Sugar Sweetened Beverage Taxation
A reasonable public health policy option?
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Summary

Sugar sweetened beverages (SSBs) are nutrient-poor, calorie-rich products, the removal of which from the diet without substitution of another such product, would result in numerous health benefits. SSBs displace more nutritious beverages and add to overall daily calorie intake. People do not compensate as well for beverage calories as they do for food calories. Sustained reductions in intake of approximately 100 calories per day—less than 1 can of soda—could theoretically stop weight gain for 90 percent of the US population. Furthermore, SSB consumption is associated with significantly increased risk of diabetes, cardiovascular disease, and other serious health consequences.

The need for decreased SSB consumption in the US is a salient issue; however, guidance on healthy beverage consumption is lacking, while the beverage industry spends billions of dollars on marketing annually. Research evidence suggests that education alone is not enough to achieve acceptable levels of SSB consumption. State and local governments have begun to consider policy options as means of deterring SSB consumption, one of which is a tax on SSBs. Taxing SSBs is just one of many potential elements in a comprehensive approach to addressing the complex obesity problem.

SSB taxes would lead to reductions in SSB consumption, overweight and obesity, the resulting disease burden, and related health care costs. Although special taxes on SSBs are few, there is increasing support from health experts, the public, and a number of reputable agencies and organizations. A penny-per-ounce excise tax on SSBs could generate nearly two hundred million dollars per year for the state of Colorado. The new revenue from the SSB tax could be earmarked for specific research and programs to address nutrition and obesity, which would further potentiate the public health benefits of the tax.
Introduction

The definition of sugar sweetened beverages (SSBs) varies from source to source. For the purpose of this document, when not referencing other work, the term SSB will refer to all sodas, fruit drinks, sport drinks, low-calorie drinks, and other beverages that contain added caloric sweeteners, such as sweetened tea, rice drinks, bean beverages, sugar cane beverages, horchata, and nonalcoholic wines/malt beverages.

Role of SSBs in nutrition, obesity, and overall health

As obesity and SSB consumption simultaneously increase in the United States, researchers are placing greater emphasis on investigating the roles of certain dietary trends, such as dining out and drinking SSBs, in nutrition, obesity, and health. Studies consistently indicate a relationship between SSB consumption, increased calorie intake, decreased nutrient intake, weight gain, and increased risk for chronic disease and other negative health outcomes. While there is no single cause of the obesity epidemic, SSBs undoubtedly contribute to the growing problem. SSBs are nutrient-poor, calorie-rich products, the removal of which from the diet without substitution of another such product, would result in numerous health benefits. Sustained reductions in intake of approximately 100 calories per day—less than 1 can of soda—could theoretically stop weight gain for 90 percent of the US population.

SSB taxation as one part of a broad approach to address the obesity problem

State and local governments have begun to consider policy options as means of deterring SSB consumption, one of which is a tax on SSBs. Opponents of the SSB tax argue that the SSB tax alone will not reduce obesity. They are probably correct. Interventions intended to achieve behavior change and, subsequently, positive health outcomes must span multiple levels of environmental influence, such as those depicted in the Social Ecological Model (SEM) (Figure 1). Policy and environmental changes affect large groups of individuals, compared to interventions that reach only individuals who choose to participate. Kim and Kawachi compared general taxation of foods and beverages to pricing incentives and disincentives on foods and beverages sold in schools and worksites, and they concluded that a taxation strategy would be preferable to a pricing strategy to generate funds for obesity prevention programs and reach a larger population. They further state that the two strategies might be used in tandem to achieve a greater effect. Taxing SSBs is just one of many potential elements in a comprehensive approach to addressing obesity.
Rationale for SSB taxation

Why SSBs?

Lack of nutritional value and displacement of more nutritious beverages

Added sugars—white sugar, brown sugar, raw sugar, cane sugar, powdered sugar, corn syrup, corn syrup solids, malt syrup, maple syrup, pancake syrup, high fructose corn syrup, fructose sweetener, liquid fructose, honey, molasses, anhydrous dextrose, and crystal dextrose—contribute an average of 16 percent of total daily calories in the US. SSBs contribute approximately 50 percent of the added sugar in the US diet—or about 8 percent of total daily calories—but contribute little to no nutritional value. Nielsen and Popkin analyzed beverage intake among a nationally representative sample of Americans ≥2 years of age since 1977, and they reported alarming trends: Americans are consuming more calories from SSBs in larger portions and more servings per day than they were thirty years ago. They drew the study sample from the 1977-1978 Nationwide Food Consumption Survey (NFCS77), the 1989-1991 and 1994-1996 Continuing Survey of Food Intake by Individuals (CSFII89 and CSFII96), and the 1999-2001 National Health and Nutrition Examination Survey (NHANES 99-01), each of which collected interviewer-administered dietary intake information. They considered eating occasion (snacks vs. meals), eating location (at home, vending, store eaten...
out, restaurant/fast food, and school), age, survey year, portion size, and number of servings. For all age groups, they observed an increase in proportion of total calories from soft drinks and fruit drinks and a decrease in proportion of total calories from milk. Among the different age groups, the largest decrease in milk consumption occurred in the 2- to 18-year olds (13.2 percent of total calories in 1977 vs. 8.3 percent of total calories in 2001). Soft drink consumption was highest among 19- to 39-year olds. The proportion of individuals consuming SSBs increased by 15 percent, while the proportion consuming milk decreased by 12 percent. Mean servings of SSBs increased from 1.96 to 2.39, while mean servings of milk decreased from 2.95 to 2.21, regardless of location. The authors reported per consumer servings (not per capita servings) to show that the number of servings among consumers has changed. Per capita servings would have underestimated true consumption. SSB serving size increased significantly for all ages. Milk serving size decreased slightly, but the decrease was significant for the 2- to 18-year olds only. The authors reported per consumer mean (not per capita mean) portion size to show that the mean portion size among consumers has changed. Per capita mean portion size would have underestimated true consumption. Because the dietary intake information was self-reported, and because people who are overweight tend to under-report calorie intake, the results from this study likely underestimate the role of SSBs in the US diet. The decrease in milk consumption associated with SSB consumption is of particular concern, especially among children and adolescents (Figure 2). Milk contains nutrients important for adequate growth—protein, calcium, and vitamins A and D (from fortification), among others. Reduced consumption of these nutrients could place children at risk of suboptimal growth, nutrient deficiency, and a number of deficiency-related diseases.

