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Variations in beverage consumption in Brazilian adults per weight status: Analysis of the 2008-2009 and 2017-2018 National Food Surveys

Variações no consumo de bebidas em adultos brasileiros segundo o status de peso: análise dos Inquéritos Nacionais de Alimentação 2008-2009 e 2017-2018

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ABSTRACT

Objective
To evaluate the variations between 2008 and 2018 in the consumption of beverages by Brazilian adults per their weight status.

Methods
This panel study analyzed data from two National Food Surveys referring to the adult population (20-59 years of age) (2008-2008: n=21,003; 2017-2018: n=28,153), with data from food consumption obtained by one food record day and one 24-hour recall day, respectively. The drinks were grouped into 11 groups, for which we estimated the reporting proportion (%), daily means of ingested volume (mL), and contribution (%) to daily energy intake. We assessed weight status by Body Mass Index in not overweight, overweight, and obese.

Results
No differences were observed in the proportion of adults who reported consuming a drink (98.5% vs. 98.3%) during the period evaluated. However, the mean daily volume (631.9mL vs. 535.1mL) and the caloric contribution of drinks (17.7% vs. 13.6%) decreased. The drinks most cited in both surveys were coffee, fruit juices, and soft drinks. Not overweight and overweight individuals showed a reduction in the reported and mean volume consumed of coffee, soft drinks, milk, dairy drinks, and processed refreshments/juices. We observed a decline in the reported consumption and volume consumed of soft drinks and milk in obese individuals.

Conclusion
We identified decreased reporting, mean volume, and mean caloric contribution of drinks in general in the Brazilian adult population over the 10-year period between the two surveys.

Keywords: Adult, Beverages, Food intake, Weight status.

RESUMO

Objetivo
Avaliar as variações, entre 2008 e 2018, no consumo de bebidas de adultos brasileiros de acordo com o status de peso.

Métodos
Estudo do tipo painel que analisou dados de dois Inquéritos Nacionais de Alimentação referentes à população adulta (20 a 59 anos de idade) (2008-2008: n=21.003; 2017-2018: n=28.153), sendo os dados de consumo alimentar obtidos por um dia de registro alimentar e um dia de recordatório de 24 horas, respectivamente. As bebidas foram agrupadas em 11 grupos, para os quais foram estimadas a proporção de relato (%) e as médias diárias do volume ingerido (mL) e da contribuição (%) para a ingestão energética diária. O status de peso foi avaliado pelo Índice de Massa Corporal em sem excesso de peso, sobrepeso e obesidade.

Resultados
No período avaliado não foram observadas diferenças na proporção de adultos que relataram consumir alguma bebida (98,5% vs. 98,3%); porém, o volume médio diário (631,9mL vs. 535,1mL) e a contribuição calórica das bebidas (17,7% vs. 13,6%) reduziram. As bebidas mais citadas nos dois inquéritos foram café, sucos de frutas e refrigerantes. Indivíduos sem excesso de peso e com sobrepeso apresentaram redução do relato e no volume médio consumido de café, refrigerantes, leite, bebidas lácteas e refrescos/sucos processados. Para indivíduos com obesidade, observou-se redução no relato de consumo e no volume consumido de refrigerantes e leite.

Conclusão
No período de 10 anos entre os dois inquéritos, observou-se, na população adulta brasileira, redução do relato, volume médio e contribuição calórica média das bebidas em geral.

Palavras-chave: *Adulto, Bebidas, Consumo alimentar, Status de peso.*

INTRODUCTION

The prevalence of overweight and obesity has increased throughout the Brazilian population in recent decades, along with rising rates of chronic NonCommunicable Diseases (NCDs), characterizing it as one of the leading public health problems in the country [1,2]. The 2019 National Health Survey (PNS 2019) revealed that around 60% of Brazilian adults are overweight (Body Mass Index – BMI ≥25kg/m2) and 26% are obese (BMI≥30kg/m2) [3].

Inadequate diet is one of the leading causes of obesity and NCDs [4–6], with frequent consumption of ultra-processed foods standing out as one of the primary health risk markers [7–9]. In 2019, the consumption of ultra-processed foods was responsible for more than 10% of premature deaths in Brazilian adults aged 30-69 [10]. Sugar-added beverages such as soft drinks, dairy drinks, and processed fruit drinks are ultra-processed foods that have gained a place in the global population diet, adversely affecting diet quality [11–13]. Leal et al. [14] estimated that approximately BRL 56 million were spent on medium- and high-complexity procedures in the Brazilian Unified Health System for treating NCDs attributed to sweetened beverages in 2019.

Bray [15] affirms that the consumption of sugar-sweetened beverages is associated with the risk of developing obesity, diabetes mellitus, cardiovascular diseases, and metabolic syndrome. Moreover, the consumption of beverages has been identified as an additional energy source in the diet that is not compensated for by lower consumption of other foods [16,17].

Brazil recorded an increase in the size of portions consumed of alcoholic beverages, refreshments, caloric soft drinks, milk, dairy products, and fruit juices, particularly among individuals aged 20-40 [18] between the 2008-2009 and 2017-2018 National Food Surveys. On the other hand, results from national surveys indicate a decline in the purchase of minimally processed beverages, such as whole and skimmed milk [19].

Thus, beverages play an essential role in the diet and are relevant to developing diseases that are public health problems, such as obesity, diabetes, and other metabolic disorders. However, only some nationwide studies have identified the consumption of different beverages in the Brazilian population. This study aims to evaluate the variations between the 2008-2009 and 2017-2018 periods in the intake of beverages in the Brazilian adult population per weight status.

METHODS

This panel study evaluated adult individuals examined in the National Food Surveys included as modules of the 2008-2009 and 2017-2018 *Pesquisa de Orçamentos Familiares* (POF, Household Budget Surveys) conducted by the Brazilian Institute of Geography and Statistics. Both surveys were performed on representative samples of the Brazilian population, and data collection covered all geographic and socioeconomic strata. More sampling details were published by the *Instituto Brasileiro de Geografia e Estatistica* [20,21].

A total of 55,970 households were surveyed in the 2008-2009 POF, and 57,920 households were included in the 2017-2018 POF. The 2008-2009 *Inquérito Nacional de Alimentação (*INA, National Food Survey) subsample included 13,569 households with 21,003 adults aged 20-59 (after excluding 1,065 pregnant and breastfeeding women) [20]. In the 2017-2018 INA, the sample consisted of 20,112 households, and 28,153 individuals were adults aged 20-59, excluding pregnant and breastfeeding women (n=1,200) [21].

This study analyzes data on beverage consumption (dependent variable) by weight status (independent variable) adjusted for sex (male and female), age (continuous), and per capita household income, which are potential confounding factors.

Food consumption data was obtained by food records in the 2008-2009 INA and 24-hour recall in the 2017-2018 INA on two non-consecutive days [20,21]. Only the information collected on the first day of each survey was used for this analysis. Data from the first day of food consumption assessment tends to be of better quality than data from subsequent days [22]. Furthermore, for population studies, one day of assessment allows for estimating the mean population intake [23,24].

When completing the food records in the INA 2008-2009, respondents wrote down all the food and drink consumed throughout the day and information on the food type, amount, time, place, and preparation method when necessary. Respondents received a booklet with detailed instructions for completing the records, along with photos of the kitchen utensils and containers most commonly used for portioning food [20], to assist in the quality of the data collected on consumption.

