its share of total energy consumption also decreased (16·3 % *v.* 12·7 %). However, the share of consumption of soft drinks and sweets outside the household is important[49]. In this sense, our results, which indicate that the Brazilian population, on average, already exceeds the limit established for the consumption of added sugars, may be underestimated. However, the comparison between survey data from household budgets and individual food consumption surveys, for the evaluation of sugars, in particular, points to considerable agreement between methods[50–52]. Furthermore, the availability of sugars in households may be a measure of greater accuracy than its actual consumption, since this information in food surveys tends to be standardised in the case of culinary preparations, owing to respondents' difficulty in providing accurate intake values. The short period for collecting data on household food purchases (seven days) could be considered a limitation because it does not cover common fluctuations in the purchase of food over a month, for example, a higher number of purchases in a given week. However, to minimise this effect, we adopted the strata as a unit of study; they are aggregates of homogeneous households in terms of geographic location and socio-economic characteristics, which were studied over 12 months. Nevertheless, it is essential to consider that the added sugar information was derived from the USDA composition table, thereby potentially impacting the accuracy of estimations for Brazil. Discrepancies between foods from different countries may arise. Ideally, Brazil should develop its own composition table to estimate sugar intake, including added sugar. This should be accomplished through a comprehensive approach, combining bromatological analysis of domestic products and information gathered from product labels. On the other hand, a strong point is the use of nationally representative data and the comparability between the surveys, allowing analyses to be carried out over 15 years. An innovative aspect of the study was to assess the impact of variations in food sources on the total purchase of added sugar, by calculating predicted sugar share values to identify the sources that contributed the most to the change in the observed scenario.

In conclusion, despite the stable share of energy from added sugar in the total energy purchased in Brazil between 2002–2003 and 2008–2009, there was a reduction in such share between 2008–2009 and 2017–2018, which seems to be due, for the most part, to the decreased share of sugar from soft drinks. Monitoring consumption trends is essential to raise awareness of the country's scenario and to advise on the most appropriate intervention policies to promote adequate and healthy food consumption.

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The present study used secondary data (2003–2002, 2008–2009 and 2017–2018 Household Budget Surveys) collected by the IBGE and available for public online consultation (https://www.ibge.gov.br/estatisticas/sociais/saude/24786-pesquisa-de-orcamentos-familiares-2.html). The information contained in the database is confidential since specific data about each household such as identification of the household members, address and telephone are excluded.

