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Use of table sugar and non-caloric sweeteners in Brazil: associated factors and changes across a decade

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Abstract

This study evaluated changes in the use of sweeteners over one decade and the relationship between socio-demographics, diet and weight status with the type of sweetener. Data came from the Brazilian National Dietary Surveys of 2008–2009 and 2017–2018, including ≥ 10-year-old individuals (*n* 32 749; *n* 44 744, respectively, after excluding pregnant and lactating women). The use of table sugar, non-caloric sweeteners (NCS), both or none was reported through a specific question. Food consumption was assessed using two non-consecutive food records (2008–2009) and 24-h recalls (2017–2018). For the last survey, means of energy, macro and micronutrient intake, food groups' contribution (%) to daily energy intake and age- and energy-adjusted nutrient intake were estimated according to the type of sweetener used. Differences in means and proportions across the categories of sweeteners used were evaluated based on the 95 % CI. All analyses were stratified by sex and considered sample design and weights. Over 10 years, the use of table sugar decreased by 8 %, while the habit of not using any sweetener increased almost three times, and the use of NCS remained stable. Larger reductions in the use of table sugar were observed in the highest income level and among men. Regardless of sex, compared with NCS users, table sugar users had greater mean intake of energy, carbohydrates and added sugar and lower micronutrient intake means. Although table sugar is still the most used sweetener, the increased choice of 'no sweetener' is noteworthy in Brazil.

Keywords: **Sugars: Nutritive Sweeteners: Non-Nutritive Sweeteners: Dietary Surveys**

High sugar intake has been associated with unfavourable health outcomes, mainly dental caries, obesity, type 2 diabetes and other metabolic disorders[1,2]. On the other hand, although it is still controversial, potential long-term use of non-caloric sweeteners (NCS)[3], sugar substitutes with high sweetening power and none or negligible energetic content have also been associated with adverse health outcomes, such as weight gain or no weight reduction[4], insulin resistance[5] and imbalance of the intestinal microbiota[6]. Therefore, reducing both sugar and NCS intakes has been recommended in nutrition guidelines[3,7–9].

Hence, efforts to monitor trends in the use of these sweeteners are relevant to inform nutrition policies. Nevertheless, globally, data on sweetener use from National Dietary Surveys (NDS) are scarce and irregularly collected[10]. This gap in the literature may be due to several factors, for example the variability in the terminology used to name the

Abbreviations: NCS, non-caloric sweeteners; NDS, National Dietary Surveys.

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different types of sweeteners[11]. Furthermore, this information is obtained primarily by means of dietary assessment tools, which are usually subject to misreporting, especially underreporting[12]. Additionally, sweeteners, as most of the additive items, are recognised as frequently omitted items in food consumption reports[13]. In most countries, sugar intake is either stable or decreasing,[11] while the NCS use has increased worldwide, with the most significant growth observed in Latin American and China markets[14]. Over the lifespan, the intake of added sugars decreases[15] and the NCS use increases[16].

Socio-demographic and dietary factors associated with using caloric and non caloric sweeteners have been evaluated. Lee *et al.*[17], in the United States of America (USA), observed that adults reporting high intake of added sugar (> 15 % of daily energy intake) had lower education and income levels, and the main sources of added sugar were sugary beverages, baked goods and caloric sweeteners. In the Australian population, the NCS use was reported mainly by adult women with higher body mass index (BMI), individuals that reported being on a diet for weight loss and those who self-reported having diabetes; moreover, the main food sources of NCS were sweetened beverages, yogurt and other flavoured drinks[18]. Nationally representative survey carried out in Canada showed that adults with moderate sugar intake had greater intake of fibre, vitamin A, vitamin C, Fe and phosphorus than those with high or low sugar intake[19].

In Brazil, data from the first Brazilian National Dietary Survey (2008–2009) showed that the majority of Brazilians (86 %) chose table sugar to sweeten foods and beverages, while 8 % opted by NCS[20]; however, the sweeteners choice has not been a frequent target of Brazilian studies. Therefore, the objective of this study was twofold: first, to evaluate changes in sweetener use (table sugar and NCS) between the nationwide dietary surveys carried out in 2008–2009 and in 2017–2018[21,22], considering socio-demographic and individual characteristics; second, to analyse data from the 2017–2018 survey to investigate the association between the type of sweetener used and diet characteristics.