![Percentage of Beverage Calories from Sweetened Beverages and Milk, for Children Ages 2-18](image)

Figure 2. Percentage of Beverage Calories from Sweetened Beverages and Milk, for Children Ages 2-18.
Increased caloric intake

Not only do SSBs displace more nutritious beverages, but SSBs also add to overall daily calorie intake. People do not compensate as well for beverage calories as they do for food calories, perhaps due to lower satiety value of liquids compared to solids, less need for oral processing, shorter gastrointestinal transit times, and greater bioaccessibility and bioavailability of SSB calories\textsuperscript{14}. Mattes classifies fluids into categories based on satiety value and potential to promote positive energy balance. SSBs fall into the category of fluids with weak satiety value that may promote positive energy balance\textsuperscript{15}. On average, 64 percent of calories from solid foods is offset by a decrease in calories consumed, but only 9 percent of calories from liquids is offset by a decrease in calories consumed. Clear liquids have the lowest satiety value compared to thicker liquids, e.g. soup, meaning clear liquids elicit the least calorie compensation\textsuperscript{16}. For this reason, one might say that SSBs may be more harmful than solid sugar. In a crossover experiment, 15 participants consumed either 450 calories per day of regular soda or jelly beans. During the time they consumed the regular soda, total daily calorie intake increased and participants gained weight, suggesting that other calorie intake was not offset by the soda intake. In contrast, during the jelly bean phase, there was no change in total daily calorie intake because participants compensated by reducing their intake of other foods\textsuperscript{17}.

Caloric beverages other than SSBs, such as milk, also contribute to overall calorie intake; however, intake of such beverages has not increased over time to the degree that intake of SSBs has increased. An analysis of beverage consumption among children and adolescents with completed dietary intake information from the NHANES 1988-1994 (n = 9882) and 1999-2004 (n = 10,962) indicated that the percentage of children and adolescents consuming SSBs remained constant from the first survey to the next. There was a significant decrease in the percentage of children 2 to 5 years of age who drank milk, and there was a significant increase in percentage of adolescents 12 to 19 years of age who drank fruit juice. Calorie intake from SSBs increased across all children and adolescents (including those who did not consume SSBs or fruit juice on the day of the dietary recall), but was significant in boys. The largest increase in calorie intake from SSBs (20 percent from 1988 to 2004) occurred among children 6 to 11 years of age. Calorie increases were larger among Black and Mexican American than white. When excluding participants who did not consume SSBs or fruit juice on the day of the dietary recall, the increases in SSB consumption from 1988 to 2004 were significant for nearly all groups\textsuperscript{4}.
Association with unhealthy dietary patterns, weight gain, obesity, and risk for chronic disease

Duffey and Popkin found that individuals with less healthy dietary patterns tend to have less healthy beverage patterns. They classified 9,491 adults with completed NHANES dietary and medical information into six distinct beverage patterns—water and tea; coffee, tea, and water; coffee and soda; diet; nutrients and soda; and soda—and six food patterns—fast food, vegetables, fruit and low-fat dairy, normal, cereal and low-fat meats, and snacks and high-fat foods. Individuals in the fast food and high-fat foods and snacks patterns were more likely to be in the calorically sweetened beverage clusters compared with individuals in the other food patterns, who were more likely to be in the water or diet patterns. Tendency to consume unhealthful foods along with SSBs could exacerbate the nutrition and health consequences of SSBs. This study reveals more of the complexity of the US diet and suggests that interventions to decrease SSB consumption should target people who consume fast food and high fat foods and snacks.\(^\text{18}\)

Evidence indicates that replacing SSBs with water (but not diet beverages) is associated with a mean decrease in caloric intake of 200 calories per day over a one-year period. The study participants were 118 overweight premenopausal adult women from the Stanford A TO Z randomized clinical weight loss trial that compared popular diets with different macronutrient profiles. The women received different food and beverage recommendations, depending on their weight loss diet group: Atkins, Zone, LEARN, or Ornish. The researchers calculated three-day mean daily intakes of water, sweetened-caloric, nutritious-caloric, and non-caloric beverages at baseline, 2 months, 6 months, and 12 months. Beverage patterns were similar across the diet groups; therefore the researchers combined the groups into one sample for the purposes of this paper. At month 2, after participants completed diet classes, intake of SSBs decreased by 50 percent, and intake of water increased as a proportion of beverages by 18 percent. Most participants (84 percent) who decreased SSB intake increased water intake. Change in non-caloric beverage intake was not significant. At 12 months, SSB intake remained significantly lower than baseline, and water intake remained significantly higher than baseline. Holding constant the food composition, each 1 unit of SSBs replaced with 1 unit of water was associated with a significant 4 calories per day decrease in total calorie intake. Replacing SSBs with water was associated with significant reduction in body weight, percentage body fat, and waist circumference. Replacing SSBs with non-caloric or nutritious caloric beverages was not associated with change in calorie intake. While the tendency to decrease SSB intake, increase water intake, and not compensate by eating more food might be partly explained by the motivation to adhere to a diet, the tendencies are not specific to any particular one of the four diets included in the study.\(^\text{19}\) Of 4,755 individuals ≥
18 years of age who completed the NHANES 1999-2001, total daily calorie intake was significantly less among the individuals who consumed water as a beverage compared with individuals who did not consume water as a beverage. Individuals who did not consume water were more likely to consume SSBs. Older, more highly educated adults were more likely to consume water. This finding suggests that interventions to decrease SSB consumption should target people who are younger and less educated. Based on these findings, the Beverage Guidance Panel issued beverage intake recommendations for six beverage categories—water, tea and coffee, low fat and nonfat milk and soy beverages, noncalorically sweetened beverages, caloric beverages with some nutrients, and calorically sweetened beverages—based on calorie and nutrient content and related health benefits and risks. The Panel sought to address the lack of guidance on the use of beverages in the US diet. The Panel recommends people consume noncaloric or low calorie beverages over caloric beverages. Figure 3 depicts recommended acceptable beverage intake for an adult consuming 2,200 calories per day. This plan would allow 220 calories from beverages, or 10 percent of total calorie intake.