References

1. WHO (2015) Guideline: Sugars Intake for Adults and Children. https://www.who.int/publications-detail-redirect/9789241549028 (accessed July 2022).
2. Bowman SA, Clemens JC, Friday JE, *et al.* (2020) *Food Patterns Equivalents Database 2017–2018: Methodology and User Guide [Online]*. Beltsville, Maryland: Food Surveys Research Group, Beltsville Human Nutrition Research Center, Agricultural Research Service, U.S. Department of Agriculture. http://www.ars.usda.gov/nea/bhnrc/fsrg (accessed January 2024).
3. Huang Y, Chen Z, Chen B, *et al.* (2023) Dietary sugar consumption and health: umbrella review. *BMJ* **381**, e071609.
4. USDA – United States Department of Agriculture (2020) U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2020–2025. https://www.dietaryguidelines.gov/resources/2020-2025-dietary-guidelines-online-materials (accessed April 2024).
5. Monteiro CA, Cannon G, Levy RB, *et al.* (2019) Ultra-processed foods: what they are and how to identify them. *Public Health Nutr* **22**, 936–941.
6. Martini D, Godos J, Bonaccio M, *et al.* (2021) Ultra-processed foods and nutritional dietary profile: a meta-analysis of nationally representative samples. *Nutrients* **13**, 3390.
7. Martínez Steele E, Baraldi LG, da Costa Louzada ML, *et al.* (2016) Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. *BMJ Open* **6**, e009892.
8. Latasa P, Louzada MLDC, Martinez Steele E, *et al.* (2018) Added sugars and ultra-processed foods in Spanish households (1990–2010). *Eur J Clin Nutr* **72**, 1404–1412.
9. Zapata ME, Rovirosa A & Carmuega E (2022) Intake of energy and critical nutrients according to the NOVA classification in Argentina, time trend and differences according to income. *Cad Saúde Pública* **38**, e00252021.
10. Cediel G, Reyes M, Da Costa Louzada ML, *et al.* (2018) Ultra-processed foods and added sugars in the Chilean diet (2010). *Public Health Nutr* **21**, 125–133.
11. Canella DS, Levy RB, Claro RM, *et al.* (2015) Food consumption: lots of sugar (1987–2009). Old and new health problems in Brazil: from Geisel to Dilma. São Paulo: Hucitec.
12. Levy RB, Claro RM, Bandoni DH, *et al.* (2012) Availability of added sugars in Brazil: distribution, food sources and time trends. *Rev Bras Epidemiol* **15**, 3–12.
13. Alves IA, Monteiro LS, Araújo MC, *et al.* (2024) Use of table sugar and non-caloric sweeteners in Brazil: associated factors and changes across a decade. *Br J Nutr* **131**, 1591–1599.
14. Colchero MA, Salgado JC, Unar-Munguía M, *et al.* (2015) Changes in prices after an excise tax to sweetened sugar beverages was implemented in Mexico: evidence from urban areas. *PLoS One* **10**, e0144408.
15. HM Government (2016) Childhood Obesity: A Plan for Action. https://www.gov.uk/government/publications/childhood-obesity-a-plan-for-action (accessed July 2023).
16. HM Government (2018) Soft Drinks Industry Levy Comes into Effect. https://www.gov.uk/government/news/soft-drinks-industry-levy-comes-into-effect (accessed July 2023).
17. SACN (2015) Carbohydrates and Health Report. https://www.gov.uk/government/publications/sacn-carbohydrates-and-health-report (accessed July 2023).
18. Silver LD, Ng SW, Ryan-Ibarra S, *et al.* (2017) Changes in prices, sales, consumer spending, and beverage consumption one year after a tax on sugar-sweetened beverages in Berkeley, California, US: a before-and-after study. *PLoS Med* **14**, e1002283.
19. PAHO (2019) Ultra-Processed Food and Drink Products in Latin America: Sales, Sources, Nutrient Profiles, and Policy Implications. https://iris.paho.org/handle/10665.2/51094 (accessed April 2024).
20. WCRF (2018) Building Momentum: Lessons on Implementing a Robust Sugar Sweetened Beverage Tax. www.wcrf.org/buildingmomentum (accessed July 2022).
21. WHO (2017) Taxes on Sugary Drinks: Why do it? World Health Organization. https://iris.who.int/bitstream/handle/10665/260253/WHO-NMH-PND-16.5Rev.1-eng.pdf (accessed April 2024).
22. IBGE – Instituto Brasileiro de Geografia e Estatística (2004) Consumer Expenditure Survey (POF) 2002–2003: Analysis of the Household Availability of Food and Nutritional Status in Brazil. [document in Portuguese]. https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=24472 (accessed April 2024).
23. IBGE – Instituto Brasileiro de Geografia e Estatística (2020) Consumer Expenditure Survey (POF) 2017–2018: Analysis of the Household Availability of Food in Brazil. [document in Portuguese]. https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=2101704 (accessed April 2024).
24. IBGE – Instituto Brasileiro de Geografia e Estatística (2010) Consumer Expenditure Survey (POF) 2008–2009: Analysis of the Household Availability of Food in Brazil. [document in Portuguese]. https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=247310 (accessed April 2024).
25. USP/FoRC U-U de SP (USP)/F-FRC (2020) Brazilian Food Composition Table (TBCA). Version 7.1. São Paulo. http://www.fcf.usp.br/tbca (accessed April 2024).
26. USDA – United States Department of Agriculture (2010) Agricultural Research Service. 2010. USDA National Nutrient Database for Standard Reference, Release 23. Nutrient Data Laboratory. https://www.ars.usda.gov/research/publications/publication/?seqNo115=257886 (accessed April 2024).

