Sugar-Sweetened Beverage Taxes in Brazil

Rafael M. Claro, PhD, Renata B. Levy, PhD, Barry M. Popkin, PhD, and Carlos A. Monteiro, PhD

Objectives. We investigated whether taxing sugar-sweetened beverages (SSBs) would improve the diets of households in Brazil.

Methods. We used household food consumption data that the Brazilian Institute of Geography and Statistics collected in 2002–2003 from a nationally representative sample of 48 470 Brazilian households. The consumption of SSBs is expressed as the total SSB calories consumed and as the SSB percentage of the total calories purchased. We investigated price elasticity with regression models, controlling for demographic variables, income, and prices of all other foods and drinks.

Results. Increases in the price of SSBs led to reductions in consumption. A 1.00% increase in the price of SSBs led to a 0.85% reduction of SSB calories consumed (1.03% reduction for the poor and 0.63% for the nonpoor). Increased income had a positive effect on SSB consumption, but the effect was less than half the size of the price elasticity (0.41% increase in SSB calories consumed for every 1.00% increase in income).

Conclusions. High SSB price elasticity in Brazil indicates that a tax on purchased weight or volume would lead to reductions in SSB consumption. (*Am J Public Health.* 2012;102:178–183. doi:10.2105/AJPH.2011.300313)

In recent years obesity has reached epidemic proportions in developed and many developing countries.[1,2] Concerns about the major diseases linked with obesity, including several cancers, type 2 diabetes, hypertension, and cardiovascular disease, have grown.[3–7] The global diet has experienced concurrent changes, and extensive research has focused on added sugars in food, particularly in beverages.[8,9]

Much of the research on sugar-sweetened beverages (SSBs) and their health impact has focused on higher income countries. It is generally shown that a shift from noncaloric to caloric beverages is not associated with any compensation in food intake.[10–12] Numerous rigorous studies of the relationship between caloric beverages and energy intake and weight gain have shown that shifting from a noncaloric beverage to an SSB adds significantly to total energy intake and leads to weight gain.[13,14] Neither satiety nor health outcomes are affected by the type of sweetener used in beverage manufacture (e.g., sucrose vs high-fructose corn syrup).[15–17] Thus regular intake of SSBs, even in small amounts, may lead to weight gain in the long term.[18]

Trend studies indicate that increased consumption of SSBs coincides with the occurrence of overweight and obesity.[19,20] In the United States, data from the US Department of Agriculture show an increase of approximately 500.0% in the consumption of soft drinks in the past 30 years, making SSBs a primary source of energy intake among Americans (approximately 7.0% of total calories).[21–24] In Mexico, between 1999 and 2006, the consumption of calories from soft drinks doubled in some age groups and tripled in others, from 100 to 225 kilocalories per day among adolescents and from 81 to 250 kilocalories per day among adult women.[25] In Brazil, the share of soft drinks in household food availability in metropolitan areas increased by 525.0% between 1974 and 2002–2003 (from 0.4% to 2.1% of total calories).[26] Likewise, in the same period the prevalence of overweight (body mass index ≥ 25 kg/m^2) in the Brazilian adult population increased from 18.6% to 41.1% among men and from 28.6% to 39.2% among women.[27]

Governments across the globe have begun to implement programs and policies to control SSB consumption. Mexico organized a panel to examine SSB and other beverage intake and propose actions to shift from less healthy beverages to a healthier, reduced-calorie beverage profile.[28] France and the United Kingdom have removed SSBs from schools, as have many other countries. Denmark has a 3-tiered tax: high for SSBs, medium for diet beverages, and zero for water. Extensive literature addresses the rationale for taxation and public control of SSBs.[29] Imposing an economic disincentive, such as a tax, on the consumption of SSBs emerges as an attractive proposal, as it would inhibit consumption and raise funds for health promotion.[29] However, few studies have investigated the relationship between the price of SSBs and their consumption, and most of those studies have been conducted in developed countries.[29–33] We aim to help fill this gap by identifying and quantifying the influence of SSB prices on SSB consumption in households in Brazil, a large middle-income country.