In 2017-2018, 24-hour recalls were performed through personal interviews by trained survey agents based on the multiple-pass method [25]. In both surveys, consumption data was collected with a computer program developed specifically for this survey [20,21].

The amount consumed in grams or milliliters was calculated from the mass and volume measurements defined in a database compiled for the surveys [20,21]. The Brazilian Food Composition Table from the University of São Paulo's Food Research Center (http://www.fcf.usp.br/tbca/) was

Chart 1 – Groups of beverages. 2008-2009 and 2017-2018 National Food Survey, Brazil.

Group	Beverages
Coffee	Coffee, coffee with milk, cappuccino, coffee with flour and barley
Fruit juices	Coconut water, sugarcane juice, fruit/vegetable juice
Soft drinks	Soft drink of any kind, regular or light/diet
Milk	Whole milk, skimmed milk, goat milk
Milk-based drinks	Regular and diet chocolate drinks/milk, milk-based drinks, flavored milk, fermented milk
Tea and infusions	Black or herbal tea, mate, yerba mate, mate traditional mate, and tereré
Processed refreshments/juices	Bottle refreshment, canned and powdered, regular and diet
Vitamins	Fruit vitamin (milk + fruit)
Beer	Beer with and without alcohol and draft beer
Other alcoholic beverages	Batida, cachaça, cognac, whisky, vodka, rum, fruit cocktail, caipirinha, cider, champagne, and wine
Other sugar-added beverages	Soja milk, energy drink, and isotonic drink

adopted to estimate the caloric content of the drinks mentioned in both surveys [26]. The drinks reported in both surveys were categorized into 11 groups, as detailed in Chart 1.

In the 2008-2009 INA, the research agents measured anthropometric data (weight and height). These data were self-reported in the 2017-2018 INA. Weight status was assessed using the Body Mass Index (BMI=weight/height2) and classified under the criteria proposed by the World Health Organization [27]. In this study, weight status was categorized as not overweight (grouping the categories of underweight and adequate weight – BMI<25 kg/m^2), overweight (25≤BMI<30 kg/m^2), and obese (BMI ≥ 30kg/m^2).

Per capita monthly household income was estimated by dividing the total household income (estimated from the sum of the monthly monetary and non-monetary income of all family members) by the number of individuals in the household. Income was categorized based on multiples of the official Brazilian monthly minimum wage in force in January 2009 (BRL 415.00) [20] and January 2018 (BRL 954.00) [21] into <0.5 minimum wage per capita; 0.5 to <1.0 minimum wage per capita; 1.0 to 2.0 minimum wages per capita; and > 2.0 minimum wages per capita.

The data were analyzed using the Statistical Package for Social Sciences (SPSS), version 19 (IBM®SPSS® Statistics), considering sample weights and the design effect. The proportion of reported consumption (%), the mean volume consumed (mL), and the mean caloric contribution (%) to daily energy intake and their respective 95% confidence intervals (95%CI) were estimated for the beverage groups and all beverages reported in both surveys.

The calculation of the caloric contribution considered the energy intake from each group of drinks and the total daily energy intake. It was estimated using the following formula: Caloric contribution of beverages = [Energy from beverages (kcal) / Daily energy (kcal)] * 100. The means were adjusted for gender, age, and per capita household income. The overlap of the 95%CI was considered to assess variations in the estimates (proportions and means) over the period studied and between weight status categories (not overweight, overweight, and obese).

Odds Ratios (OR) and respective 95% confidence intervals were estimated for changes in reported beverage consumption using logistic regression models, considering each beverage group's reported (yes vs. no) consumption. Mean differences in beverage consumption (volume and caloric contribution) between the two surveys (2017-2018 minus 2008-2009) were estimated using Generalized Linear Models with Gamma distribution and identity link function. Both estimates were adjusted for gender, age, and per capita household income and stratified by weight status.

This study was considered exempt by the Research Ethics Committee of the Institute of Social Medicine of the State University of Rio de Janeiro (opinion no. 4.316.087) under the National Health

Council Resolution n° 46/2012 and Operational Law n° 001/2013 since the data is de-identified and made publicly available.

RESULTS

In the 2008-2009 INA, the mean age of adults was 37.6 years, 50.2% of the population was male, 34.0% were overweight, 14.5% were obese, and 33.0% belonged to households with a per capita income of more than two minimum wages. In the 2017-2018 INA, the mean age of adults was 39.0 years; 50.2% were female, 38.7% were overweight, 16.7% were obese, and 28.2% had a per capita household income of more than two minimum wages (data not shown).

Overall, a reduction in the proportion of adults who reported consuming any beverage (98.5% vs. 96.8%) was observed between 2008-2009 and 2017-2018. The most frequently mentioned drinks in both surveys were coffee (82.7% and 81.4%), fruit juices (33.9% and 33.5%), and soft drinks (25.1% and 16.3%). A significant decline in reported consumption of coffee (OR=0.84), soft drinks (OR=0.61), milk (OR=0.39), dairy drinks (OR=0.70), processed refreshments/juices (OR=0.61), and other sugar-added drinks (OR=0.44) was found between 2008-2009 and 2017-2018. On the other hand, the reported consumption of tea and infusions increased (OR=1.16) (Table 1).

When evaluating changes in reported beverage consumption by weight status categories, we observed a decline in beverages in general among non-overweight and overweight individuals. However, no significant variation in the reported beverage consumption, in general, was found among obese individuals. A reduction in coffee (OR=0.88 and OR=0.79), soft drinks (OR=0.62 and OR=0.61), milk (OR=0.45 and OR=0.38), dairy drinks (OR=0.71 and OR=0.59), and processed refreshments/juices (OR=0.59 and OR=0.61) among not overweight and overweight individuals was noted.

Obese individuals showed a decline in the reported consumption of soft drinks (OR=0.58), milk (OR=0.29), and processed refreshments/juices (OR=0.71). Not overweight individuals showed a reduction in the report of other sugar-added drinks (OR=0.41), while overweight individuals had an increase in the report of tea and infusions (OR=1.29) (Table 1).

The 2008-2009 and 2017-2018 INA did not show, in general, differences in the reported consumption of beverages between weight status categories. In 2008-2009, dairy drink consumption

Table 1 – Beverage consumption in Brazilian adults (total population and per weight status) in two national food surveys: report[1] (% and 95% CI) and odds ratio[2] of change between the two studies. Brazil, 2008-2009; 2017-2018.