Materials and methods

Study design and population

Data came from two Brazilian NDS (in Portuguese: Inquérito Nacional de Alimentação – INA) which examined subsamples of 2008–2009 and 2017–2018 Household Budget Surveys (in Portuguese: Pesquisa de Orçamentos Familiares – POF). Both Household Budget Surveys' representative samples were selected using a complex sample design, in which the census tracts were the primary sampling units and the households, the secondary sample units. Details on the sampling design are available elsewhere[23]. The NDS subsamples comprised about 25 % and 35 % of the households included in the 2008–2009 and 2017–2018 Household Budget Surveys, which corresponded to 13 659 and 20 112 households, respectively. In each selected household, the NDS investigated all subjects ≥ 10 years old; therefore, 34 003 individuals were included in the first study and 46 164 in the second. Data were collected over 12 months in all census tracts providing information on seasonal variations in food consumption[23]. After excluding pregnant and lactating women (*n* 1254 and *n* 1420, respectively), this analysis included 32 749 subjects from the 2008–2009 NDS and 44 744 from the 2017–2018 NDS. In both 2008–2009 and 2017–2018 surveys, data were collected in the households using structured questionnaires through in-person interviews.

Assessment of the sweetener choice

Individuals were asked about the type of sweetener they usually choose through an objective question 'What type of sweetener do you often use?' with the following options to answer: 'table sugar', 'non caloric sweeteners (NCS)', 'sugar and NCS' or 'none'[24].

Food consumption: 2017–2018 national dietary survey

Two 24-h recalls were applied on non-consecutive days selected within a 1-week span by a previously trained research agent, and the subjects reported all the foods and drinks (including water) consumed during the days before both interviews. The in-person interviews were based on the Multiple-Pass Method[25] and were carried out with the support of a tablet-based software designed specifically for this assessment. The interviewee was asked to detail information on the amount of food consumed, cooking method, place and time of consumption[26].

The software database was composed of 1 832 food items, and the field agent could include items not found in the database. Measures of the food and drinks reported were converted into units of mass or volume (grams or milliliters)[27], and energy and nutrient intake was estimated using the Brazilian Food Composition Table (TBCA) v.7.0.[28].

By answering yes-no questions, the participants gave information on the use of twelve items that are usually added to selected foods and drinks, including spreads, honey, table sugar and NCS. The estimation of energy and nutrient intake took into account the consumption of such items following standardised procedures since no information on the amount added to food was available. For fat-based items (olive oil, butter/margarine, mayonnaise, grated cheese and sour cream), a maximum of 20 % of the intake in grams was added to the food, summing up all items added (for example, if the participant added olive oil and grated cheese, the intake of each one was estimated as 10 % of the amount reported). A maximum of 10 % of the amount consumed was added to the food if the addition of sugar, honey, molasses, ketchup, mustard or soy sauce was reported. The addition of table sugar was estimated as 10 % of the amount consumed when only table sugar was added to foods and beverages, and as 5 % of the amount consumed, if table sugar and NCS were added to foods and beverages[26].

Usual mean daily energy, macronutrients and micronutrients intake was estimated using the two 24-h recalls with correction for the within-person variability using a method adopted by the National Cancer Institute, including age as a covariate and stratified by sex[29,30]. The National Cancer Institute method is composed of two-part nonlinear mixed model: in the first part is estimated the probability of nutrient intake modeled as a mixed effects logistic regression, and in the second part the usual intake

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amount of nutrients is estimated through mixed effects linear model[29,30].

Additionally, the percentage contribution (%) of macronutrients to total energy intake was estimated, and micronutrients intake was adjusted by total energy intake using the nutrient density method[31]. The foods reported in the first 24-h recall used in 2017–2018 NDS were categorised into thirteen food groups (rice and other cereals; beef, pork, poultry, eggs and fish; beans; candies and desserts; fast foods and processed meats; oils and fats; roots and tubers; milk and dairy; fruit-based drinks and soda; coffee and tea; cookies and crackers; fruits and vegetables and 'other items' (nuts and seeds; mixed dishes; broth, chowders and soups), according to their nutritional characteristics and consumption habits (see online supplementary material, Supplemental Table). The food groups' contribution (%) to total daily energy intake was calculated.