Figure 3. Suggested beverage consumption patterns (10% of energy from beverages) for a person with a 2200-kcal daily energy requirement. The values 50, 28, 16, and 4 fl oz are shown for illustrative purposes only; the total should sum to 98 fl oz, as shown at the top of the figure. (1)The Beverage Guidance Panel’s suggested range for each beverage. (2)Range: caffeine is a limiting factor up to 400 mg/d, or 32 fl oz coffee/d (can replace water). (3)Can substitute for tea and coffee with the same limitations.
regarding caffeine. (4) 100% fruit juices, 0 – 8 fl oz/d; alcoholic beverages, 0 – 1 drink/d for women and 0 – 2 drinks/d for men; whole milk, 0 fl oz/d. 1 fl oz = 29.57 mL.\textsuperscript{21}

A 2-year prospective, observational study on SSB consumption among 548 11- and 12-year olds in Massachusetts found that the odds of becoming obese increased by 60 percent for each additional serving of SSB consumed daily, but that increased consumption of diet sodas was negatively associated with incidence of obesity. Baseline SSB consumption, as well as change in SSB consumption over the course of the study period, independently predicted change in BMI\textsuperscript{5}. An analysis by Forshee, et al\textsuperscript{22} concluded that the correlation between SSB consumption and BMI among children and adolescents is near zero; however, the methodology was flawed. Malik, Willet, and Hu re-analyzed the same articles and revealed that studies with energy-adjusted estimates show a nonsignificant inverse trend, and studies with unadjusted energy estimates show a positive association between SSB consumption and BMI. Malik, et al further assert that the associations from their re-analysis are still conservative due to measurement error in dietary assessment (e.g., under-reporting). The Forshee analysis was supported by a grant from the American Beverage Association. Woodford-Lopez, et al reviewed twelve high-quality longitudinal studies that found a \textit{significant} positive association between SSB consumption and adiposity. The authors of the review concluded that SSBs account for at least 20 percent of the increase in weight in the US over the past three decades\textsuperscript{23}. A meta-analysis of 88 studies on SSB consumption and nutrition and health outcomes found a clear association between SSB consumption and calorie intake and body weight, as well as association between SSB consumption and more severe health outcomes, e.g. diabetes. Stronger studies (longitudinal and experimental versus cross-sectional studies) reported larger effect sizes\textsuperscript{13}. Again, studies funded by the food and beverage industry report significantly smaller effect sizes than non-industry-funded studies.

Twenty years of data from the CARDIA Study—a prospective study of cardiovascular risk factors among 5,115 US adults 18-30 years old at baseline—link SSB consumption and risk for high waist circumference, high LDL cholesterol, low HDL cholesterol, high triglycerides, and hypertension. The authors examined three consumption trends—energy per capita, percentage consuming, and energy per consumer—for low-fat milk, whole-fat milk, fruit juice, and SSBs. The article did not consider diet beverages. Of all beverages considered, the most consistent adverse associations with incident cardiometabolic outcomes were observed for SSBs\textsuperscript{24}. Dhingra, et al\textsuperscript{25} found that, in middle-aged white adults, soft drink consumption is associated with a significantly higher prevalence and incidence of metabolic risk factors. The participants were in the Framingham Offspring Study. After adjusting for age, sex, physical activity, smoking, dietary consumption of saturated fat, trans fat, fiber, magnesium, total calories, and glycemic index, prevalence of
metabolic syndrome was 48 percent higher among those who consumed 1 or more soft drinks per day and 67 percent higher among those who consumed 2 or more per day compared to those who consumed less than 1 per week. Consuming 1 or more soft drinks per day was associated with a 44 percent greater risk of developing metabolic syndrome. Shay and colleagues just shared results of a brand new study from the University of Oklahoma. They examined five years of data on 4,166 men and women ages 45 to 84 from the Multi-Ethnic Study of Atherosclerosis (MESA). They assessed risk factors in follow-up exams, monitoring the participants’ weight, waist circumference, HDL and LDL cholesterol, glucose, and triglycerides. They found that women who consumed two or more SSBs per day had greater increases in waist circumference and were nearly four times as likely to develop high serum triglycerides, regardless of weight gain, compared to those who drank one or fewer SSBs per day. The women who consumed the most SSBs were also more likely to develop impaired glucose tolerance. These associations were not found in the male population.