METHODS

We analyzed data of the national representative Household Budget Survey (HBS) collected from a probabilistic sample of 48 470 Brazilian households that the Brazilian Institute of Geography and Statistics (IBGE) carried out between July 1, 2002 and June 30, 2003 (HBS–IBGE 2002–2003).[31] The HBS–IBGE 2002–2003 used a complex clustered sampling procedure, first selecting census tracts and then selecting households within those tracts. The selection of census tracts was preceded by an examination of the tracts of the 2000 demographic census to obtain strata of households with high geographic and socioeconomic homogeneity. The geographic locations of tracts (region, state, capital city or other, urban or rural) and the years of schooling of the heads of households in the sector were considered, and 443 strata of households that were geographically and socioeconomically homogeneous were selected. The number of tracts selected from each stratum was proportional to the total

number of households in that stratum, with a minimum of 2 tracts selected per stratum. Next, households were selected in each tract by random sampling without reposition. Interviews were distributed uniformly in each selected stratum during the 4 quarters of the study to reproduce seasonal variations in income, prices, and purchases of food and other products.

We focused on the records of food purchased for consumption by the household for 7 consecutive days. Household members recorded purchases in a booklet under the supervision of the IBGE interviewer. Detailed information is available for each acquisition, including total quantity acquired (in grams) and its cost. The short reference period (7 days) employed for recording household food expenditures does not allow identification of the usual food purchase patterns of each household. In this analysis, our study unit was a cluster of households corresponding to the set of households visited within each of the 443 strata in the sample. The mean number of households in each study unit was 109.4. IBGE did not record food consumed away from home with sufficient detail (they recorded only the expenditure with each acquisition), and we did not include this in our study.

Variable Creation and Definition

Initially, we added all purchase records for a same food by a same household. We compiled approximately 1300 foods and beverages. Of the total food purchase, when appropriate, we excluded the inedible fraction using corresponding correction factors.[34] We then converted the amount of each food item into energy (in kcals) with AQUINUT beta 1.2 (NUPENS/USP, Sao Paulo, Brazil)[35] software, using the food compositions in TACO, the Brazilian food composition table.[36] For foods not included in this table, we consulted the US official food composition table.[37] We collected all records pertaining to purchases of SSBs (soft drinks, industrialized juices, isotonic or sports drinks, and energy drinks) into an SSB group. We classified all other records into a single complementary group.

We expressed the amounts of SSBs and of all other foods and beverages purchased in each household stratum as kilocalories per adult equivalent (AE)[38] per day. We divided the sum of calories relative to the purchases of each group by the total number of AE units in the stratum and by the number of days recorded (i.e., 7). We also expressed the consumption of SSBs as a percentage of the total purchased calories. We obtained the mean costs of SSBs and of all other foods and beverages, expressed as reais per 1000 kilocalories (R$/1000 kcal) by dividing the total expenses related to an item by the total calories obtained and multiplying the result by 1000.

We obtained mean income, expressed as reais per person per month (R$/person/month), by dividing the sum of the monthly incomes of all households in the stratum by the total number of persons living in those households. In a similar manner, we calculated the mean age for each stratum, the proportion of women, and the proportion of individuals in the age ranges younger than 5 years, 5–10 years, 11–15 years, and 64 years and older. The geographic region where the stratum was located and its rural or urban status completed the characterization of the units.

Data Analysis

We examined the relationship between the price of SSBs and their consumption using multiple regression models that generated price elasticity coefficients. We examined the relationship between income and consumption of SSBs in an analogous way to estimate income elasticity. Elasticity coefficients indicate the percentage variation (positive or negative) in the consumption of SSBs given a 1.0% variation in the price of SSBs (price elasticity) or in income (income elasticity). Elasticity coefficients correspond to the regression coefficients (i.e., 2) of explanatory variables in log–log regression models.[39,40] The general model used in our study can be defined as follows:

$$(1)\quad \ln(\mathrm{SSB}) = \alpha + b_1 \ln(I) + b_2 \ln(\mathrm{Price\_A}) + b_3 \ln(\mathrm{Price\_B}) + \chi_1(\mathrm{CVs}),$$

where SSB is the amount per AE of calories from SSBs, I is the per capita monthly income (R$), Price_A is the price per unit energy of SSBs (R$/1000 kcal), Price_B is the price per unit energy of the set of other foods and beverages complementary to SSBs (R$/1000 kcal), and CVs are control variables.

We applied this general model to all household strata and separately to the strata with monthly incomes of less than R$250 per capita (or US$125 per capita, first quartile of the household strata income distribution) and the remaining strata.

Variables that we considered potential confounders in the regression models included the geographical region and rural or urban status of the stratum; the mean age of residents; the proportions of women and of residents younger than 5 years, aged 5–10 years, aged 11–15 years, and aged 65 years and older; and the mean price paid for the set of foods and beverages complementary to SSBs. We incorporated as control variables all confounders whose introduction into the model led to a change of at least 10% in the regression coefficient for SSB price or income. We carried out all analytic procedures in Stata version 9.2 (StataCorp LP, College Station, TX), taking into consideration the survey's design effect and population sample weights.