27. Levy RB, Claro RM & Monteiro CA (2009) Sugar and total energy content of household food purchases in Brazil. *Public Health Nutr* **12**, 2084–2091.
28. Amoutzopoulos B, Steer T, Roberts C, *et al.* (2020) Free and added sugar consumption and adherence to guidelines: the UK National Diet and Nutrition Survey (2014/15–2015/16). *Nutrients* **12**, E393.
29. Marinho AR, Severo M, Correia D, *et al.* (2020) Total, added and free sugar intakes, dietary sources and determinants of consumption in Portugal: the National Food, Nutrition and Physical Activity Survey (IAN-AF 2015–2016). *Public Health Nutr* **23**, 869–881.
30. Levy RB, Andrade GC, Cruz GL, *et al.* (2022) Three decades of household food availability according to NOVA - Brazil, 1987–2018 *Rev Saude Publica* **56**, 75.
31. Berger N, Cummins S, Smith RD, *et al.* (2021) Have socio-economic inequalities in sugar purchasing widened? A longitudinal analysis of food and beverage consumer data from British households, 2014–2017. *Public Health Nutr* **24**, 1583–1594.
32. Perrar I, Schadow AM, Schmitting S, *et al.* (2019) Time and age trends in free sugar intake from food groups among children and adolescents between 1985 and 2016. *Nutrients* **12**, E20.
33. Ricciuto L, Fulgoni VL, Gaine PC, *et al.* (2022) Trends in added sugars intake and sources among US children, adolescents, and teens using NHANES 2001–2018. *J Nutr* **152**, 568–578.
34. Della Corte K, Fife J, Gardner A, *et al.* (2021) World trends in sugar-sweetened beverage and dietary sugar intakes in children and adolescents: a systematic review. *Nutr Rev* **79**, 274–288.
35. Brazil (2021) Strategic Action Plan for Tackling Chronic Diseases and Non-Communicable Diseases in Brazil 2021–2030 [electronic resource]/Ministry of Health, Health Surveillance Secretariat, Department of Health Analysis and Non-Communicable Disease Surveillance. https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/publicacoes-svs/doencas-cronicas-nao-transmissiveis-dcnt/09-plano-de-dant-2022_2030.pdf/view (accessed May 2023).
36. Brazil (2014) Food Guide for the Brazilian Population. Ministry of Health. https://bvsms.saude.gov.br/bvs/publicacoes/dietary_guidelines_brazilian_population.pdf (accessed April 2024).
37. Russell C, Baker P, Grimes C, *et al.* (2023) Global trends in added sugars and non-nutritive sweetener use in the packaged food supply: drivers and implications for public health. *Public Health Nutr* **26**, 952–964.
38. Caro JC, Corvalán C, Reyes M, *et al.* (2018) Chile's 2014 sugar-sweetened beverage tax and changes in prices and purchases of sugar-sweetened beverages: an observational study in an urban environment. *PLoS Med* **15**, e1002597.
39. Cuadrado C, Dunstan J, Silva-Illanes N, *et al.* (2020) Effects of a sugar-sweetened beverage tax on prices and affordability of soft drinks in Chile: a time series analysis. *Social Sci Med* **245**, 112708.
40. Sánchez-Romero LM, Canto-Osorio F, González-Morales R, *et al.* (2020) Association between tax on sugar sweetened beverages and soft drink consumption in adults in Mexico: open cohort longitudinal analysis of Health Workers Cohort Study. *BMJ* **369**, m1311.
41. Azeredo CM, Leite MA, Rauber F, *et al.* (2020) Are laws restricting soft drinks sales in Brazilian schools able to lower their availability? Rev Saúde Pública 54, 1–11.
42. Rio de Janeiro (2023) RIO DECREE No. 52842 OF JULY 11, 2023. Regulates Municipal Law No. 7,987, of July 11, 2023, Which Establishes Actions to Combat Childhood Obesity, and Provides Other Measures. https://doweb.rio.rj.gov.br/portal/visualizacoes/pdf/5930#/p:8/e:5930?find=ultraprocessados (accessed April 2024).
43. Canella DS, Pereira Montera VD, Oliveira N, *et al.* (2023) Food additives and PAHO's nutrient profile model as contributors' elements to the identification of ultra-processed food products. *Sci Rep* **13**, 13698.
44. Jáuregui A, Vargas-Meza J, Nieto C, *et al.* (2020) Impact of front-of-pack nutrition labels on consumer purchasing intentions: a randomized experiment in low- and middle-income Mexican adults. *BMC Public Health* **20**, 463.
45. Roberto CA, Ng SW, Ganderats-Fuentes M, *et al.* (2021) The influence of front-of-package nutrition labeling on consumer behavior and product reformulation. *Annu Rev Nutr* **41**, 529–550.
46. Brazil (2020) NORMATIVE INSTRUCTION No. 75, OF OCTOBER 8, 2020. Establishes the Technical Requirements for Declaring Nutritional Labeling on Packaged Foods. https://www.gov.br/agricultura/pt-br/assuntos/inspecao/produtos-vegetal/legislacao-1/biblioteca-de-normas-vinhos-e-bebidas/instrucao-normativa-no-75-de-8-de-outubro-de-2020.pdf/view (accessed May 2023).
47. Khandpur N, Mais LA, de Morais Sato P, *et al.* (2019) Choosing a front-of-package warning label for Brazil: a randomized, controlled comparison of three different label designs. *Food Res Int* **121**, 854–861.
48. Sambra V, López-Arana S, Cáceres P, *et al.* (2020) Overuse of non-caloric sweeteners in foods and beverages in Chile: a threat to consumers' free choice? *Front Nutr* **7**, 68.
49. Bezerra IN, Vasconcelos TM, Cavalcante JB, *et al.* (2021) Evolution of out-of-home food consumption in Brazil in 2008–2009 and 2017–2018. *Rev. Saúde Pública* **55**, 6s.
50. de Oliveira DCRS, de Moura Souza A, Levy RB, *et al.* (2019) Comparison between household food purchase and individual food consumption in Brazil. *Public Health Nutr* **22**, 841–847.
51. da Costa Louzada ML, Levy RB, Martins APB, *et al.* (2017) Validating the usage of household food acquisition surveys to assess the consumption of ultra-processed foods: evidence from Brazil. *Food Policy* **72**, 112–120.
52. Naska A, Vasdekis VGS & Trichopoulou A (2001) A preliminary assessment of the use of household budget survey data for the prediction of individual food consumption. *Public Health Nutr* **4**, 1159–1165.