Covariables

Socio-demographic covariables considered in this study were: sex; age group (adolescents (10–19 years old), adults (20–59 years old), and elderly (≥ 60 years old)); urban or rural area and monthly per capita family income (estimated from the sum of household incomes divided by the number of household members and categorised according to multiples of the country official minimum wage in the middle of the surveys: USA$ 174·40, in January 2009, and USA$ 298·50, in January 2018)[21,22]. Self-reported weight and height were used to calculate the BMI (BMI=weight/height^2) and assess weight status according to the World Health Organization (WHO) criteria (adolescents were classified as overweight if z-scores of BMI were > +1 of the reference distribution[32]; adults and elderly were overweight if the BMI was ≥ 25 kg/m^2[33]). The participants informed if they were on a diet at the time of the interview through the yes-no question 'Are you on a diet?'. Information on supplement use was also obtained through the yes-no question 'Have you taken any kind of supplement in the 30 d prior to the interview?'[22].

Statistical analysis

The proportions (%) of use of sweeteners were estimated considering total population and the covariables categories in both surveys, except for being on a diet and taking supplements, which were collected only in the 2017–2018 NDS. Also, diet characteristics according to the use of sweeteners were investigated only in the 2017–2018 NDS, specifically, the mean contribution (%) of food groups to total energy intake and the usual intakes of macronutrients and micronutrients, which were estimated using the National Cancer Institute method with age as covariate in the model and stratified by sex, additionally, the nutrients were adjusted by energy intake.

Differences in means and proportions across the analysed categories were evaluated based on the 95 % CI overlapping. Cohen's d and h effect sizes were used to examine differences of means and proportions, respectively, using the following ranges: ≥ 0·2 small, ≥ 0·5 medium and ≥ 0·8 large[34]. The analyses were performed on SAS on demand, considering sample weights (SAS Institute Inc.).

Table 1. Population distribution (%) according to socio-demographic variables, weight status, dieting, and supplement use. National Dietary Surveys, Brazil, 2008–2009 and 2017–2018

Characteristics	2008–2009	2017–2018
Sex		
Female	50·2	49·3
Male	49·8	50·7
Age group		
Adolescents*	21·5	17·9
Adults†	64·7	63·9
Elderly‡	13·8	18·1
Weight status		
No excess weight	58·1	48·5
Overweight or obese§	41·9	51·5
Area		
Urban	83·6	85·6
Rural	16·4	14·4
Monthly family per capita income (in multiples of the country minimum wage)‖		
<0·5	17·2	16·6
0·5–< 1·0	23·6	24·2
1·0–2·0	28·6	31·9
>2·0	30·7	27·3
Being on a diet¶		
Yes	–	14·0
No	–	86·0
Supplement intake¶		
Yes	–	18·8
No	–	81·2

* Adolescents: 10–19 years old.
† Adults: 20–59 years old.
‡ Elderly: ≥ 60 years old.
§ Overweight or obese: adolescents classified according to age- and sex-BMI (body mass index) above +1 z-score of the reference distribution; adults and elderly: BMI ≥ 25 kg/m^2[32,33].
‖ Monthly per capita family income: categorized in multiples of the country's official minimum wage in the middle of the surveys (January 2009: USA$ 174.40; January 2018: USA$ 298.50).
¶ This information was collected only in the 2017–2018 NDS.

Results

Both in 2008–2009 and 2017–2018 NDS, most of the population were adults (64·7 % and 63·9 %) and lived in urban areas (83·6 % and 85·6 %). Females comprised 50·2 % of the population in 2008–2009 and 49·3 % in 2017–2018; in addition, excess weight prevalence (overweight + obesity) was 41·9 % and 51·5 %, respectively. In 2017–2018, 14 % of the population reported being on a diet and 18·8 % took at least one kind of supplement in the 30 d prior the interview (Table 1).

In general, comparing 2008–2009 and 2017–2018 NDS data, the use of sugar table decreased by 8 % (85·7 % *v.* 79·2 %), while the use of no sweetener increased almost three times (1·6 % *v.* 6·8 %) with a small effect size and the use of NCS alone (7·6 % *v.* 8·8 %) and both options (5·1 % *v.* 5·2 %) remained stable. In the ten-year period, table sugar use was steady among the elderly and decreased among adolescents (94·9 % *v.* 91·3 %) and adults (86·1 % *v.* 79·9 %). This reduction varied between 4 and 7 percentage points similarly across the categories of sex, weight status and urban or rural situation. The decrease in table sugar use was also observed across the income categories, with effect sizes of 0·26 and 0·23 for the categories of per capita income < 0·5 and between 0·5 and < 1·0 minimum wage.