A prospective cohort study of 43,960 adult Black women across the US found that black women who drink SSBs are at increased risk of type 2 diabetes. The women were participants in the BWHS that began in 1995. The women provided dietary information via a validated food frequency questionnaire. The beverage intake data were compiled into a variable that represented the number of 6-fl oz servings per week. In ten years of follow up, there were 2,713 incident cases of diabetes. Risk of diabetes increased with increased intake of SSBs. After controlling for dietary factors, women consuming at least two regular sodas or at least two fruit drinks per day were 24 percent more likely or 31 percent more likely to develop type 2 diabetes, respectively. After controlling for BMI, the women drinking sodas were at only a 5 percent increased risk and the women drinking fruit drinks were at a 33 percent increased risk, indicating that the association between sodas and diabetes is mediated by BMI, but the association between fruit drinks and diabetes is not. Controlling for total calorie intake did not affect the estimates. Schultze and colleagues followed 91,249 women free of diabetes and other chronic diseases at baseline and found 741 new cases of type 2 diabetes in these women between 1991 and 1999. The women were participants in the Nurses’ Health Study II, a primarily white population. Women who consumed at least one SSB per day increased their risk of type 2 diabetes by 83 to 98 percent compared to those consuming less than one per week. Palmer speculates that the weaker associations found among the BWHS cohort are due to higher baseline risk of diabetes in Black women. Using Schultze’s age adjusted results, Chaloupka et al estimate that the relative risks of diabetes for different frequencies of SSB consumption are 1 (< 1 per week), 1.32 (once or more per week but less than daily), 1.63 (≥1 but <2 per day), and 2.37 (≥2 per day).
A meta-analysis of eleven studies found that, among eight studies, individuals in the highest quantile of SSB consumption had 26 percent greater risk of developing type 2 diabetes than those in the lowest quantile, and among three studies, individuals consuming the most SSBs had a 20 percent greater risk of developing metabolic syndrome than those consuming the least. Despite differences in study designs, each study controlled for confounding, and most found an independent effect of SSBs.

**Potential for sugar addiction**

The Yale Rudd Center for Food Policy and Obesity hosted a 2-day conference on food addiction. The conference participants—experts in the fields of addiction, nutrition, obesity, and policy—concluded that food addiction is plausible. Foods and addictive drugs have some common characteristics—cravings, continued use despite negative consequences, and eventual loss of control over consumption. Reciprocal relationships among foods and other substances, e.g. the tendency to gain weight upon smoking cessation, suggest some foods or food additives might compete for the same brain pathways. Sweetness of a beverage, regardless of calorie content, may result in preference for sweet taste and habitual consumption of SSBs and possibly other sweet products. If foods are capable of triggering addictive processes, public health interventions to improve nutrition and prevent obesity could focus on applying lessons learned from drug addiction, which would include policy-level strategies to reduce consumption. More research is needed to elucidate the potential mechanisms and identify biomarkers of food addiction.

**Why taxes?**

**Potential revenue in Colorado**

A tax on SSBs could generate substantial revenue for the state of Colorado. Using the Yale Rudd Center’s Revenue Calculator for SSB Taxes, a $0.01 per fluid ounce excise tax on SSBs could generate $198,048,226 in Colorado in 2012. In Denver alone, this tax could generate $24,752,468, which is 12.5 percent of the overall potential revenue generated in Colorado. The calculator accounts for regional variation in per capita beverage consumption and uses sales data from 2008. It includes regular sodas, fruit drinks, sports drinks, ready-to-drink calorically sweetened teas, caloric flavored waters, energy drinks, and ready-to-drink calorically sweetened coffees. Projections of future beverage consumption are based on historic
trends in beverage consumption. The new revenue from the SSB tax could be earmarked for specific research and programs to address nutrition and obesity, which would further potentiate the public health benefits of the tax.

**Historic public health success of taxation**

Based on the success in reversing the epidemic of tobacco use, public health experts believe interventions based on ecological models can reverse the obesity epidemic by improving or creating environments and policies related to food and physical activity\(^7\). Tobacco taxes generate considerable new revenue, some of which is earmarked for tobacco control programs that lead to greater reductions in tobacco use and its effects. Tobacco taxes in the US account for well over 40 percent of retail cigarette prices, inclusive of taxes. Sales taxes account for only about 5 percent of tax inclusive prices, which might partly explain why current sales taxes on SSBs have not impacted SSB consumption.

WHO published “best practices” for tobacco taxation\(^32\), many of which appear applicable to SSB taxation:

- The taxes should be excise taxes to generate sustained revenues in the short- to mid-term
- The taxes should have a simple, specific structure that applies equally to all products
  - For SSBs, a tax should be based on volume or added sugars such that the tax would be the same for all types of SSBs
- The taxes should increase with inflation so that the taxes do not become diluted over time
- Some or all of the new tax revenue should be earmarked for public health
- The tax advocates should be prepared to respond to the opposition’s arguments regarding supposed potential economic consequences
- The tax should have an accompanying plan for its administration, which might include
  - Monitoring production
  - Tracking and tracing products through the distribution chain
  - Facilitating enforcement, e.g. via penalties
  - Requiring licensing of those involved in manufacturing and distribution

**Potential impact**

SSB taxes would lead to reductions in SSB consumption, overweight and obesity, the resulting disease burden, and health care costs. Two factors can reduce the impact of SSB tax: a tax rate that is too low (e.g., current sales tax
rates) and substitution of other calorie sources. The most widely recommended tax—an excise tax—actually taxes the businesses that sell sugar-sweetened beverages, not the consumers. The business will decide whether to pass all or a portion of the cost along to the consumer. A greater pass through of the tax to shelf price would result in greater reductions in SSB consumption, obesity, and related consequences, but somewhat lower tax revenues. A lesser pass through of the tax to shelf price (partial absorbing of the tax by beverage companies, distributors, and/or retailers) would lead to smaller reductions in beverage consumption, obesity, and related public health consequences and economic costs, but larger tax revenues. If a SSB tax is high enough to eliminate consumption, it will generate no revenue. If the tax does not affect consumption behavior, it will generate considerable revenue but have no direct impact on obesity; the burden of reducing obesity will fall on how the revenues are spent.

