Sugar-sweetened beverage taxation in the Region of the Americas

PAHO Pan American Health Organization
World Health Organization
REGIONAL OFFICE FOR THE Americas

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Contents

Preface

As policymakers consider taxation of sugar-sweetened beverages (SSBs) as a policy tool to reduce SSB consumption and reduce health risks related to such consumption, the documentation and exchange of experiences and evidence accumulated becomes paramount.

Taxation of sugar-sweetened beverages has been implemented in more than 73 countries worldwide. In the Region of the Americas, 21 PAHO/WHO Member States apply national-level excise taxes on SSBs and seven jurisdictions apply local SSB taxes in the United States of America. While the number of countries applying national excise taxes on SSBs in the Region is promising, some of these taxes have been implemented to increase tax revenue, without considering their role as a health policy instrument. Most of these taxes could be further leveraged to improve their impact on SSB consumption and health.

This publication provides readers with economic concepts related to the economic rationale for using SSB taxes and the costs associated with obesity; key considerations on tax design including tax types, bases, and rates; an overview of potential tax revenue and earmarking; evidence on the extent to which these taxes are expected to impact prices of taxed beverages, the demand for taxed beverages, and substitution to untaxed beverages; and responses to frequent questions about the economic impacts of SSB taxation.

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Acronyms and abbreviations

CU	Currency units
CVD	Cardiovascular diseases
GST	General sales taxes
NCD	Noncommunicable disease
NUGAG	Nutrition Guidance Expert Advisory Group
PAHO	Pan American Health Organization
SDIL	Soft drink industry levy
SES	Socioeconomic status
SSB	Sugar-sweetened beverage
UPC	Universal Product Codes
VAT	Value added taxes
WHO	World Health Organization

Introduction

Noncommunicable diseases (NCDs) lead to morbidity and premature mortality worldwide and the burden of NCDs is a major challenge for social and economic development. The five principal NCDs are cardiovascular diseases (CVD), cancers, chronic respiratory diseases, diabetes, and mental and neurological conditions. These NCDs have five shared risk factors: tobacco use, harmful use of alcohol, air pollution, unhealthy diet, and physical inactivity. In the Region of the Americas, NCDs were responsible for an estimated 5.55 million deaths (80.7% of all deaths) in 2016. Thirty-nine percent of these NCD-related deaths occurred prematurely in persons aged 30 to 69 years. CVD is the leading cause of NCD mortality, accounting for 28% of all NCD deaths *(1)*. Worldwide, the cost of the five principal NCDs has been estimated at US$ 47 trillion over the period 2011-2030 *(2)*.

Over the past few decades, obesity/overweight and related NCDs have progressively increased in every age group and have become the major cause of death and disability in the Region of the Americas (55% of all causes in 2012), according to WHO Global Health Estimates *(3)*. The growing problem of NCDs is occurring in tandem with several nutritional deficiencies (e.g., low intake of iron, zinc, vitamin A, folate, and other micronutrients) which result from poverty and unhealthy diets and remain significant in several areas in the Americas, including the Andean, Central American, and Caribbean sub-regions.

The prevalence of adult overweight and obesity has increased substantially over the last 20 years in the Region of the Americas (63.7% for males and 61.0% for females, in 2016). The highest prevalence rates are the United States of America (68%), Mexico (65%), Canada (64%), and the Bahamas (64%) *(4)*. Prevalence rates have grown among children and adolescents and available data show that 20% to 25% are overweight or obese *(5)*.

Scientific knowledge about the influence of specific dietary intake patterns on the development of obesity/overweight and other NCDs is fairly robust *(6, 7)*. In particular, sugar-sweetened beverage (SSB) consumption is linked to obesity, and is independently related to adverse health outcomes including type 2 diabetes, cardiovascular disease, dental caries, and osteoporosis *(8, 9, 10, 11)*.

There is growing evidence of the importance of taxes on SSBs as part of a comprehensive approach to reducing SSB consumption. In addition to reducing consumption of SSBs and related health risks, public health benefits to the population can be even higher if tax revenues are used for targeted obesity prevention and for health promotion programs and efforts. Earmarking some portion of the revenues may also improve the transparency of the taxation process and use of revenues, which may increase acceptability of the tax by politicians and the public. Taxes on SSBs have been described as a triple win for governments, because they 1) improve population health, 2) generate revenue, and 3) have the potential to reduce long-term associated healthcare costs and productivity losses *(12, 13)*.