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Beverages	Total	Weight status		
		Not overweight	Overweight	Obese
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
All beverages				
2008/2009	98.5 (98.3; 98.9)	98.5 (98.2; 98.9)	98.8 (98.5; 99.2)	97.9 (97.2; 98.6)
2017/2018	96.8 (96.4; 97.1)	96.8 (96.3; 97.3)	96.7 (96.2; 97.2)	96.7 (96.1; 97.4)
Odds ratio	0.44 (0.36; 0.53)	0.44 (0.33; 0.58)	0.35 (0.25; 0.50)	0.67 (0.44; 1.03)
Coffee				
2008/2009	82.7 (81.7; 83.7)	81.9 (80.6; 83.3)	83.7 (82.0; 85.5)	82.9 (80.9; 84.9)
2017/2018	81.4 (80.5; 82.3)	81.4 (80.1; 82.6)	81.6 (80.3; 82.9)	81.0 (79.1; 82.9)
Odds ratio	0.84 (0.77; 0.93)	0.88 (0.77; 0.99)	0.79 (0.68; 0.94)	0.83 (0.68; 1.02)
Fruit juices				
2008/2009	33.9 (32.5; 35.3)	33.9 (32.3; 35.6)	34.2 (32.1; 36.3)	33.1 (30.3; 35.8)
2017/2018	33.5 (32.4; 34.6)	33.4 (31.9; 34.8)	34.6 (33.0; 36.2)	31.4 (29.2; 33.7)
Odds ratio	1.01 (0.94; 1.09)	0.99 (0.89; 1.09)	1.05 (0.94; 1.18)	0.96 (0.81; 1.13)
Soft drinks#				
2008/2009	25.1 (23.9; 26.4)	24.5 (22.8; 26.1)	25.1 (23.3; 27.0)	27.5 (24.8; 30.1)
2017/2018	16.3 (15.4; 17.2)	16.0 (14.7; 17.2)	16.3 (15.0; 17.6)	17.3 (15.5; 19.0)

Table 1 – Beverage consumption in Brazilian adults (total population and per weight status) in two national food surveys: report[1] (% and 95% CI) and odds ratio[2] of change between the two studies. Brazil, 2008-2009; 2017-2018.

Beverages	Total	Weight status		
		Not overweight	Overweight	Obese
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Odds ratio	0.61 (0.55; 0.67)	0.62 (0.54; 0.71)	0.61 (0.53; 0.71)	0.58 (0.48; 0.70)
Milk				
2008/2009	13.9 (12.9; 14.8)	13.9 (12.7; 15.1)	13.5 (12.0; 15.0)	14.4 (12.4; 16.5)
2017/2018	6.0 (5.5; 6.4)	6.8 (6.0; 7.5)	5.6 (4.9; 6.3)	4.6 (3.7; 5.5)
Odds ratio	0.39 (0.35; 0.44)	0.45 (0.38; 0.52)	0.38 (0.32; 0.46)	0.29 (0.23; 0.38)
Milk-based drinks				
2008/2009	5.9 (5.1; 6.7)	6.7 (5.5; 7.8)	5.6 (4.4; 6.7)	4.1 (2.9; 5.2)
2017/2018	3.8 (3.4; 4.3)	4.3 (3.6; 5.0)	3.2 (2.6; 3.7)	4.1 (3.1; 5.2)
Odds ratio	0.70 (0.58; 0.86)	0.71 (0.55; 0.91)	0.59 (0.44; 0.80)	1.15 (0.75; 1.76)
Tea and infusions				
2008/2009	6.3 (5.6; 6.9)	6.2 (5.3; 7.1)	6.1 (5.2; 7.1)	7.2 (5.5; 8.8)
2017/2018	7.4 (6.8; 7.9)	7.2 (6.5; 8.0)	7.8 (7.0; 8.7)	6.7 (5.7; 7.8)
Odds ratio	1.16 (1.01; 1.34)	1.16 (0.95; 1.43)	1.29 (1.05; 1.59)	0.98 (0.68; 1.18)
Refreshment/processed juices#				
2008/2009	7.5 (6.7; 8.3)	7.6 (6.6; 8.6)	7.4 (6.3; 8.5)	7.3 (5.7; 8.8)
2017/2018	4.6 (4.1; 5.1)	4.5 (3.8; 5.2)	4.6 (3.9; 5.2)	5.1 (4.0; 6.2)
Odds ratio	0.61 (0.52; 0.72)	0.59 (0.47; 0.73)	0.61 (0.49; 0.76)	0.71 (0.51; 0.98)
Vitamins				
2008/2009	2.9 (2.4; 3.4)	3.0 (2.3; 3.7)	2.9 (2.3; 3.7)	2.6 (1.6; 3.7)
2017/2018	2.5 (2.2; 2.8)	2.8 (2.3; 3.2)	2.3 (1.8; 2.8)	2.4 (1.7; 3.1)
Odds ratio	0.88 (0.72; 1.09)	0.94 (0.70; 1.30)	0.79 (0.57; 1.10)	0.89 (0.54; 1.50)
Beer				
2008/2009	4.1 (3.5; 4.7)	3.5 (2.9; 4.1)	4.6 (3.6; 5.6)	5.1 (3.4; 6.8)
2017/2018	3.6 (3.1; 4.2)	3.4 (2.8; 4.0)	3.9 (3.0; 4.9)	3.5 (2.6; 4.5)
Odds ratio	0.91 (0.73; 1.15)	1.03 (0.8; 1.40)	0.88 (0.62; 1.20)	0.71 (0.43; 1.20)
Other alcoholic beverages*				
2008/2009	1.5 (1.2; 1.8)	1.9 (1.4; 2.4)	1.1 (0.7; 1.6)	0.9 (0.4; 1.6)
2017/2018	1.4 (1.1; 1.7)	1.4 (1.1; 1.8)	1.3 (0.9; 1.7)	1.5 (0.8; 2.2)
Odds ratio	0.93 (0.69; 1.24)	0.75 (0.51; 1.10)	1.12 (0.71; 1.78)	1.4 (0.70; 2.80)
Other sugar-added beverages**				
2008/2009	0.8 (0.5; 0.1)	0.8 (0.4; 1.1)	0.8 (0.2; 1.4)	0.8 (0.4; 1.5)
2017/2018	0.3 (0.2; 0.4)	0.3 (0.2; 0.4)	0.3 (0.2; 0.5)	0.4 (0.001; 0.8)
Odds ratio	0.44 (0.27; 0.72)	0.41 (0.22; 0.77)	0.45 (0.19; 1.03)	0.4 (0.10; 1.70)

Note: *Other alcoholic beverages include wine and Spirits; **Other sugar-added beverages include energy, isotonic, and soy-based drinks; #Regular and low-calory. [1]Frequencies adjusted by gender, age, and per capita household income; [2]Odds ratio of change in reporting between the two surveys, with the dependent variable being the frequency of reporting consumption and the independent variable being the survey year. CI: Confidence Interval.

was reported to a more significant proportion among individuals who were not overweight (6.7%) than those who were obese (4.1%). In 2017-2018, milk consumption was mentioned in a more significant proportion among individuals who were not overweight (6.8%) than those who were obese (4.6%) (Table 1).

In the period evaluated, we observed a reduction in the mean volume of drinks generally consumed daily (631.9mL vs. 535.1mL), with a significant decline in the volume of consumed coffee (-57.5mL), soft drinks (-27.1mL), milk (-20.2mL), processed refreshments/juices (-7.8mL), and dairy drinks (-4.2mL). On the other hand, we identified a growing volume of tea and infusions (16.2mL) and fruit juices (9.25mL) consumed (Table 2).

When evaluating the variation between the two surveys in the volume of beverages consumed by weight status categories, we observed that individuals who were not overweight and overweight/obese reduced, in general, their mean volume of beverages. The same thing was observed for coffee, which had a mean decrease of -59.5mL in not overweight and overweight individuals, and -41.0mL for obese, soft drinks (-24.4mL, -30.4mL, and -32.6mL) and milk (-18.6mL, -20.1mL and -24.8mL).