The increase in the option 'no sweetener' was observed in all the categories analysed, and the greatest increases were observed among men (1·3 % *v.* 7·0 %; effect size = 0·31), in rural areas (0·9 % *v.* 4·6 %; effect size = 0·24), among those with per capita family income between 1 and 2 minimum wages (1·1 % *v.* 6·0 %; effect size = 0·28) and in the category with per capita family income ≥ 2 minimum wages (2·5 % *v.* 10·2 %; effect size = 0·33) (Table 2).

In 2017–2018 NDS, the use of table sugar was reported in greater proportion by adolescents (91·3 %) compared to adults and elderly (79·9 %; 64·6 %) with effect sizes of 0·33 and 0·68, respectively, among those living in rural compared to urban area (77·6 % *v.* 89·0 %; effect size = 0·31), in the lowest income category compared to the highest one (90·0 % *v.* 65·0 %; effect size = 0·62), among individuals reporting not being on a diet compared to those on a diet (83·5 % *v.* 51·5 %; effect size = 0·70), and among those that did not report any supplement use compared to those taking supplements (81·9 % *v.* 66·3 %; effect size = 0·36). The use of NCS alone was more frequent among elderly than adults and adolescents (20·2 % *v.* 7·7 % *v.* 1·5 %; effect sizes of 0·37 and 0·69), in the highest than in the lowest income category (15·8 % *v.* 3·0 %; effect size = 0·47), and among individuals on a diet compared to those that were not dieting (11·1 % *v.* 4·3 %; effect size = 0·26). The use of NCS in combination with table sugar presented the same trend observed for the exclusive use of NCS. The option of not sweetening foods and beverages neither with table sugar nor NCS was more frequent among those from families with per capita income < 0·5 minimum wage monthly compared to those from families with per capita income ≥ 2 minimum wages monthly (4·8 % *v.* 10·2 %; effect size = 0·21) (Table 2).

In general, no important differences were observed in the energy contribution of food groups to total energy intake according to sweetener used. Even though the effect sizes were not important, differences were observed for 'candies and desserts' and 'fruits and vegetables'. The contribution of 'candies and desserts' to energy intake among table sugar users was greater than the estimated to NCS users (9·7 % *v.* 5·3 %; effect size = 0·17). Inversely, 'fruits and vegetables' contributed less to energy intake among table sugar users in comparison to NCS users (3·8 % *v.* 7·1 %; effect size = 0·14) (Table 3).

For both men and women, the usual energy intake was greater among individuals using table sugar (men: 1985 kcal; women: 1566 kcal) than those choosing NCS (men: 1846 kcal; women: 1467 kcal), both (men: 1813 kcal; women: 1470 kcal), or none (men: 1790 kcal; women: 1454 kcal) and for women the effect sizes ranged from 0·44 to 0·53. Similarly, the intake of total carbohydrates and added sugar was greater among those using table sugar compared to individuals reporting the use of NCS or no sweetener, but the effect sizes were small or negligible. Regardless of sex, table sugar users had lower intake of micronutrients than NCS users, especially for calcium (men: 233 mg *v.* 310 mg; women: 246 mg *v.* 343 mg), potassium (men: 1254 mg *v.* 1389 mg; women: 1281 mg *v.* 1481 mg), phosphorus (men: 573 mg *v.* 628 mg; women: 558 mg *v.* 623 mg), vitamin A (men: 149 mcg *v.* 248 mcg; women: 191 mcg *v.* 312 mcg), and vitamin C (men: 54 mg *v.* 75 mg; women: 67 mg *v.* 97 mg). The effect sizes of such comparisons ranged between 0·22 and 0·31, except for calcium and vitamin C in men that had lower values of effect size (Table 4).

Discussion

Although sugar is still the preferred choice of sweetener in Brazil, its use decreased by 8 % over ten years, while the proportion of individuals reporting not using any sweetener nearly tripled; on the other hand, the use of NCS alone or in combination with table sugar remained stable. The decrease in the use of table sugar was observed in all strata investigated; nevertheless, it was more noticeable among individuals at the highest income level. Among individuals with an income between 1 and 2 minimum wages, men, and in rural areas, the choice of no sweetener increased over 5 times. Additionally, comparing the results with the analysis of Monteiro *et al.* for the 2008–2009 NDS[20], it is evident that, in the studied 10-year period, no substantial changes were observed in food groups' contribution to energy intake across the categories of sweetener choice.