The World Health Organization Technical Meeting on Fiscal Policies for Diet of May 2015 concluded that appropriately-designed fiscal policies, when implemented with other policy actions, can diminish the obesogenic environment and promote healthy diets *(14)*. Further, the WHO Global Action Plan for the Prevention and Control of NCDs (2013-2020) *(15, 16)* and the Report of the WHO Commission on Ending Childhood Obesity *(17)* recommend fiscal policies, taxes and subsidies that discourage unhealthy diets, create incentives to improve access to healthier foods, and encourage behaviors associated with improved health outcomes. Fiscal policy is a key part of a package of regulatory policies, such as marketing restrictions, school food policies, and labeling of foods, that can help improve the food environment and change behavior. While a comprehensive strategy is required to control growing rates of overweight and obesity, and to encourage healthier dietary intake and lifestyles, fiscal policies are effective complementary tools that have broad reach and can mitigate the obesity epidemic at a population level. Fiscal policies such as taxes on SSBs are policy actions recommended by WHO to modify behavioral risk factors associated with obesity and NCDs, as featured in the updated Appendix 3 of the WHO Global Action Plan *(16, 18)*. The WHO Nutrition Guidance Expert Advisory Group (NUGAG) Subgroup on Policy

Actions has also initiated development of evidence-informed WHO guidance on fiscal and pricing policies as part of its support for Member States to develop effective policies enabling food environments that promote healthier diets and nutrition. This work contributes to achieving the commitments of the Political Declaration of the third high-level meeting of the United Nations General Assembly on the prevention and control of noncommunicable diseases to "promote and implement policy, legislative and regulatory measures aiming at minimizing the impact of the main risk factors for noncommunicable diseases, and promote healthy diets, and lifestyles" *(19)*.

Taxes on SSBs have been implemented in more than 73 countries worldwide *(20)*. In the Region of the Americas, 21 Member States of the Pan American Health Organization (PAHO) apply national-level excise taxes on SSBs, and seven jurisdictions apply local SSB taxes in the United States of America *(20, 21, 22)*. While the number of countries applying national excise taxes on SSBs in the Region is promising, some of these taxes have been implemented to increase tax revenue, without consideration of potential impact as a health policy instrument to tackle NCDs (e.g., taxing bottled water). Most of these taxes could be further leveraged to improve their impact on SSB consumption and health *(22)*.

Significant barriers and challenges can be present that adversely impact effective SSB taxation policy development. Policymakers considering SSB taxes need technical assistance and references as well as a detailed situational analysis pertaining specifically to the health situation and goals for their own jurisdiction.

This technical reference is intended to provide assistance as follows: Section 1 presents economic concepts related to the costs associated with obesity and the economic rationale for using SSB taxes. Section 2 provides key considerations on tax design including tax types, bases, and rates. Section 3 outlines the estimation of potential tax revenue and earmarking. Section 4 provides evidence on the extent to which these taxes are expected to increase prices of taxed beverages, change the demand for taxed beverages, and lead to substitution to untaxed beverages. Section 5 provides an overview of potential unintended consequences and available evidence that counter the arguments against such taxes.

1. Economic concepts

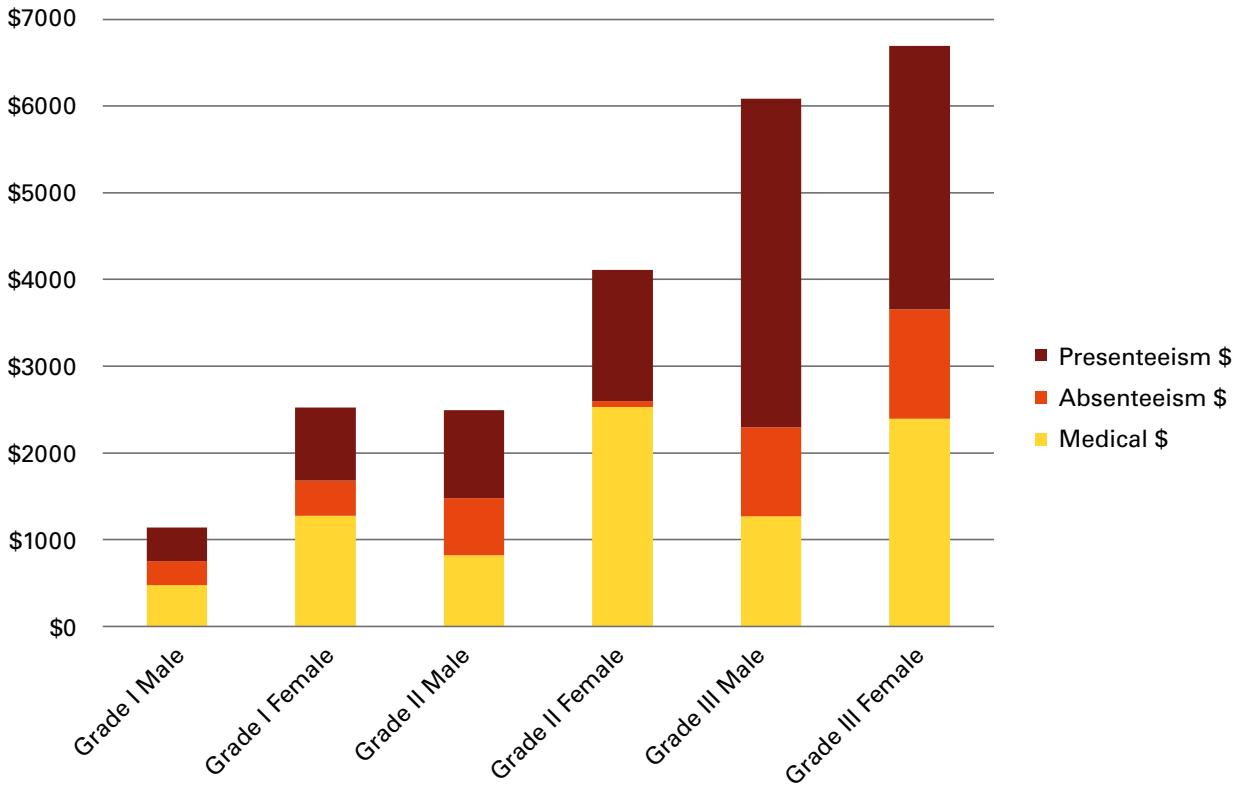
1.1 Economic rationale for sugar-sweetened beverage (SSB) taxes