Table 2 – Beverage consumption in Brazilian adults (total population and according to weight status) in two national food surveys: means[1] [in mL] (and 95% CI) of daily intake and difference[2] in intake between the two surveys. Brazil, 2008-2009; 2017-2018.

Beverages	Total	Weight status		
		Not overweight	Overweight	Obese
	Mean (in mL) (95% CI)	Mean (in mL) (95% CI)	Mean (in mL) (95% CI)	Mean (in mL) (95% CI)
All beverages				
2008/2009	631.9 (617.7; 646.1)	620.9 (604.5; 637.3)	636.3 (614.2; 658.4)	660.7(620.0; 701.4)
2017/2018	535.1(522.9; 547.2)	523.6 (508.1; 539.1)	534.1 (516.4; 551.8)	567.8(536.9; 598.6)
Difference (*p*-value)[†]	-87.3 (<0.01)	-90.5 (<0.01)	-91.4 (<0.01)	-85.1(<0.01)
Coffee				
2008/2009	223.6 (217.5; 229.8)	228.0 (219.9; 236.0)	223.0 (213.9; 232.0)	209.8(198.7; 221.0)
2017/2018	169.9 (165.1; 174.7)	172.5 (165.5; 179.5)	166.3 (160.1; 172.5)	171.4 (157.7; 185.1)
Difference (*p*-value)	-57.5 (<0.01)	-59.5 (<0.01)	-59.5 (<0.01)	-41.0 (<0.01)
Fruit juices				
2008/2009	122.9 (117.2; 128.6)	122.3 (115.2; 129.4)	124.8 (115.5; 134.2)	120.3(108.5;132.0)
2017/2018	128.5 (123.1; 133.8)	124.8 (118.1; 131.5)	130.8 (122.9; 138.7)	132.8 (119.7; 145.8)
Difference (*p*-value)	9.25 (0.02)	4.6 (0.36)	10.9 (0.08)	16.1 (0.07)
Soft drinks[#]				
2008/2009	103.8 (97.6; 110.1)	97.3 (89.7; 105.0)	107.0 (95.6; 118.3)	119.5(103.8; 135.3)
2017/2018	71.1 (66.6; 75.7)	67.2 (61.0; 73.4)	71.3 (64.5; 78.1)	81.1 (71.1; 91.2)
Difference (*p*-value)	-27.1 (<0.01)	-24.4 (<0.01)	-30.4 (<0.01)	-32.6 (<0.01)
Milk				
2008/2009	35.3 (32.7; 37.9)	35.9 (32.2; 39.5)	33.7 (29.8; 37.7)	37.1(31.2; 43.0)
2017/2018	14.8 (13.4; 16.2)	17.1 (14.8; 19.4)	13.3 (11.5; 15.1)	12.2 (9.5; 14.9)
Difference (*p*-value)	-20.2 (<0.01)	-18.6 (<0.01)	-20.1 (<0.01)	-24.8 (<0.01)
Milk-based drinks				
2008/2009	15.7 (13.6; 17.9)	17.3 (14.3; 20.3)	15.6 (12.1; 19.0)	10.6 (7.6; 13.5)
2017/2018	10.3 (9.0; 11.6)	11.6 (9.6; 13.7)	8.2 (6.8; 9.6)	11.5 (7.7; 15.2)
Difference (*p*-value)	-4.2 (0.01)	-4.5 (0.016)	-6.2 (<0.01)	1.8 (0.39)
Tea and infusions				
2008/2009	35.7 (30.0; 41.4)	31.8 (24.7; 38.9)	35.2 (27.9; 42.5)	50.7 (34.8; 66.5)
2017/2018	52.6 (47.3; 57.9)	48.7 (42.2; 55.2)	54.8 (47.6; 62.0)	57.9 (45.0; 70.8)
Difference (*p*-value)	16.2 (<0.01)	14.6(<0.01)	20.2 (<0.01)	6.9 (0.50)
Refreshment/processed juices[#]				
2008/2009	25.3 (21.9; 28.7)	25.2 (20.9; 29.6)	24.7(20.1; 29.3)	26.8 (20.1; 33.6)
2017/2018	17.0 (14.8; 19.1)	15.9 (13.0; 18.8)	16.5 (13.9; 19.2)	20.8 (14.4; 27.1)
Difference (*p*-value)	-7.8 (<0.01)	-9.0 (<0.01)	-7.7 (<0.01)	-4.6 (0.32)
Vitamins				
2008/2009	9.4 (7.9; 10.9)	9.4 (7.4; 11.5)	9.8 (7.2; 12.3)	8.3 (5.2; 11.4)
2017/2018	8.6 (7.4; 9.8)	9.6 (7.9; 11.4)	7.7 (5.9; 9.4)	7.9 (5.6; 10.3)
Difference (*p*-value)	-0.51 (0.59)	0.3 (0.83)	-1.8 (0.27)	-0.32 (0.87)
Beer				
2008/2009	43.5 (35.7; 51.9)	35.0 (27.8;42.2)	47.4 (33.1;61.8)	64.6 (32.6; 96.6)
2017/2018	47.9 (41.2; 54.5)	42.2 (34.1; 50.4)	49.5 (38.5; 60.5)	59.0 (42.7; 75.3)
Difference (*p*-value)	5.68 (0.30)	9.7 (0.07)	2.03 (0.84)	-6.8 (0.72)
Other alcoholic beverages*				
2008/2009	3.6 (2.8; 4.4)	4.6 (3.3; 5.9)	2.8 (1.5; 4.0)	2.3 (1.0; 3.6)
2017/2018	4.5 (3.3; 5.8)	4.0 (2.5; 5.6)	4.9 (2.4; 7.5)	5.0 (2.2; 7.8)
Difference (*p*-value)	0.95 (0.24)	-0.3 (0.76)	2.0 (0.18)	2.2 (0.14)
Other sugar-added beverages**				
2008/2009	2.2 (1.4; 3.0)	2.1 (1.1; 3.1)	2.5 (0.5; 4.5)	2.1 (0.2; 3.9)
2017/2018	1.0 (0.6; 1.4)	0.8 (0.4; 1.2)	1.2 (0.4; 1.9)	1.2 (0.1; 2.5)
Difference (*p*-value)	-1.07 (0.02)	-1.1 (0.02)	-1.2 (0.20)	-0.98 (0.39)

Note: *Other alcoholic beverages include wine and Spirits; **Other sugar-added beverages include energy, isotonic, and soy-based drinks; [†]Statistical significance using generalized linear models; [#]Regular and low-calory. [1]Means adjusted by sex, age, and per capita household income; [2]Mean difference between the evaluated periods: 2017-2018 – 2008-2009. CI: confidence interval.

For not overweight and overweight individuals, a reduction in the mean volume consumed of dairy drinks (-4.5mL and -6.2mL) and processed refreshments/juices (-9.0mL and -7.7mL) and an increase for tea and infusions (14.6mL and 20.2mL) was noted between the two surveys. In 2017-2018, not overweight individuals reported a higher mean daily intake of dairy drinks (11.6mL) than those overweight (8.2mL) (Table 2).