Adolescents and individuals in the lowest income level were the main users of sugar and those reporting to a lesser extent the use of NCS and not adding any sweetener. In contrast, the elderly reported more frequently the use of NCS and less frequently the use of table sugar. In addition, dieters and individuals in the highest income level reported in greater frequency using NCS and adding no sweetener to foods and beverages and were those who reported the use of table sugar to a lesser extent. Such findings are consistent with studies carried out in Brazil[20], and in the USA[35] examining demographic characteristics associated with the use of sweeteners, which found that sugar intake was more prevalent among younger individuals, men, individuals with lower education levels, living in rural areas and in the lowest income level, while the NCS use was more frequent among the elderly, women, individuals with overweight/obesity, those living in urban areas and belonging to the highest income level.

The use of table sugar was related to greater consumption of candies and desserts and lower intake of fruits and vegetables compared with NCS users. Therefore, the food choices of table sugar users may explain their dietary profile, which is marked by higher energy and lower micronutrient intake than their counterparts.

These findings are consistent with the trend of decrease or stability in sugar intake that has been observed worldwide in the last years[11,36,37] and can be related to the association of sugar with adverse conditions, such as dental caries, obesity, noncommunicable diseases and other illnesses[2,38]. Surely, this scenario is in accordance with the Brazilian Dietary Guidelines[39] and 94 % of dietary guides that recommend sparing table sugar intake[7,39] following the WHO suggestions to limit free sugar intake[40].

Results on the steadiness in the report of the use of NCS are consonant with the results from a review that examined NCS use globally between 2008 and 2017 and showed no shift in the use of NCS over time globally[41], except regarding specific groups, such as those diagnosed with diabetes mellitus, obesity or other metabolic disorders. Nonetheless, the estimation of NCS use has been presenting uncertain results[4].

Table 2. Use of table sugar and non-caloric sweeteners (%) according to socio-demographic variables, weight status, dieting and supplement use. National Dietary Surveys, Brazil, 2008–2009 and 2017–2018

	2008–2009								2017–2018							
	Table sugar		Non-caloric Sweeteners		Both		None		Table sugar		Non-caloric Sweeteners		Both		None	
Characteristics	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI
Total	85·7	84·7, 86·6	7·6	6·9, 8·3	5·1	4·6, 5·8	1·6	1·3, 1·9	79·2	78·3, 80·1	8·8	8·2, 9·3	5·2	4·8, 5·7	6·8	6·2, 7·4
Sex																
Female	82·0	80·7, 83·2	9·7	8·8, 10·6	6·5	5·8, 7·3	1·9	1·5, 2·3	76·4	75·3, 77·4	10·5	9·9, 11·3	6·5	5·9, 7·2	6·6	5·9, 7·3
Male	89·4	88·4, 90·4	5·5	4·8, 6·4	3·8	3·2, 4·4	1·3	0·9, 1·7	82·3	81·3, 83·3	6·8	6·2, 7·5	3·9	3·4, 4·3	7·0	6·3, 7·8
Age group																
Adolescents*	94·9	93·9, 95·8	1·9	1·3, 2·6	1·9	1·4, 2·4	1·3	0·9, 2·0	91·3	90·1, 92·3	1·5	1·1, 2·0	1·7	1·2, 2·3	5·6	4·8, 6·5
Adults†	86·1	85·0, 87·1	6·9	6·2, 7·7	5·5	4·8, 6·2	1·5	1·2, 1·9	79·9	78·8, 80·9	7·7	7·0, 8·3	5·6	5·1, 6·2	6·8	6·1, 7·7
Elderly‡	69·3	66·3, 72·2	19·9	17·6, 22·4	8·7	6·8, 11·1	2·0	1·4, 3·0	64·6	62·7, 66·4	20·2	18·7, 21·7	7·5	6·5, 8·7	7·7	6·8, 8·8
Weight status																
No excess weight	88·5	87·4, 89·5	5·9	5·1, 6·7	4·3	3·7, 4·9	1·4	1·1, 1·8	83·0	82·0, 84·0	6·3	5·8, 6·9	3·8	3·4, 4·3	6·8	6·1, 7·6
Overweight or obese§	81·8	80·4, 83·1	10·0	9·0, 11·1	6·4	5·6, 7·3	1·8	1·4, 2·3	75·7	74·5, 76·8	11·0	10·3, 11·9	6·6	6·0, 7·2	6·7	6·0, 7·5
Area																
Urban	84·2	83·1, 85·3	8·5	7·7, 9·4	5·6	5·0, 6·3	1·7	1·4, 2·0	77·6	76·5, 78·6	9·6	8·9, 10·2	5·7	5·2, 6·3	7·1	6·4, 7·9
Rural	93·3	91·5, 94·7	3·0	2·4, 3·6	2·8	1·7, 4·5	0·9	0·4, 1·9	89·0	87·7, 90·2	4·1	3·4, 4·9	2·3	1·9, 2·9	4·6	3·8, 5·6
Monthly family per capita income (in multiples of the country minimum wage)‖																
<0·5	96·4	95·4, 97·2	1·6	1·1, 2·2	1·0	0·7, 1·5	1·0	0·5, 1·9	90·0	87·8, 91·8	3·0	2·5, 3·7	2·2	1·7, 2·9	4·8	3·2, 7·1
0·5–< 1·0	92·8	91·7, 93·8	3·3	2·7, 4·1	2·5	2·0, 3·2	1·3	0·8, 2·0	85·7	84·3, 87·0	5·5	4·8, 6·3	3·3	2·8, 3·9	5·5	4·5, 6·7
1·0–2·0	86·5	84·9, 87·9	7·6	6·5, 8·8	4·9	4·0, 6·0	1·1	0·8, 1·6	80·2	78·8, 81·5	8·6	7·8, 9·5	5·2	4·5, 5·9	6·0	5·3, 6·8
>2·0	73·5	71·2, 75·7	14·3	12·7, 16·1	9·7	8·4, 11·2	2·5	1·9, 3·2	65·0	62·9, 67·0	15·8	14·4, 17·4	9·0	7·8, 10·3	10·2	8·8, 11·8
Being on a diet¶																
Yes	–		–		–		–		51·5	49·4, 53·5	11·1	9·8, 12·6	28·5	26·7, 30·4	8·8	7·8, 10·1
No	–		–		–		–		83·5	82·6, 84·4	4·3	3·9, 4·8	5·7	5·2, 6·2	6·5	5·8, 7·2
Supplement intake¶																
Yes	–		–		–		–		66·3	64·4, 68·2	9·2	8·1, 10·5	16·8	15·4, 18·4	7·7	6·8, 8·7
No	–		–		–		–		81·9	81·0, 82·9	4·4	3·9, 4·9	7·1	6·6, 7·6	6·6	5·9, 7·4