**Impact of SSB taxation**

**Consumption**

Several researchers have estimated the impact of beverage taxes and prices on beverage consumption. In general, the evidence indicates that higher SSB prices could significantly reduce SSB consumption. Estimating changes in SSB consumption in response to a tax (same-price elasticity) is simpler than estimating accompanying changes in the consumption of other foods or beverages (cross-price elasticity). Shifts among different beverages would have different effects, depending on whether consumers substituted water, milk, diet drinks, or equivalent generic brands of SSBs. Understanding cross-price elasticities is important from a policy perspective in that relative shifts in prices through taxes or subsidies can influence demand for other products that are not regulated by policies.

Sturm, et al examined whether small taxes are likely to change consumption and weight gain or whether larger tax increases would be needed. They concluded that existing taxes on soda, which average approximately 4 percent in grocery stores, do not substantially affect overall soda consumption or obesity.

A review of 160 US studies on food and beverage price elasticities found that price elasticities for foods and nonalcoholic beverages ranged from 0.27 to 0.81, with food away from home, soft drinks, juice, and meats being most responsive to price changes (0.7 to 0.8). Andreyeva et al. predict that a 10 percent increase in soft drink prices will reduce soft drink consumption by 8 to 10 percent. Lin and colleagues estimate that a 10 percent increase in the price of SSBs would reduce consumption by 9.5 to 12.6 percent. In a more recent paper, Andreyeva, et al estimated substantial changes in beverage consumption from a national penny-per-ounce tax
on SSBs and diet varieties, not accounting for substitution. A penny-per-ounce tax is equivalent to approximately 17 percent price increase\textsuperscript{31}.

Block, et al\textsuperscript{37} conducted an experimental study to estimate the price elasticity of demand for regular soda. The researchers increased the price of regular soda by 35 percent in a hospital cafeteria in Boston, Massachusetts, for one month, after a two-week baseline phase during which existing prices were posted. The price change was associated with a 26 percent reduction in sales of regular soda, translating to an elasticity of -0.7. This study also included an education phase with posted educational materials on the health benefits of reducing SSB intake; this phase had no independent effect on soda sales, suggesting that education alone may not impact SSB consumption.

A small behavioral economics study on beverage price elasticities was conducted in a population of 108 college students (56 women, 52 men; ages 18–22 years) in southern Taiwan. Estimates for same-price elasticity for unhealthy and healthy beverages were significant and strong (-0.91 and -0.93, respectively). Estimates for cross-price elasticity were positive and significant (0.69 and 0.53 for unhealthy and healthy beverages, respectively), but lower than those for same-price elasticity. These estimates indicate complementary relationships between price of one beverage type and purchase of the other. Health claims interacted with the price of unhealthy beverages and the price of healthy beverages to influence purchase of unhealthy beverages. With addition of health claims to increased price of unhealthy beverages, reduction in unhealthy beverages went from -0.91 to -1.27 and increase in healthy beverages went from 0.53 to 0.95. With addition of health claims to increased price of healthy beverages, increase in unhealthy beverages went from 0.69 to 0.24 and decrease in healthy beverages went from -0.93 to -0.52. The strong same-price elasticity relationship between purchases and prices suggests that an increase in the price of unhealthy beverages may result in reduction in purchases of unhealthy beverages, and a reduction in the price of healthy beverages may result in increased purchases of healthy beverages. The cross-price-elasticity finding indicated that an increase in price of unhealthy beverages may result in increased purchases of healthier alternatives. Also, health claims may strengthen the cross-price-elasticity effect and weaken the same-price-elasticity effect. Based on these results, the authors conclude that obesity prevention efforts targeting unhealthy beverages may have potential in undergraduate populations\textsuperscript{38}.

Duffey, et al\textsuperscript{39} studied US trends in food and beverage prices compared to consumption (price elasticity of demand), total energy intake, weight, and insulin sensitivity over twenty years of data from the CARDIA Study. The researchers used food price data from the Council for Community and Economic Research. They analyzed soda, whole milk, hamburgers purchased away from home, and pizza purchased away from home, plus these foods’ hypothesized complements: beer, wine, steak, parmesan cheese, and fried chicken. They took into account inflation and respondents’ geographic location and controlled for age, education, SES, cost of living, family structure, and physical activity. The price of soda and pizza (especially
soda) decreased steadily throughout the study period, whereas the price of hamburgers and milk remained relatively constant. Some participants experienced price increases, depending on food group. The changes in the price of soda and pizza were associated with changes in probability of consumption and amount of consumption. A 10 percent increase in the price of soda (approximately 20 cents per liter) translated to a 3 percent decrease in the probability of consuming soda and a 7.12 percent decrease in daily calories from soda. A 10 percent increase in the price of pizza translated to an 11.5 percent decrease in calories from pizza and a 3 percent increase in daily calories from soda, suggesting cross-price elasticities were smaller than own-price elasticities. A $1.00 increase in the price of soda was associated with significantly fewer daily calories, lower weight, and lower HOMA-IR score (improved insulin sensitivity). An increase in price of both soda and pizza had an additive effect on decreased calorie intake, decreased body weight, and HOMA-IR score. The results of this study represent the strongest evidence available to support price strategies to decrease SSB consumption.

Price responsiveness is greater among young people, those on lower incomes, and those already at higher weight, i.e. those at increased risk of obesity. Therefore, in the case of the SSB tax, these populations could reap the greatest benefit of decreased SSB consumption.

**Weight and BMI**

A key assumption in predicting reductions in body weight and obesity from reductions in calorie intake relates to substitution effects, i.e. the extent to which people compensate for the reduction in SSB calories. Existing evidence is mixed with respect to the degree of substitution in response to changes in beverage prices, including those that result from current sales taxes on various beverages. Smith and colleagues found only modest substitution from other caloric beverages when SSB calories decrease in response to SSB taxes. The authors predict that a 20 percent tax on SSBs would result in a substantial reduction in obesity prevalence—3 percent in adults and 2.9 percent in children. Fletcher, et al explored 2 different options for reducing SSB consumption in children and adolescents: school vending machine restrictions and taxes on soft drinks. They concluded that reductions in SSB calories from higher SSB prices are largely offset in children and adolescents by substitution from other beverages, particularly whole milk, and that, as currently practiced, neither vending machine restrictions nor soft drink taxes will lead to noticeable weight reduction in children. The authors state that further research is needed to understand the behavioral responses of soft drink policies, which should be incorporated in a comprehensive policy framework.