In general, the caloric contribution of beverages to daily energy intake declined between the two surveys (17.7% vs. 13.6%). Moreover, there was a significant reduction for coffee (-2.4 percentage points – pp), milk (-0.68 pp), fruit juices (-0.37 pp), soft drinks (-0.35 pp), dairy drinks (-0.17 pp), and tea and infusions (-0.11 pp) (Table 3).

Table 3 – Beverage consumption in Brazilian adults (total population and by weight status) in two national food surveys: means[1] (and 95% CI) of the percentage contribution to daily energy intake[2] and difference[3] in this contribution between the two studies. Brazil, 2008-2009; 2017-2018.

Beverages	Total	Weight status		
		Not overweight	Overweight	Obesity
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
All beverages				
2008/2009	17.7 (17.4; 18.0)	17.7 (17.3; 18.0)	18.1 (17.6; 18.6)	16.9 (16.3; 17.6)
2017/2018	13.6 (13.4; 13.9)	13.7 (13.3; 14.0)	13.5 (13.1; 13.9)	13.8 (13.3; 14.4)
Difference (*p*-value)[†]	-3.93 (<0.01)	-3.9 (<0.01)	-4.4 (<0.01)	-3.0 (<0.01)
Coffee				
2008/2009	7.2 (7.0; 7.5)	7.3 (7.0; 7.6)	7.5 (7.1; 7.8)	6.4 (6.1; 6.8)
2017/2018	4.9 (4.8; 5.1)	4.9 (4.7; 5.1)	4.9 (4.7; 5.1)	5.1 (4.7; 5.4)
Difference (*p*-value)	-2.4 (<0.01)	-2.5 (<0.01)	-2.7 (<0.01)	-1.6 (<0.01)
Fruit juices				
2008/2009	4.1 (3.9; 4.3)	4.1 (3.8; 4.3)	4.2 (3.9; 4.6)	3.9 (3.5; 4.3)
2017/2018	3.6 (3.5; 3.8)	3.7 (3.5; 3.9)	3.7 (3.4; 3.9)	3.5 (3.2; 3.8)
Difference (*p*-value)	-0.37 (<0.01)	-0.34 (0.04)	-0.50 (0.02)	-0.32 (0.21)
Soft drinks[#]				
2008/2009	1.8 (1.7; 1.9)	1.7 (1.6; 1.9)	1.9 (1.6; 2.1)	2.0 (1.7; 2.2)
2017/2018	1.4 (1.3; 1.5)	1.3 (1.2; 1.5)	1.3 (1.2; 1.5)	1.6 (1.4; 1.8)
Difference (*p*-value)	-0.35 (<0.01)	-0.31 (<0.01)	-0.45 (<0.01)	-0.28 (0.08)
Milk				
2008/2009	1.3 (1.2; 1.4)	1.3 (1.2; 1.5)	1.2 (1.1; 1.4)	1.5 (1.2; 1.8)
2017/2018	0.66 (0.59; 0.72)	0.74 (0.64; 0.84)	0.61 (0.52; 0.69)	0.54 (0.42; 0.66)
Difference (*p*-value)	-0.68 (<0.01)	-0.62 (<0.01)	-0.64 (<0.01)	-0.96 (<0.01)
Milk-based drinks				
2008/2009	0.68 (0.58; 0.78)	0.78 (0.64; 0.93)	0.68 (0.53; 0.83)	0.52 (0.36; 0.68)
2017/2018	0.51 (0.45; 0.57)	0.55 (0.45; 0.64)	0.39 (0.32; 0.46)	0.50 (0.36; 0.65)
Difference (*p*-value)	-0.17 (<0.01)	-0.19 (0.03)	-0.24 (<0.01)	0.03 (0.75)
Tea and infusions				
2008/2009	0.24 (0.20; 0.27)	0.25 (0.19; 0.30)	0.20 (0.17; 0.27)	0.23 (0.15; 0.30)
2017/2018	0.13 (0.11; 0.15)	0.12 (0.10; 0.15)	0.15 (0.12; 0.18)	0.11 (0.08; 0.14)
Difference (*p*-value)	-0.11 (<0.01)	-0.13 (<0.01)	-0.08 (0.01)	-0.14 (<0.01)
Refreshment/processed juices[#]				
2008/2009	0.36 (0.31; 0.41)	0.35 (0.29; 0.41)	0.37 (0.30; 0.44)	0.40(0.29; 0.51)
2017/2018	0.39 (0.34; 0.44)	0.37 (0.30; 0.44)	0.39 (0.31; 0.46)	0.46(0.34; 0.58)
Difference (*p*-value)	0.33 (0.38)	0.02 (0.59)	0.02 (0.67)	0.08(0.36)
Vitamins				
2008/2009	0.43 (0.34; 0.51)	0.43 (0.33; 0.52)	0.48 (0.31; 0.64)	0.34 (0.23; 0.45)
2017/2018	0.49 (0.43; 0.56)	0.50 (0.41; 0.60)	0.46 (0.35; 0.57)	0.51 (0.35; 0.66)
Difference (*p*-value)	0.07 (0.21)	0.08 (0.22)	0.004 (0.97)	0.17 (0.07)
Beer				
2008/2009	0.68 (0.56; 0.79)	0.55 (0.45; 0.65)	0.76 (0.56; 0.96)	1.0 (0.57; 1.4)
2017/2018	0.80 (0.67; 0.92)	0.71 (0.57; 0.84)	0.82 (0.63; 1.01)	0.92 (0.68; 1.17)
Difference (*p*-value)	0.12 (0.17)	0.19 (0.03)	0.06 (0.68)	-0.08 (0.76)
Other alcoholic beverages*				
2008/2009	0.21 (0.16; 0.25)	0.27 (0.20; 0.34)	0.15 (0.9; 0.20)	0.13 (0.05; 0.21)
2017/2018	0.26 (0.19; 0.32)	0.26 (0.19; 0.34)	0.25 (0.14; 0.37)	0.25 (0.13; 0.37)
Difference (*p*-value)	0.05 (0.02)	0.01 (0.88)	0.1 (0.15)	0.1 (0.21)
Other sugar-added beverages**				
2008/2009	0.07 (0.04; 0.09)	0.05 (0.03; 0.07)	0.09 (0.003; 0.19)	0.06 (0.02; 0.10)
2017/2018	0.02 (0.01; 0.03)	0.02 (0.01; 0.03)	0.03 (0.01; 0.04)	0.03 (0.001; 0.06)
Difference (*p*-value)	-0.04 (<0.01)	-0.03 (<0.01)	-0.06 (0.13)	-0.03 (0.18)

Note: *Other alcoholic beverages include wine and Spirits; **Other sugar-added beverages include energy, isotonic, and soy-based drinks; [†]Statistical significance using generalized linear models; [#]Regular and low-calory. [1]Means adjusted by sex, age, and per capita household income; [2]Percentage contribution to daily energy intake: (Energy from drinks / Daily energy) * 100; [3]Mean difference between the evaluated periods: 2017-2018 – 2008-2009. CI: confidence interval.