* Adolescents: 10–19 years-old.
† Adults: 20–59 years-old.
‡ Elderly: ≥ 60 years-old.
§ Overweight or obese: adolescents classified according to age- and sex-BMI above +1 z-score of the reference distribution; adults and elderly: BMI ≥ 25 kg/m^2[32,33].
‖ Monthly per capita family income: categorized in multiples of the country's official minimum wage in the middle of the surveys (January 2009: USA$ 174.40; January 2018: USA$ 298.50).
¶ This information was collected only in the 2017–2018 NDS.

Table 3. Contribution (%) of selected food groups to daily energy intake according to the use of table sugar and non-caloric sweeteners. National Dietary Survey, Brazil, 2017–2018

	Contribution to daily energy intake*									
	Total		Table sugar		Non-caloric sweeteners		Both		None	
Food groups	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI	%	95 % CI
Rice and other cereals	25·8	25·4, 26·1	26·2	25·8, 26·6	24·0	23·2, 24·8	23·0	21·9, 24·0	25·1	23·6, 26·5
Beef, pork, poultry, eggs and fish	19·7	19·4, 20·0	19·8	19·5, 20·2	18·9	18·0, 19·8	19·0	18·0, 20·0	19·8	18·5, 21·1
Beans	9·4	9·1, 9·6	9·7	9·5, 9·9	7·7	7·2, 8·3	7·4	6·8, 8·0	9·0	7·8, 10·3
Candies and desserts	9·0	8·8, 9·2	9·7	9·4, 9·9	5·3	4·6, 5·9	9·3	8·6, 10·0	5·8	5·1, 6·5
Fast-food and processed meats	7·6	7·2, 8·0	7·6	7·1, 8·1	8·0	6·9, 9·0	8·0	6·9, 9·0	7·5	6·4, 8·6
Fruits and vegetables	4·4	4·3, 4·5	3·8	3·7, 4·0	7·1	6·6, 7·6	6·5	6·0, 7·1	5·7	5·1, 6·4
Oils and fats	4·1	4·0, 4·3	4·0	3·9, 4·1	5·0	4·6, 5·5	4·7	4·0, 5·4	4·2	3·7, 4·8
Roots and tubers	3·9	3·8, 4·1	3·9	3·8, 4·1	4·1	3·7, 4·6	4·2	3·6, 4·7	3·8	3·2, 4·3
Milk and dairy products	3·9	3·8, 4·1	3·4	3·3, 3·6	6·2	5·5, 6·8	4·8	4·2, 5·4	5·7	5·0, 6·4
Fruit-based drinks and soda	3·9	3·7, 4·0	3·9	3·8, 4·0	3·4	3·1, 3·6	4·2	3·8, 4·6	3·9	3·4, 4·4
Cookies and crackers	3·6	3·4, 3·7	3·6	3·4, 3·8	3·4	3·0, 3·8	3·2	2·8, 3·6	3·6	2·9, 4·3
Coffee and tea	2·2	2·1, 2·2	2·1	2·0, 2·1	2·9	2·7, 3·1	2·4	2·2, 2·6	2·1	1·9, 2·4
Other items†	2·2	2·0, 2·3	2·0	1·8, 2·1	3·4	2·8, 4·1	2·7	2·2, 3·3	3·0	2·2, 3·7