RESULTS

Table 1 describes the characteristics of the Brazilian households we studied in the analysis. Table 2 describes the mean amount that those households paid for SSBs and for other foods and beverages and the mean consumption of SSBs. SSBs on average accounted for 1.7% of all calories the households purchased, and their price was roughly twice that of the set of other foods and beverages. The relative consumption of SSBs tended to increase with income (from 0.8% of all calories purchased by the lowest quartile of the income distribution to 2.6% among the highest quartile), whereas the price per calorie of SSBs did not change substantially with the increase in income. The price of the complementary set of foods and beverages tended to increase with family income (Table 2).

Table 3 presents the relative consumption of SSBs reflected in total household food and beverage purchases according to price quartiles of the price paid for SSBs (R$1.95 per 1000 kcal in the lowest quartile and R$3.20 per 1000 kcal in the highest). Consumption of SSBs, without adjustment for income, remained constant across all SSB price quartiles. However, after adjustment for income, as price increased, the consumption of SSBs decreased from 2.1% of the total purchased calories in the lowest SSB price quartile to 1.5% in the highest.

TABLE 1—Demographic and Economic Characterization of the Study Units (443 Household Strata): Household Budget Survey–Brazilian Institute of Geography and Statistics, Brazil, 2002–2003

Indicator	Mean	Interquartile Range
Monthly income per capita, R$	546.60	257.40–713.95
Age of household members, y	29.20	26.90–31.20
Household members aged < 5 y, %	6.30	4.20–8.10
Household members aged ≥ 65 y, %	8.80	7.30–10.50
SSB price, R$/1000 kcal	2.46	2.21–3.03
Price of other foods and beverages, R$/1000 kcal	1.13	0.86–1.35

Note. SSB - sugar-sweetened beverage.

Table 4 presents adjusted price elasticity and income elasticity coefficients for household consumption of SSBs in Brazil. The price elasticity coefficient is –0.85, indicating that a 1.00% shift in the price of SSBs would lead to a 0.85% change in the consumption of SSBs. In this model, the income elasticity was 0.41, indicating an effect of income that was opposite in direction to and less than half the size of that of SSB prices: a 1.00% shift in income would lead to a 0.41% change in the consumption of SSBs. The effects of income elasticity and price elasticity for poor households were almost twice the size of those for nonpoor households.

DISCUSSION

We analyzed data from a national sample of Brazilian households that recorded all household food and beverage purchases during a 12-month period. We examined how changes in food prices and income affect SSB consumption. We detected a substantial shift in the consumption of SSBs as their prices change: for every 1.00% increase in price, there was on average a 0.85% decrease in consumption. Shifts in family income also influenced the consumption of SSBs but in the opposite direction and with an effect that was less than half of that observed for changes in price: every 1.00% increase in family income led to a 0.41% increase in the consumption of SSBs. The income and price effects on SSB consumption for poor households were twice the size of those for nonpoor households.

It should be noted that our results refer only to foods and beverages purchased for consumption inside the home. In Brazil, foods and beverages purchased for consumption inside the home account for roughly 76% of total household food expenditures.[41] Assuming similar consumption patterns inside and outside the home, our results would apply to about three quarters of all foods purchased. In addition, it is unclear whether the proportion of foods and beverages consumed outside the home is the same for all products. Studies conducted in the United States suggest that the proportion of soft drinks consumed outside the home is larger than is the proportion consumed inside the home.[21]

A systematic review of studies conducted in the United States on the influence of food prices on consumption identified 14 studies presenting estimates of price elasticity for SSBs. The mean price elasticity for the intake of soft drinks (the SSB most consumed in the United States[22]) was –0.79 and for juices it was –0.76 and therefore similar to the –0.85 coefficient estimated in our study.[30] Population-based studies of the price elasticity of SSB consumption are rare in developing countries. On the basis of data collected in an HBS conducted in Mexico in 2006, the price elasticity for soft drink consumption was estimated at –1.08, slightly higher than the value observed in Brazil.[25]