The economic rationale for using fiscal policies, in this case taxation, to address a public health issue such as NCDs is that market failures lead individuals to overconsume. Negative internalities and externalities, such as health care costs (excluding out-of-pocket ones) and losses in productivity may not be accounted for in individuals' consumption decisions. Internalities may also lead to overconsumption. For example, individuals may not have full information on the negative health consequences and impacts associated with SSB consumption. And, even if individuals are fully informed, they may not appropriately discount the future costs of their behaviors. Thus, the rationale for applying a tax is overconsumption which occurs due to the fact that the full cost of consumption is not accounted for in the market price. A "Pigouvian" tax (set equal to the social cost of the negative externalities) is one way to help internalize the external costs. A fiscal policy instrument, such as an SSB tax, can change relative prices which, in turn, can impact behavior choices related to consumption *(23)*.

1.2 Economic costs of obesity

SSB consumption is linked to obesity and independently related to adverse health outcomes including type 2 diabetes, cardiovascular disease, dental caries, and osteoporosis *(8, 9, 10, 11)*. Obesity is a significant driver of preventable chronic diseases and high healthcare costs. For example, in 2005, the United States' annual national medical care costs due to obesity-related illness in adults have been estimated to be $209.7 billion for adults *(24)*; and higher body weight for children has been associated with $14.1 billion in additional prescription drug, emergency room, and outpatient visit costs annually *(25)*. Additionally, for the United States, incremental per capita medical expenditures and absenteeism and presenteeism costs associated with obesity have been shown to increase substantially by obesity status (See Figure 1) *(26)*.

Figure 1: Per capita incremental medical expenditures, absenteeism, and presenteeism costs, by obesity status and gender, United States