* Contribution to daily energy intake = (energy from food group × 100)/daily energy intake.
† Other items: Nuts and seeds; mixed dishes; broth, chowders and soups.

In this study, ageing, the NCS use was more frequent among individuals who reported being on a diet and taking supplements; comparable results were observed in studies carried out in Brazil[20,42,43] and other countries[44,45], which showed that dietary changes motivated by the desire to lose weight, a healthy lifestyle or a better health condition were associated with NCS use. In addition, the use of NCS was related to a higher intake of fruits and vegetables and selected micronutrients. Changes in eating habits driven by health problems such as diabetes mellitus, cardiovascular diseases or excess weight may explain these findings since increasing the consumption of fruits and vegetables and avoiding sugar intake are usual dietary therapeutic strategies adopted in these conditions[44–46]. Therefore, reverse causality may be a possible explanation for these findings, given that in this sample, 65 % of the NCS users were individuals with excess weight (data not shown). In addition, the high prices of NCS could also contribute to explaining the higher intake of NCS among individuals in the highest income category.

Other studies conducted in Brazil, such as a nationwide population-based survey conducted in 2013–2014,[43] found similar results regarding socio-demographic and lifestyle characteristics associated with NCS use. Additionally, a study carried out in 2010 in the Southern region observed that NCS were used in greater proportion by women, the elderly, individuals with excess weight and in the highest income level[42].

Comparing the findings with other studies is challenging since different methods have been applied to estimate the use of sweeteners, diverse definitions are adopted for both caloric and NCS[15], and food composition databases did not present uniform information about those sweeteners[10,47,48]. Moreover, commonly, sugar- and NCS-sweetened beverages consumption is the exposition estimated to investigate the association between the intake of sweeteners and health outcomes[49–52].

This study is not free from limitations. One limitation is the estimation of table sugar added to foods and beverages which was based on a yes-no question. Therefore, the amount of table sugar added to foods and beverages was estimated taking into account standardised procedures established by The Brazilian Institute of Geography and Statistics (IBGE)[22]. Also, NCS consumption from processed foods and beverages was not evaluated.

A strength of this study is the adoption of robust statistical techniques to correct bias related to dietary intake assessment throughout the estimation of mean usual intake using the National Cancer Institute method[53]. Also, to avoid bias in the comparisons, nutrient intake estimates were adjusted by the main possible confounders, specifically sex, age and total energy intake. Therefore, the results of this study can contribute to indicating trends in the choice of sweeteners and to understanding eating habits and dietary characteristics related to the use of sweeteners, consequently, providing support to health promotion initiatives.

Conclusion

In Brazil, table sugar use has decreased between 2008–2009 and 2017–2018 and the proportion of individuals choosing not to use caloric or NCS increased during the studied period. Table sugar is the sweetener most used in the country and adolescents, individuals in the lowest income level and those living in rural areas were the groups that reported using table sugar in greater proportions. Given the importance of these results to support initiatives to promote healthy eating, future studies should favour the standardisation of definitions and methods used to obtain information on sweeteners use.