Increasingly, governments across the world are focusing on fiscal policies that rectify decades of subsidies for foods and other goods linked with poor health,[29] which the World Health Organization has recommended for almost a decade as a way to influence food prices and encourage healthy eating.[42,43] The case of SSBs is an important example. Our biology has conditioned us to consume beverages without reducing food intake,[44,45] a lack of compensation that was important when water was the major beverage consumed. However, over the past few decades there has been a marked shift toward caloric beverages across the globe, and these beverages have been linked with increased obesity, diabetes, and other cardiometabolic adverse outcomes.[13,14] In addition, the food industry's sophisticated marketing campaigns (often designed to approach the subconscious and influence behavior through emotional appeal) have succeeded in distorting this reality by aggressively promoting a positive image of the consumption of SSBs.[46]

As Brownell et al.[29] note, several factors should be considered when designing an effective taxation policy. The first factor is a rigid definition of the products to be taxed. Given that SSBs are a health hazard regardless of the type of

TABLE 2—Mean Food Prices and Consumption of SSBs in Household Food Purchases According to Quartiles of the Per Capita Income Distribution: Household Budget Survey–Brazilian Institute of Geography and Statistics, Brazil, 2002–2003

Quartiles of Income Distribution	SSB Price, R$/1000 kcal	Price of Other Foods and Beverages, R$/1000 kcal	Total Purchased Calories, kcal/AE/Day	Calories From SSBs, kcal/AE/Day	Relative Consumption of SSBs, % Total Purchased Calories
First (lower)	2.48*	0.84*	2060*	14*	0.75*
Second	2.20	0.94	2231	29	1.37
Third	2.24	1.14	1936	39	2.05
Fourth (upper)	2.93	1.61	1884	49	2.62
Total	2.46	1.13	2028	33	1.69

Note. AE = adult equivalent; SSB = sugar-sweetened beverage.
*$P < .001$ for linear trend.

TABLE 3—Consumption of SSBs According to Quartiles of Price of SSBs: Household Budget Survey–Brazilian Institute of Geography and Statistics, Brazil, 2002–2003

Quartiles of the SSB Price Distribution (R$/1000 kcal)	Relative Consumption of SSBs, % Total Purchased Calories	Income-Adjusted Relative Consumption of SSBs, % Total Purchased Calories
First (1.40–2.10)	1.76	2.12*
Second (2.10–2.30)	1.71	1.90
Third (2.30–2.70)	1.67	1.68
Fourth (2.70–6.10)	1.62	1.45

Note. SSB = sugar-sweetened beverage.
*$P < .001$ for linear trend.

sugar used,[15–17] all beverages containing caloric sweeteners should be taxed equally.[29]

A second decision is the amount of the tax. Our study indicates that a 1.00% increase in the price of SSBs would lead to an average decrease of 0.85% (1.03% and 0.63% for the poor and the nonpoor, respectively) in the consumption of these products. Because large amounts of SSBs are consumed, even low tax rates would generate substantial revenue. However, the experience in developed countries indicates that only high rates would have a significant effect on consumption.[33,47,48] Our results indicate that a tax that results in a 30.0% increase in the average price of SSBs would lead to an overall consumption reduction of about 25.0% or a reduction of 30.9% for poor households and 18.9% for nonpoor households.

Another factor is the type of tax. Brownell et al.[29] have proposed an excise tax per unit of volume or sugar content. Consumers see this tax on all purchases from grocery stores, supermarkets, vending machines, and restaurants. The first option seems most attractive for Brazil. It can be easily enforced and is an option frequently adopted by legislators for other applications. In addition, Brazil already has federal and state general excise taxes that could be adapted to this end. The main limitation of an excise tax per unit of volume is the need for frequent revision of the amount charged for the policy to remain effective. It is expected that manufacturers and retailers will make some adjustments to reduce the impact of the tax on the consumer. The more important adverse effect of an excise tax is its potential to shift consumption toward cheaper brands or untaxed types of unhealthy caloric beverages.[29,49] The alternative is a sales tax, which is seen only at a cash register and is not reflected on the price label at the point of purchase. Because Brazil does not have sales taxes, this option seems less appealing there.

A final issue is the specification of the use of the revenue obtained.[29] SSB taxation has the potential to improve the population's health and is likely to be less objectionable if revenues are directed to programs that promote a healthy lifestyle, including media campaigns and healthy meals in schools.[50] Data from HBS–IBGE 2002–2003 show that approximately 6.2 billion liters of SSBs were purchased for household consumption during the study period (~750 mL/person/week). Thus an excise tax of 30% per liter (an average increase of R$0.25 in price per liter) would generate R$1.6 billion in tax revenues (not accounting for the retraction in demand) or almost US$1 billion, a sufficient amount to fund programs promoting a healthy lifestyle or to subsidize healthy foods. The tax would also affect all the SSBs consumed, inside and outside the home.