Powell, et al compared state-level grocery and vending taxes on soda with weight among 8th-, 10th- and 12th-grade students in the nationally representative Monitoring the Future study sample. Mean state-level soda tax rates were 4.25% (grocery) and
4.51% (vending). Average BMI for the students was 22.13. The analysis revealed no statistically significant association between any taxes and BMI of the entire sample. Results showed a small and weakly statistically significant inverse association between tax and BMI among those at risk of overweight. A 1 percent increase in vending tax was associated with 0.006 point decrease in BMI among those at risk of overweight. Therefore, the authors concluded that current state-level soda taxes are not significantly associated with adolescent weight outcomes. The taxes would likely need to be raised substantially to detect significant associations between taxes and adolescent weight. Fletcher, et al. found the same to be true for adult weight. The study evaluated the impact of both the incremental soft drink tax rate, which is the tax specifically on soft drinks that is in addition to taxes on other foods, and the total soft drink tax rate, which incorporates states’ specific exclusions of soft drinks from the food exemptions to the sales tax. Results suggest that soft drink taxes influence BMI, but the impact is small in magnitude. A 1 percent increase in the state soft drink tax rate corresponded to a 0.003 point decrease in BMI.

**Health care costs**

The 2008 estimated US medical cost of overweight was $15.8B and obesity was $98.1B, totaling $113.9B. Literature demonstrates that obese individuals spend more than non-obese individuals on health care due to obesity-related health problems. Individuals with diabetes spend more than twice as much on health care as they would in the absence of diabetes, and about 10 percent of overall health care expenditures can be attributed to diabetes. The average annual cost of diabetes is about $6,000 per case. A typical diabetes case is also associated with $3,326 annually in nonmedical costs such as absenteeism, reduced productivity at work, disability that prevents working, reduced non-workforce labor, and early mortality. Reducing overweight, obesity, diabetes, and other negative health outcomes through SSB taxation would reduce the associated medical costs. Given the higher prevalence of obesity in lower-income populations, a greater reduction in obesity-related health care spending would occur in the Medicaid program. More research is needed to determine the attributable risk from SSBs in order to evaluate the contribution of SSBs to health care costs.

**Lessons from other states**

Efforts to enact excise taxes on SSBs in other states have thus far been unsuccessful for various reasons. From January 2009 to May 2010, seventeen states filed SSB tax legislation. There have been twenty-seven bills introduced in the 2011 legislative session, most proposing a $0.01 per fluid ounce excise tax.

Since 1992, the state of Arkansas has had an excise tax levied upon the sale of soft drinks, syrups, simple syrups, powders, and base products by manufacturer, wholesaler, or
distributor to a retailer or other purchaser, or upon the purchase by a retailer of soft drinks, syrups, simple syrups, powders, and base products from an unlicensed manufacturer, wholesaler, or distributor. The tax levies $2.00 per gallon of soft drink syrup and $0.21 per gallon of SSB. The tax generates approximately $46M per year, earmarked for Medicaid. The intent of the tax was solely revenue; there were no plans for communicating health messages or evaluating public health impact. The beverage industry has tried to have the tax repealed, but has failed due to lack of evidence of harm to the food, beverage, or bottling industry.

In Philadelphia, Mayor Michael Nutter introduced plans for a SSB tax in spring of 2010. The city proposed a $0.02 per fluid ounce tax on SSBs to be levied through Business Privilege Tax on Philadelphia retailers based on annual volume of SSB sales. Syrup would be taxed at $0.18 per fluid ounce because one ounce of syrup generally produces nine ounces of beverage. The city proposed that proposed that $20M (about 30 percent) of the revenue from the SSB tax would be earmarked for obesity prevention programs. In a poll conducted by the Campaign for Healthy Kids, 55 percent of likely Philadelphia voters said they would support the tax if revenue were earmarked for obesity prevention programs. Opposition to the tax included the beverage industry, small business owners, union members, and other anti-tax groups. Many viewed the tax as just a budget deficit filler that would harm local businesses. Mayor Nutter introduced the tax again in 2011 as a means of in closing the $629 million budget gap faced by School District of Philadelphia. The tax failed again due to the short timeline, protests from the beverage industry, and mixed messages about the tax. Instead, the Council made a deal for a temporary 3.85 percent property tax increase, the second increase in real-estate taxes in two years. Combined with several other measures, the deal will create $53M in revenue.

Former Senator Dean Flores of California proposed an excise tax that would levy a penny per teaspoon of sugar in SSBs. The hope was to provide an incentive for beverage manufacturers to reduce the amount of sugar in beverages and to educate consumers about the amount of sugar in beverages. In a poll conducted by the California Center for Public Health Advocacy, 56% of Californians said they would support the SSB tax. The tax failed partly due to heavy lobbying by the California Automatic Vendors Council.

The Cook County Department of Public Health in Illinois recently published an extensive analysis of the potential economic and public health impact of four different excise tax options: $0.01 per fluid ounce of SSBs only, $0.01 per fluid ounce of SSBs and diet beverages, $0.02 per fluid ounce of SSBs only, and $0.02 per fluid ounce of SSBs and diet beverages. The authors concluded that existing sales taxes on beverages are too small to have significant impact, but that sizeable excise taxes, such as those explored in the report, could significantly decrease consumption, increase revenue, decrease obesity prevalence, decrease diabetes incidence, and reduce health care costs.