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Table 4. Male and female usual daily energy*, macronutrient* and energy-adjusted micronutrient*,† intake according to the use of table sugar and non-caloric sweeteners. National Dietary Survey, Brazil, 2017–2018

		Male					Female				
Mean daily intake		Total	Table sugar	Non-caloric sweeteners	Both	None	Total	Table sugar	Non-caloric sweeteners	Both	None
Energy intake (kcal)	Mean	1941	1985	1846	1813	1790	1549	1566	1467	1470	1454
	95 % CI	1921, 1961	1951, 2018	1825, 1868	1777, 1848	1750, 1831	1522, 1577	1561, 1569	1439, 1481	1439, 1486	1424, 1469
Total carbohydrates‡ (%)	Mean	48	49	45	47	46	50	50	47	49	47
	95 % CI	48, 49	49, 49	44, 46	45, 48	45, 47	49, 50	50, 51	46, 48	48, 50	46, 49
Added sugar‡ (%)	Mean	11	11	7	10	8	11	12	8	11	9
	95 % CI	11, 11	11, 11	6, 8	9, 10	7, 9	11, 11	12, 12	7, 8	10, 11	8, 10
Total protein‡ (%)	Mean	17	17	18	17	17	17	16	18	17	17
	95 % CI	17, 17	17, 17	17, 18	16, 17	17, 18	16, 17	16, 16	17, 18	16, 17	16, 18
Total fat‡ (%)	Mean	27	26	28	27	27	27	27	28	28	28
	95 % CI	26, 27	26, 27	27, 29	26, 28	26, 28	27, 27	27, 27	27, 29	27, 29	27, 28
Saturated fat‡ (%)	Mean	9	9	10	10	10	9	9	10	10	10
	95 % CI	9, 10	9, 9	10, 11	10, 10	10, 11	9, 10	9, 9	10, 10	9, 10	10, 10
Trans fat‡ (%)	Mean	0·7	0·7	0·7	0·6	0·7	0·7	0·7	0·7	0·7	0·7
	95 % CI	0·7, 0·7	0·7, 0·7	0·7, 0·7	0·6, 0·6	0·7, 0·7	0·7, 0·7	0·7, 0·7	0·7, 0·7	0·7, 0·7	0·7, 0·7
Calcium† (mg/1000 kcal)	Mean	253	233	310	266	286	255	246	343	318	287
	95 % CI	245, 261	224, 242	281, 340	262, 270	260, 312	247, 263	242, 250	318, 368	285, 350	259, 315
Sodium† (mg/1000 kcal)	Mean	1343	1340	1360	1309	1369	1299	1295	1340	1275	1296
	95 % CI	1331, 1354	1328, 1353	1314, 1405	1255, 1364	1326, 1413	1288, 1310	1283, 1307	1310, 1370	1238, 1313	1246, 1345
Potassium† (mg/1000 kcal)	Mean	1289	1254	1389	1312	1338	1300	1281	1481	1390	1353
	95 % CI	1277, 1302	1245, 1262	1357, 1421	1287, 1336	1319, 1357	1290, 1310	1268, 1294	1454, 1508	1318, 1461	1224, 1481
Phosphorus† (mg/1000 kcal)	Mean	574	573	628	587	610	574	558	623	589	578
	95 % CI	570, 577	570, 577	607, 650	573, 601	591, 628	571, 578	555, 561	617, 630	573, 605	546, 610
Vitamin A† (mcg/1000 kcal)	Mean	189	149	248	214	202	192	191	312	297	275
	95 % CI	182, 195	142, 155	240, 257	201, 227	185, 218	185, 198	179, 202	296, 327	245, 349	225, 325
Vitamin C† (mg/1000 kcal)	Mean	66	54	75	82	66	66	67	97	106	84
	95 % CI	63, 69	51, 56	67, 83	72, 92	52, 80	63, 69	65, 69	91, 103	84, 128	70, 99

* Age-adjusted estimates of usual intake were estimated by means of The National Cancer Institute statistical method[29].
† Energy-adjusted by nutrient density method[31].
‡ Percent contribution to daily energy intake.

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The Research Ethics Committee of the Institute of Social Medicine of the University of the State of Rio de Janeiro approved the research protocol of the 2008–2009 National Dietary Survey (CAAE 0011.0.259.000-11) and deemed exempt the 2017–2018 National Dietary Survey (# 4.316.087) since data are de-identified and publicly available (www.ibge.gov.br), as authorized by the Brazilian National Health Council Resolution number 46/2012 and Operational Act number 001/2013.

Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S0007114523003057

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