Objections to taxing SSBs have been raised.[51,52] Some of the objections are that taxation would affect individuals' freedom of choice and would be regressive (i.e., disproportionately affecting lower income families); food is essential to survival and should not be taxed; the relationship between SSBs and obesity is controversial, and the proposal of a tax to fight obesity is simply an excuse for raising taxes; it would be unfair to select a single item for taxation given that obesity is multifactorial, thus imposing a tax on only SSBs would not solve the problem of obesity; and the global effect of reducing the consumption of SSBs instead of improving the quality of diets in general is unclear and unpredictable. We agree with Brownell et al.[29] that the potential benefits of an SSB tax outweigh such objections. Low-income people in Brazil[53] and in many other countries[2] tend to be disproportionately affected by obesity and other diseases related to SSB intake and would therefore be the primary beneficiaries of a reduction in consumption. Subsidizing the prices of healthy foods with the tax revenues, as mentioned, would offset the regressive effects and could actually increase freedom of choice. Obviously, SSBs are not critical for either survival or improved diet quality. Indeed a single intervention will not solve the problem of obesity, but that is not a sound rationale for taking no action.

It is in fact difficult to determine to what extent a reduction in SSB demand would

TABLE 4—Adjusted Income and Price Elasticity Coefficients for the Household Consumption of SSBs: Household Budget Survey–Brazilian Institute of Geography and Statistics, Brazil, 2002–2003

Variables	Household Strata		
	All Income Quartiles	First Income Quartile	Second, Third, and Fourth Income Quartiles
Monthly per capita income, R$	0.41	0.43	0.22
Price of SSBs, R$/1000 cal	–0.85	–1.03	–0.63
R^2	0.76	0.58	0.59

Note. SSB = sugar-sweetened beverage. All regression coefficients are statistically significant ($P < .05$). We adjusted coefficients for geographic region and urban or rural status of the household stratum, proportion of members aged ≥ 65 years, and mean price of the set of foods and beverages complementary to SSBs. We obtained price elasticity coefficients in 3 separate log-log linear regression models.

improve overall diet quality. However, it is a fair assumption that a reduction would affect the population's health, especially by preventing obesity, given that beverage substitutes are generally calorie-free (such as water) or have higher nutritional value (such as milk) and that solid foods tend to favor autoregulation of energy balance. A study in the United States followed thousands of adults over a 20-year period and found a large reduction in net calories, reduced weight, and reduced risk of diabetes when SSB prices increased.[33]

The food industry strongly concurs with the objections to SSB taxes.[51,52,54] The tobacco industry similarly fought proposals to tax tobacco around the world for years, yet today higher taxes are associated with a reduction in smoking and an improvement in the quality of life.[55]

It is worth mentioning that the increased income of the Brazilian population in the past few years has probably influenced the increased consumption of SSBs. The average income in Brazil increased 28.2% between 2003 and 2008,[56] which according to our estimates should lead to an 11.6% increase in the consumption of SSBs.

The idea of taxing SSBs has been proposed in developed countries and in other Latin American countries to curb consumption while raising funds for specific measures aimed at promoting a healthy diet.[28,29,57] Our results indicate that this initiative would produce significant positive health results in Brazil. ■

About the Authors

Rafael M. Claro is with the Center for Epidemiological Studies in Health and Nutrition, School of Public Health, University of São Paulo, São Paulo, Brazil. Renata B. Levy is with the Departamento de Medicina Preventiva da Faculdade de Medicina da Universidade de São Paulo. Barry M. Popkin is with the Department of Nutrition, University of North Carolina, Carolina Population Center, Chapel Hill. Carlos A. Monteiro is with the Department of Nutrition, School of Public Health, University of São Paulo.

Correspondence should be sent to Rafael M. Claro, Center for Epidemiological Studies in Health and Nutrition-University of São Paulo (NUPENS-USP), 715 Arnaldo Av., Sao Paulo–SP, Brazil 01246-904 (e-mail: rafael.claro@gmail.com). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints/Eprints" link.

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Contributors

R.M. Claro and C.A. Monteiro conceptualized this project and drafted the initial version of the report. R.M. Claro, R.B. Levy, B.M. Popkin, and C.A. Monteiro contributed to the design, execution, interpretation, and discussion of the results and contributed to and approved the final version.

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