States and cities are engaging in other efforts to reduce SSB consumption as well. As of October 2011, there were social marketing and media campaigns in New York, California, Minnesota, Massachusetts, Hawaii, Pennsylvania, Maine, Rhode Island, Washington, Texas, British Columbia, and Quebec. There were photo and video contests in California,
Massachusetts, and Washington. There were pledges and challenges in California, Massachusetts, New York, and Washington, plus the Center for Science in the Public Interest's Life's Sweeter Campaign. There are nutrition standards for beverages sold in vending machines or sold at city events in several California cities and counties; King County, WA; New York City; and Philadelphia. Cleveland Clinic (Cleveland, OH), Carney Hospital (Boston, MA), and Fairview Hospital (Great Barrington, MA) have banned SSB sales within the hospital. Boston, MA; San Antonio, TX; San Francisco, CA; and San Mateo County, CA have banned SSB sales in city/county vending and/or at city/county events. See Appendix. Poll results from some states suggest there is greater public support for the SSB tax if revenues are earmarked for public health research and programs.

**Support from influential organizations**

There is growing support from the public and health experts for the SSB tax. A number of nationally and internationally recognized organizations now support the tax. The Institute of Medicine recommends “a tax strategy to discourage consumption of foods and beverages that have minimal nutritional value, such as sugar-sweetened beverages” as one of the most promising action steps in addressing childhood obesity. The Congressional Budget Office suggested a federal excise tax of $0.03 per 12 fluid ounces of SSB to fund healthcare reform (estimated revenue $50 billion over 2009-2018). The Center for the Study of the Presidency and Congress recommends a cross-agency task force to consider strategies for disincentivizing the overconsumption of SSBs and excluding SSBs from the Supplemental Nutrition Assistance Program (SNAP) and other Federal programs while incentivizing the purchase of whole grains, fruits, and vegetables. Brownell and Frieden, who have extensively researched SSB taxes and other strategies for discouraging SSB consumption, conclude that, “in times of economic hardship, taxes that both generate substantial revenue and promote health are better options than revenue initiatives that may have adverse effects.”

During the health care debate of 2009-2010, a number of organizations endorsed a tax on SSBs in a June 2009 letter to Senator Max Baucus, Chair of the Senate Finance Committee. Signers include:

- American Public Health Association
- American Society of Bariatric Physicians
- Black Women’s Health Imperative
- California Center for Public Health Advocacy
- California Pan-Ethnic Health Network
- Center for Science in the Public Interest
- Citizens’ Committee for Children
- Consumers Union
- Fitness Forward
- Oral Health America
- Partnership for Prevention
- Physicians Committee for Responsible Medicine
Recommendations

While the link between SSB consumption and nutrition and health consequences is clear, the potential public health impact of the SSB tax is less clear. Future research efforts should focus on understanding cross-price elasticity specific to SSBs, including age-, gender-, race-, and SES-specific elasticities. This research will provide insight into consumer behavior that might result from a tax on SSBs, which might influence the language of the legislation, e.g. what beverages to include in the SSB definition, other products to include in items to be taxed, or details of earmarking the revenue. Epidemiologic research should also seek to determine attributable risk of obesity, diabetes, cardiovascular disease, and other negative health outcomes from SSB consumption in order to estimate health care costs associated with drinking SSBs. Knowing the health care costs of drinking SSBs would make possible more accurate estimates of the reductions in health care costs resulting from reduced SSB consumption.

Future policy efforts should take into account other states’ and cities’ experiences. First, form an Alliance for a Healthier Colorado and craft key messages for the public. Second, poll citizens to gauge public sentiment. Based on the poll results, consider options for raising awareness and building public support, such as a media campaign. Raise funding for activities decided upon; meanwhile, make plans for thorough evaluation of the activities in terms of effect on awareness, knowledge, and behavior. Poll citizens again to characterize change in public sentiment. If public support has increased to desired levels, and the Alliance feels the timing is right, determine key messages for policymakers, and begin reaching out to policymakers and drafting the language of the SSB tax. The tax should be an excise tax to be adjusted for inflation over time. Specific excise taxes are easier to administer, and they reduce opportunities for tax avoidance and evasion because they do not require valuation of a product. Excise taxes are likely to have a greater impact on consumption than sales taxes because excise taxes are reflected in the shelf prices of SSBs while sales taxes are imposed at the checkout after purchase decisions have largely been made. A SSB tax should result in a large, sudden increase in shelf price of SSBs because small, incremental increases tend to just be absorbed by consumers: $0.01-0.02 per fluid ounce of SSB, regardless of how many calories. At least half of the tax revenue should be earmarked for obesity prevention programs and research, and perhaps dental health programs and research. The tax must have some mechanism of enforcement. The Alliance should communicate consistent key messages to link the SSB tax to the public health rationale for the tax.

The National Policy & Legal Analysis Network to Prevent Childhood Obesity (NPLAN) created a model legislation for states planning an SSB tax. The template includes definitions for seventeen terms, as well as sample language for earmarking the revenue for public
health programs to prevent obesity and other negative health outcomes associated with SSB consumption and to increase healthy food consumption and physical activity\textsuperscript{52}.