The caloric contribution of beverages, in general, fell over the period assessed for not overweight and overweight/obese individuals, as was observed for coffee (-2.5, -2.7, and -1.6 pp, respectively), milk (-0.62, -0.64, and -0.9 pp), and tea and infusions (-0.13, -0.08 and -0.14 pp). There was a reduction in the caloric contribution of fruit juices, soft drinks, and dairy drinks among not overweight individuals (-0.34, -0.31, and -0.19 pp, respectively) and those overweight (-0.50, -0.45, and -0.24 pp). Finally, there was an increase in the caloric contribution for beer (0.19%) among not overweight individuals (Table 3).

DISCUSSION

In Brazilian adults, a slight reduction in the reported consumption of beverages, in general, was recorded in the 10 years between the two INAs. This downward trend was accompanied by a decrease of approximately 15% in the mean volume consumed and 22% in the caloric contribution to daily energy intake. However, there was no variation in the reported consumption of beverages among obese individuals, although the mean volume consumed fell by 12% and the caloric contribution of beverages by 18%.

The most frequently mentioned beverages in both surveys were coffee, fruit juices, and soft drinks, which had the highest volume consumed and contributed to energy intake. The main variations between the two studies were recorded for milk, for which the proportion of reports and the mean volume consumed decreased by ≈60%, and the caloric contribution decreased by ≈45%. Dairy drink consumption also varied consistently between the two surveys, with a decrease of around 30% for reported consumption, mean volume consumed, and energy contribution. A comparison of beverage consumption between weight status categories in the same survey showed no significant differences.

Aligned with similar studies, the consumption of soft drinks among Brazilian adults fell over the period studied, but it is unclear whether this reduction is related to an increase in the consumption of other drinks, as observed in Australia, where the decline in the purchase of soft drinks was accompanied by an increasing purchase of other sugar-added or non-caloric drinks [28–30]. In this study, the only group of drinks with a growing consumption over the period studied was teas and infusions, which include black or herbal tea, mate, yerba mate, traditional mate, and tereré.

A downward trend in the consumption of sweetened beverages among adults was observed between 2007 and 2016 by the Surveillance System for Risk and Protective Factors for Chronic Diseases by Telephone Survey (Vigitel) [31]. Similar findings were found for Australian adults in a study that analyzed different data sources and showed a declining availability and consumption of sugar-sweetened beverages between the last decades of the 20th century and the first decades of the 21st century [32]. In the American population, Marriott et al. [33] analyzed data from seven consecutive cycles of the National Health and Nutrition Examination Survey (NHANES) conducted from 2003-2004 to 2015-2016 and observed that in adults (≥20 years of age) energy intake from all beverages decreased by 23%, that from sugar-added drinks decreased by approximately 50%, and that from soft drinks by 48%. On the other hand, in the Spanish population, Rodríguez Alonso et al. [34] observed a 721% increase in the consumption of non-alcoholic drinks between 1964 and 2014, from 46 g/person/day in 1964 to 96 g/person/day in 1991, 240 g/person/day in 2000, and 332 g/person/day in 2014.

The contradiction between the lower consumption of beverages, especially soft drinks, along with the increase in excessive weight gain is also evidenced by data from VIGITEL, which shows a decrease in the frequency of adults who reported drinking soft drinks five or more days a

week from 30.9% in 2007 to 14.0% in 2021, which was accompanied by a growth in the frequency of overweight adults (BMI≥25kg/m2), from 42.6% in 2006 to 57.2% in 2021 [2], while the prevalence of obesity practically doubled in both men (from 12.4% to 22.8%) and women (from 16.9% to 30.2%), as evidenced by data from the 2008-2009 POF and the 2019 National Health Survey [35]. Barclay and Brand-Miller [36] introduced the concept of the Australian paradox by showing the inverse relationship between the secular trend of an increased prevalence of obesity and decreased refined sugar consumption, which indicates the need to consider the different sugar-added sources when proposing dietary recommendations and guidelines and considering other factors that affect body weight gain, such as physical activity.

Excessive intake of sugar-added drinks has been considered a risk factor for increased body weight and for developing NCDs [37,38]. Encouraging the consumption of artificially sweetened beverages was initially considered a strategy to improve the quality of food consumption. However, the intake of artificial sweeteners and their long-term effects have also been questioned, and they are discouraged for healthy individuals. They should be used with caution in individuals with obesity or other comorbidities [37,39]. Therefore, the intake of water and unsweetened drinks with a low glycemic index has been underscored as the best option for replacing sweetened drinks to prevent weight gain [40].

Oliveira and Canela [19] analyzed the purchase of beverages per the processing level in Brazilian households based on data from the last three POF editions (2002, 2008, and 2017) and found a declining milk purchase. In this vein, Singh et al. [11] compiled nationally representative data from 187 countries between 1980 and 2010 and found low milk consumption among individuals aged 20 and over. However, higher milk consumption was observed in countries with higher purchasing power due to higher prices. Furthermore, the authors also found that calcium intake was correlated with milk consumption in 2010 (r=0.71).

This study showed a significant reduction in milk consumption, with a 50% decrease in reported consumption. Milk is one of the primary sources of calcium, for which high prevalence levels of inadequate intake were estimated in the Brazilian population in the 2017-2018 INA [41]. In this context, low milk consumption may reflect deficient calcium intake, which also seems to favor obesity [42]. A cohort study conducted between 2010 and 2012 with high school adolescents (n=962) from schools in the Metropolitan Region of Rio de Janeiro, Brazil, reinforces the hypothesis that low calcium intake increases adiposity among adolescents [43]. A meta-analysis by Gonzalez et al. [44] highlights the possible effect of high calcium intake on increasing fat oxidation rates in adults. However, the authors stress the need for more studies to elucidate this relationship.

Coffee is one of the Brazilian food culture staples and among the six most consumed foods in the country [45]. However, in this study, the volume of coffee consumed fell between the two INAs. This decline could be explained by the greater participation of ultra-processed drinks to the detriment of minimally processed foods that make up Brazilian food culture [46]. Another point that may be linked to this reduction may be the price of coffee in the period evaluated. Per the Regional Cooperative of Coffee Growers in Guaxupé, Minas Gerais (Cooxupé), the mean price of coffee bags sold was BRL 255.94 in January 2008 and BRL 514.21 in 2017, a 100% increase in 10 years.

The analysis of a single day to assess beverage consumption can be considered a limitation of this study. However, different strategies to reduce measurement errors were used in both surveys analyzed, such as data strict review to ensure its quality, intensive training of the interviewers, the use of interviewing based on the multi-step method [47], and interview standardization adopting laptop-supported software.

Another possible limitation was the change in the methods used to obtain food consumption data between the two surveys analyzed. The change was made to obtain more accurate food consumption estimates. A validation study with the 2008-09 INA data revealed that the 24hR showed less underestimation of energy intake than the food record [48]. Furthermore, one day of 24-hour recall can accurately estimate the mean population food consumption [23].

Due to their essential role in the daily diet of Brazilian adults, beverages should be the target of strategies that aim to promote healthy eating and encourage the choice of beverages with good nutritional quality in order to improve dietary quality and provide the intake of nutrients and bioactive compounds that favor health and prevent diseases. Recognizing the beverage consumption habits of Brazilian adults can align interventions based on food and nutrition education.

CONCLUSION

This study highlighted that even with the reduction in the report, mean volume, and mean caloric contribution of beverages in general, they still represent a considerable proportion of the energy consumed daily and can impact weight status and health. Therefore, they should be the target of actions to promote healthy eating. In Brazil, there still needs to be more information on the consumption of beverages in the adult population and their impact on health, although they are a prevalent food item. This study supports the development of more effective intervention strategies to promote health in Brazilian adults.

REFERENCES

1. Nilson EAF, da Santin Andrade R, de Brito DA, de Oliveira ML. Costs attributable to obesity, hypertension, and diabetes in the Unified Health System, Brazil, 2018. Pan Am J Public Health. 2020;44:e32. https://doi.org/10.26633/RPSP.2020.32
2. Ministerio da Saude; Secretaria de Vigilancia em Saude; Departamento de Analise em Saude e Vigilancia de Doencas Não Transmissiveis (Brasil). Vigitel Brasil 2006–2020: Estado nutricional e consumo alimentar. Vigilância de fatores de risco e proteção para doenças crônicas por inquérito telefônico: Estimativas sobre frequência e distribuição sociodemográfica do estado nutricional e consumo alimentar nas capitais dos 26 estados brasileiros e no Distrito Federal entre 2006 e 2020. Brasília: Ministério da Saúde; 2022 [cited 2023 May 10]. Available from: https://www.gov.br/saude/pt-br/centrais-de-conteudo/publicacoes/svsa/vigitel/vigitel-brasil-2006-2020-estado-nutricional-e-consumo-alimentar.pdf/view
3. Instituto Brasileiro de Geografia e Estatística. Pesquisa Nacional de Saúde 2019: Atenção primária à saúde e informações antropométricas. Rio de Janeiro: IBGE; 2020 [cited 2023 May 10]. Available from: https://biblioteca.ibge.gov.br/visualizacao/livros/liv101758.pdf
4. Bellou V, Belbasis L, Tzoulaki I, Evangelou E. Risk factors for type 2 diabetes mellitus: An exposure-wide umbrella review of meta-analyses. PLoS One. 2018;13(3):e0194127. https://doi.org/10.1371/journal.pone.0194127
5. Dandamudi A, Tommie J, nommsen-rivers l, couch s. dietary patterns and breast cancer risk: A systematic review. Anticancer Res. 2018;38(6):3209-22. https://doi.org/10.21873/anticanres.12586
6. Cena H, Calder PC. Defining a healthy diet: Evidence for the role of contemporary dietary patterns in health and disease. Nutrients. 2020;12(2):334. https://doi.org/10.3390/nu12020334
7. Elizabeth L, Machado P, Zinöcker M, Baker P, Lawrence M. Ultra-processed foods and health outcomes: A narrative review. Nutrients. 2020;12(7):1955. https://doi.org/10.3390/nu12071955
8. Lane MM, Davis JA, Beattie S, Gómez-Donoso C, Loughman A, O'Neil A, et al. Ultraprocessed food and chronic noncommunicable diseases: A systematic review and meta-analysis of 43 observational studies. Obes Rev. 2021;22(3):e13146. https://doi.org/10.1111/obr.13146

9. Pagliai G, Dinu M, Madarena MP, Bonaccio M, Iacoviello L, Sofi F. Consumption of ultra-processed foods and health status: A systematic review and meta-analysis. Br J Nutr. 2021;125(3):308-18. https://doi.org/10.1017/S0007114520002688
10. Nilson EAF, Ferrari G, Louzada MLC, Levy RB, Monteiro CA, Rezende LFM. Premature deaths attributable to the consumption of ultraprocessed foods in Brazil. Am J Prev Med. 2023;64(1):129-36. https://doi.org/10.1016/j.amepre.2022.08.013
11. Singh GM, Micha R, Khatibzadeh S, Shi P, Lim S, Andrews KG, et al. Global, regional, and national consumption of sugar-sweetened beverages, fruit juices, and milk: A systematic assessment of beverage intake in 187 countries. PLoS One. 2015;10(8):e0124845. https://doi.org/10.1371/journal.pone.0124845
12. Fontes AS, Pallottini AC, Vieira DAS, Batista LD, Fontanelli MM, Fisberg RM. Increased sugar-sweetened beverage consumption is associated with poorer dietary quality: A cross-sectional population-based study. Rev Nutr. 2019;32:e180121. http://doi.org/10.1590/1678-9865201932e180121
13. Malik VS, Hu FB. The role of sugar-sweetened beverages in the global epidemics of obesity and chronic diseases. Nat Rev Endocrinol. 2022;18(4):205-18. https://doi.org/10.1038/s41574-021-00627-6
14. Leal JSV, Fogal AS, Meireles AL, Cardoso LO, Machado ÍE, de Menezes MC. Health economic impacts associated with the consumption of sugar-sweetened beverages in Brazil. Front Nutr. 2022;9:1088051. http://doi.org/10.3389/fnut.2022.1088051
15. Bray GA. Energy and fructose from beverages sweetened with sugar or high-fructose corn syrup pose a health risk for some people. Adv Nutr. 2013;4(2):220-5. https://doi.org/10.3945/an.112.002816
16. Gombi-Vaca MF, Sichieri R, Verly Jr E. Caloric compensation for sugar-sweetened beverages in meals: A population-based study in Brazil. Appetite. 2016;98:67-73. http://doi.org/10.1016/j.appet.2015.12.014
17. Mattes RD. Dietary compensation by humans for supplemental energy provided as ethanol or carbohydrate in fluids. Physiol Behav. 1996;59(1):179-87. https://doi.org/10.1016/0031-9384(95)02007-1
18. Cavalcante JB, de Vasconcelos TM, Sichieri R, Bezerra IN. Evolution of beverage portion sizes consumed in Brazil between 2008 and 2018. Front Public Health. 2023;10:969045. https://doi.org/10.3389/fpubh.2022.969045
19. Oliveira N, Canella DS. Trend of minimally processed and ultra-processed beverages purchased in Brazilian households: Less milk and much soft drink (2002–2003 to 2017–2018). Front Public Health. 2022;10:956142. http://doi.org/10.3389/fpubh.2022.956142
20. Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares: 2008–2009: Análise do consumo alimentar pessoal no Brasil. Rio de Janeiro: IBGE; 2011. Available from: http://biblioteca.ibge.gov.br/visualizacao/livros/liv50063.pdf
21. Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares: 2017–2018: Análise do consumo alimentar pessoal no Brasil. Rio de Janeiro: IBGE; 2020. Available from: https://www.ibge.gov.br/estatisticas/sociais/educacao/24786-pesquisa-de-orcamentos-familiares-2.html?edicao=28523&t=publicacoes
22. Subar AF, Kipnis V, Troiano RP, Midthune D, Schoeller DA, Bingham S, et al. Using intake biomarkers to evaluate the extent of dietary misreporting in a large sample of adults: The OPEN study. Am J Epidemiol. 2003;158(1):1-13. https://doi.org/10.1093/aje/kwg092
23. Dodd KW, Guenther PM, Freedman LS, Subar AF, Kipnis V, Midthune D, et al. Statistical methods for estimating usual intake of nutrients and foods: A review of the theory. J Am Diet Assoc. 2006;106(10):1640-50. https://doi.org/10.1016/j.jada.2006.07.011
24. Thompson FE, Kirkpatrick SI, Subar AF, Reedy J, Schap TE, Wilson MM, et al. The National Cancer Institute's Dietary Assessment Primer: A resource for diet research. J Acad Nutr Diet. 2015;115(12):1986-95. https://doi.org/10.1016/j.jand.2015.08.016
25. Conway JM, Ingwersen LA, Moshfegh AJ. Accuracy of dietary recall using the USDA five-step multiple-pass method in men: An observational validation study. J Am Diet Assoc. 2004;104(4):595-603. http://doi.org/10.1016/j.jada.2004.01.007
26. Tabela Brasileira de Composição de Alimentos (TBCA). Versão 7.1. São Paulo: Universidade de São Paulo, Food Research Center; 2020 [cited 2023 Jan 15]. Available from: http://www.tbca.net.br
27. World Health Organization. Physical status: The use and interpretation of anthropometry. Genebra: WHO; 1995 [cited 2023 Jan 21]. Available from: https://apps.who.int/iris/bitstream/handle/10665/37003/WHO_TRS_854.pdf?sequence=1&isAllowed=y