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**References**


## Efforts to reduce SSB consumption

<table>
<thead>
<tr>
<th>Campaign Name</th>
<th>URL</th>
<th>Description</th>
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<tr>
<td>Albany County Department of Health (NY)</td>
<td><a href="http://www.albanycounty.com/departments/health/kids.asp?id=483">http://www.albanycounty.com/departments/health/kids.asp?id=483</a></td>
<td>Soda Facts/Soda’s Hidden Hazards Educational website</td>
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<td>Physical Activity</td>
<td><a href="http://www.banpac.org/resources_sugar_savvy.htm">http://www.banpac.org/resources_sugar_savvy.htm</a></td>
<td>Sugar Savvy Workshop of foods/beverages and healthier choices</td>
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<td>Bar Graph of Obesity/Sweet Demise/Liquid Lies</td>
<td><a href="http://bethecatalyst.org/collen/posts/451-catalyst-to-celebrate-food-day-with-teen-activism-kits">http://bethecatalyst.org/collen/posts/451-catalyst-to-celebrate-food-day-with-teen-activism-kits</a></td>
<td>Activism approach: built large bar graph depicting obesity trends by using towers of soda cans, created activism kits with posters, sidewalk stencils, etc.</td>
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<td>Ambition</td>
<td><a href="http://www.bphc.org/healthybeverages">www.bphc.org/healthybeverages</a></td>
<td>Healthy Beverages, FatSmack, Sugar Smarts Stoplight radio marketing campaign for parents (Sugar Smarts) and youth (FatSmack). Includes TV and radio spots, poster campaigns, and Facebook apps.</td>
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<td>Society</td>
<td><a href="http://dotcms.bcpeds.ca/sipsmart/welcome/index.dot">http://dotcms.bcpeds.ca/sipsmart/welcome/index.dot</a></td>
<td>Sip Smart! BC Curriculum to educate children about healthy beverage choices</td>
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<td>Soda Sucks</td>
<td><a href="http://www.facebook.com/waterrules">http://www.facebook.com/waterrules</a></td>
<td>Anti-soda/pro-water campaign targeted at teens and linked to Soda Sucks art and video contest. Includes TV spot and Facebook page.</td>
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<tr>
<td>California Endowment</td>
<td><a href="http://www.facebook.com/waterrules">http://www.facebook.com/waterrules</a></td>
<td>Soda Sucks Anti-soda/pro-water campaign targeted at teens and linked to Soda Sucks art and video contest. Includes TV spot and Facebook page.</td>
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<td>California Project LEAN and partners</td>
<td><a href="http://www.californiaprojectlean.org/ryd/default.html">http://www.californiaprojectlean.org/ryd/default.html</a></td>
<td>Rethink Your Drink Campaign includes posters, print materials, Facebook app, and radio spots.</td>
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<td>Choose Health LA!</td>
<td><a href="http://www.choosehealthla.com/eat-healthy/sugar-loaded-beverages/">http://www.choosehealthla.com/eat-healthy/sugar-loaded-beverages/</a></td>
<td>Sugar-Loaded Drinks Tied to Project LEAN campaign with reports specific to LA County.</td>
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<td>Philadelphia Department of Health</td>
<td><a href="http://www.foodfitphilly.org">http://www.foodfitphilly.org</a></td>
<td>Time for a Change Includes print ads, radio spots, and posters in convenience stores and at farmer’s markets.</td>
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<td>Rhode Island Department of Health</td>
<td><a href="http://www.health.ri.gov/healthrisks/sugarsweetenedbeverages/">http://www.health.ri.gov/healthrisks/sugarsweetenedbeverages/</a></td>
<td>“You wouldn’t let your kids eat this much sugar…” Includes television spot adapted from Seattle/King County.</td>
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<td>Santa Clara County Public Health Department (CA)</td>
<td><a href="http://www.potterloveswater.com/">http://www.potterloveswater.com/</a></td>
<td>Potter the Otter Loves Water Educational website</td>
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<td><a href="http://www.kingcounty.gov/healthservices/health/nutrition">http://www.kingcounty.gov/healthservices/health/nutrition</a></td>
<td>“You’d never serve your kid a glass of sugar…” Original television spots.</td>
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<td>York City Department of Health</td>
<td>Let’s Do This!</td>
<td><a href="http://www.kingcounty.gov/healthservices/health/partnerships/cppw/campaigns.aspx">http://www.kingcounty.gov/healthservices/health/partnerships/cppw/campaigns.aspx</a></td>
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<td><a href="http://texanscareforchildren.org/DrinkWell">http://texanscareforchildren.org/DrinkWell</a></td>
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<td>Art and Video Contests</td>
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<td>Boys and Girls Clubs of King County</td>
<td>Soda Sucks so Save your Bucks</td>
<td><a href="http://jointhemediaclubhouse.org/submit.php">http://jointhemediaclubhouse.org/submit.php</a></td>
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<td>New America Media/YO! Youth Outlook (CA)</td>
<td>Soda Sucks</td>
<td><a href="http://www.whysodasucks.com">www.whysodasucks.com</a></td>
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<td>Alameda County Public Health Department</td>
<td>Soda Free Summer Video Contest</td>
<td><a href="http://www.sodafreesummer.org">www.sodafreesummer.org</a></td>
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<td>Boston Public Health Commission</td>
<td>Soda Free Summer Challenge</td>
<td><a href="http://www.bphc.org/programs/cib/chronicdisease/heal/sodafreesummer/Pages/Home.aspx">http://www.bphc.org/programs/cib/chronicdisease/heal/sodafreesummer/Pages/Home.aspx</a></td>
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<td>Boston Public Health Commission</td>
<td>FatSmack Free from Sugary Drinks Pledge</td>
<td><a href="https://www.facebook.com/pages/FatSmackorg/229446067100670?sk=app_176217385757369">https://www.facebook.com/pages/FatSmackorg/229446067100670?sk=app_176217385757369</a></td>
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<td>Center for Science in the Public Interest</td>
<td>Life’s Sweeter Challenge</td>
<td><a href="http://www.fewersugarydrinks.org">www.fewersugarydrinks.org</a></td>
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<td>Seattle Childhood Obesity Prevention Coalition</td>
<td>Soda Free Sundays</td>
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<td><a href="http://www.cleveland.com/healthfit/index.ssf/2010/07/sugar-sweetened_food_beverages.html">http://www.cleveland.com/healthfit/index.ssf/2010/07/sugar-sweetened_food_beverages.html</a></td>
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