28. Levy G, Tapsell L. Shifts in purchasing patterns of non-alcoholic, water-based beverages in Australia, 1997–2006. Nutr Diet. 2007;64(4):268-79. https://doi.org/10.1111/j.1747-0080.2007.00223.x

29. Levy GS, Shrapnel WS. Quenching Australia's thirst: A trend analysis of water-based beverage sales from 1997 to 2011. Nutr Diet. 2014;71(3):193-200. https://doi.org/10.1111/1747-0080.12108

30. Shrapnel WS, Butcher BE. Sales of sugar-sweetened beverages in Australia: A trend analysis from 1997 to 2018. Nutrients. 2020;12(4):1016. https://doi.org/10.3390/nu12041016

31. Figueiredo N, Maia EG, Silva LESD, Granado FS, Claro RM. Trends in sweetened beverages consumption among adults in the Brazilian capitals, 2007–2016. Public Health Nutr. 2018;21(18):3307-17. https://doi.org/10.1017/S1368980018002161

32. Brand-Miller JC, Barclay AW. Declining consumption of added sugars and sugar-sweetened beverages in Australia: A challenge for obesity prevention. Am J Clin Nutr. 2017;105(4):854-63. https://doi.org/10.3945/ajcn.116.145318

33. Marriott BP, Hunt KJ, Malek AM, Newman JC. Trends in intake of energy and total sugar from sugar-sweetened beverages in the United States among children and adults, NHANES 2003–2016. Nutrients. 2019;11(9):2004. https://doi.org/10.3390/nu11092004

34. Rodríguez Alonso P, Del Pozo de la Calle S, Valero Gaspar T, Ruiz Moreno E, Ávila Torres JM, Varela-Moreiras G. Fifty years of beverages consumption trends in Spanish households. Nutr Hosp. 2016;33 Suppl 3:316. https://doi.org/10.20960/nh.316

35. Pereira RA, Yokoo EM, Araujo MC. Evolução da má-nutrição na população brasileira. In: Noronha GS, Maluf RS, Castro L, Noronha JC, Delgado NG, Gadelha P, organizers. Alimentação e Nutrição no Brasil: Perspectiva na segurança e soberania alimentar. Rio de Janeiro: Edições Livres, 2023.

36. Barclay AW, Brand-Miller J. The australian paradox: A Substantial decline in sugars intake over the same timeframe that overweight and obesity have increased. Nutrients. 2011;3(4):491-504. http://doi.org/10.3390/nu3040491

37. Borges MC, Louzada ML, de Sá TH, Laverty AA, Parra DC, Garzillo JM, et al. Artificially sweetened beverages and the response to the global obesity crisis. PLoS Med. 2017;14(1):e1002195. https://doi.org/10.1371/journal.pmed.1002195

38. Luger M, Lafontan M, Bes-Rastrollo M, Winzer E, Yumuk V, Farpour-Lambert N. Sugar-sweetened beverages and weight gain in children and adults: A systematic review from 2013 to 2015 and a comparison with previous studies. Obes Facts. 2017;10(6):674-93. https://doi.org/10.1159/000484566

39. Rios-Leyvraz M, Montez J. Health effects of the use of non-sugar sweeteners: A systematic review and meta-analysis. Geneva: World Health Organization; 2022 [cited 2023 Aug 21]. Available from: https://www.who.int/publications/i/item/9789240046429

40. Ebbeling CB, Feldman HA, Steltz SK, Quinn NL, Robinson LM, Ludwig DS. Effects of sugar-sweetened, artificially sweetened, and unsweetened beverages on cardiometabolic risk factors, body composition, and sweet taste preference: A randomized controlled trial. J Am Heart Assoc. 2020;9(15):e015668. https://doi.org/10.1161/JAHA.119.015668

41. Verly Jr E, Marchioni DML, Araujo MC, De Carli E, Oliveira DCRS, Yokoo EM, et al. Evolução da ingestão de energia e nutrientes no Brasil entre 2008–2009 e 2017–2018. Rev Saude Publica. 2021;55 Suppl 1:5s. https://doi.org/10.11606/s1518-8787.2021055003343

42. Louie JCY, Flood VM, Hector DJ, Rangan AM, Gill TP. Dairy consumption and overweight and obesity: A systematic review of prospective cohort studies. Obes Rev. 2011;12(7):e582-e592. https://doi.org/10.1111/j.1467-789X.2011.00881.x

43. Moraes ABV, Veiga GV, Azeredo VB, Sichieri R, Pereira RA. High dietary calcium intake and low adiposity: Findings from a longitudinal study in Brazilian adolescents. Cad Saude Publica. 2022;38(6):e00144521. https://doi.org/10.1590/0102-311XEN144521

44. Gonzalez JT, Rumbold PL, Stevenson EJ. Effect of calcium intake on fat oxidation in adults: A meta-analysis of randomized, controlled trials. Obes Rev. 2012;13(10):848-57. https://doi.org/10.1111/j.1467-789X.2012.01013.x

45. Rodrigues RM, Carli ED, Araújo MC, Verly Junior E, Marchioni DML, Bezerra IN, et al. Limitations in the comparison of the Brazilian National Dietary Surveys of 2008–2009 and 2017–2018. Rev Saude Publica. 2021;55 Suppl 1:3s. https://doi.org/10.11606/s1518-8787.2021055003365

46. Louzada MLC, Martins AP, Canella DS, Baraldi LG, Levy RB, Claro RM, et al. Ultra-processed foods and the nutritional dietary profile in Brazil. Rev Saude Publica. 2015;49:38. https://doi.org/10.1590/S0034-8910.2015049006132

47. Moshfegh AJ, Rhodes DG, Baer DJ, Murayi T, Clemens JC, Rumpler WV, et al. The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. Am J Clin Nutr. 2008;88(2):324-32. https://doi.org/10.1093/ajcn/88.2.324

48. Lopes TS, Luiz RR, Hoffman DJ, Ferriolli E, Pfrimer K, Moura AS, et al. Misreport of energy intake assessed with food records and 24-h recalls compared with total energy expenditure estimated with DLW. Eur J Clin Nutr. 2016;70(11):1259-64. https://doi.org/10.1038/ejcn.2016.85

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