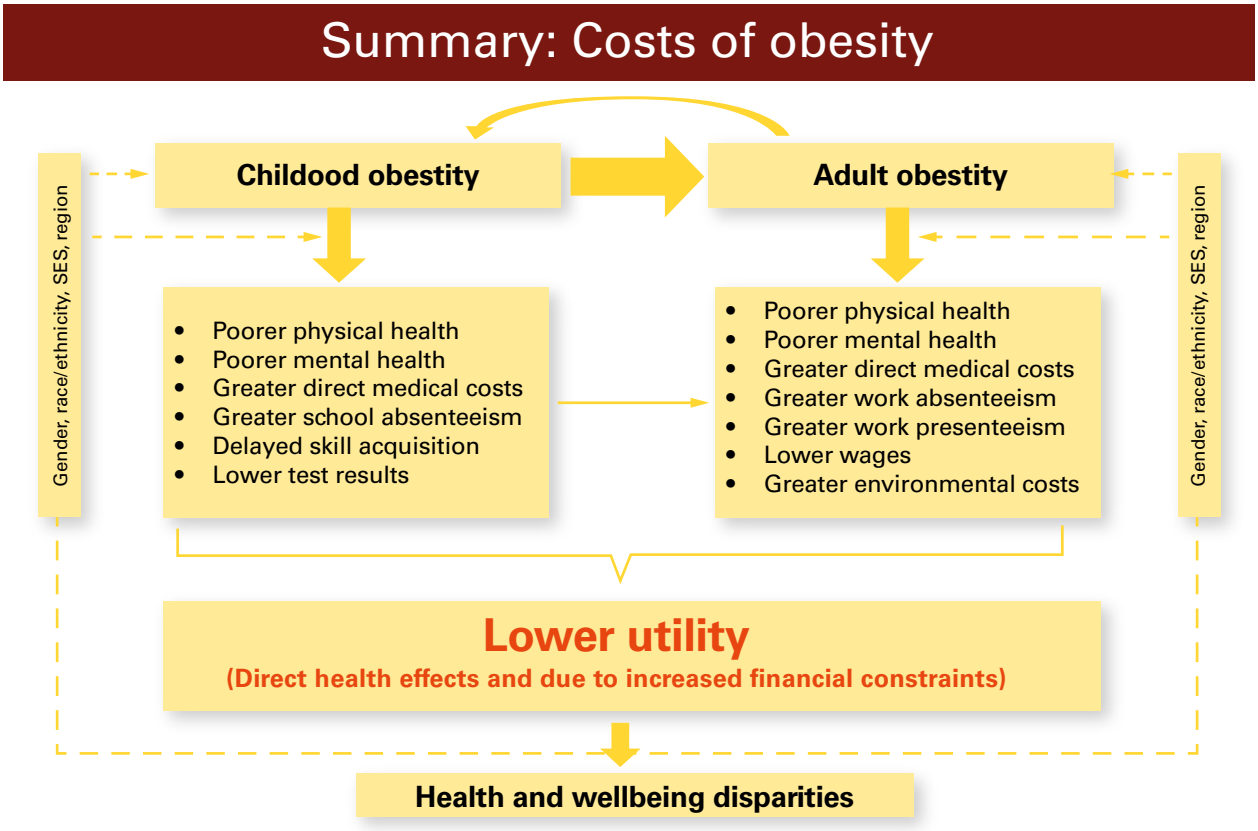
Notes: Grade I obesity: (30.0 ≤ BMI ≤ 34.9); Grade II obesity: (35.0 ≤ BMI ≤ 39.9); Grade III obesity: (BMI ≥ 40.0).
Source: Data drawn from Table 2, Finkelstein EA, DiBonaventura M, Burgess SM, Hale BC (2010) The Costs of Obesity in the Workplace. *Journal of Occupational and Environmental Medicine.* 52(10):971-6.

Obesity is associated with substantial productivity and human capital costs; in particular, job absenteeism (productivity costs due to employees being absent from work for health reasons), presenteeism (lower productivity while at work) and premature mortality, which can create significant costs for employers and the economy each year *(27)*. With respect to productivity costs attributable to SSB consumption, a study done in Mexico estimated a total productivity loss of $1.4 billion with 56.9% of the costs stemming from premature mortality and 41.1% due to presenteeism. Diabetes is the main SSB-related cause of the productivity loss (92.1% of premature death-related productivity loss and 99.8% from presenteeism) *(28)*. The economic burden of diabetes is further highlighted in a study of 25 countries in Latin America and the Caribbean, in 2000, where direct healthcare costs (medication, hospitalization, consultations, and complications) and indirect costs (forgone earnings due to premature mortality and disability costs) related to diabetes were estimated to be $10.7 billion and $54.5 billion, respectively ($1.97 billion and $13.14 billion for Mexico; $996 million and $1.1 billion across three countries in Spanish Caribbean; $218 million

and $812 million across five countries for English Caribbean; $828 million and $1.8 billion for six countries across Central America; and, $6.7 billion and $37.7 billion for 10 countries across South America) *(29)*.

Finally, it should be noted that the costs of obesity among children extend beyond the healthcare costs described above. Obesity among children has been shown to be "a direct cause of morbidities in childhood, including gastrointestinal, musculoskeletal, and orthopedic complications, sleep apnea, and the accelerated onset of cardiovascular disease and type-2 diabetes, as well as the comorbidities of the latter two noncommunicable diseases" *(17, 30)*. It is also associated with delayed skill acquisition in early childhood, greater school absenteeism, and lower school test scores, and can lead to depression, stigmatization, and poor socialization, among other social consequences *(17, 31, 32)*. These burdens, along with obesity itself, will carry into adulthood. Obesity has been shown to be associated with impairment of individuals' labor market outcomes *(17)*. Thus, the personal burden associated with obesity can become a vicious cycle and contribute to ongoing health and socioeconomic inequities. Figure 2 summarizes overall costs associated with obesity in children and adults and obesity's ultimate impact on health and wellbeing.

Figure 2: Overview of costs associated with obesity in children and adults



Source: Lisa M. Powell. Presented at the Uppsala Health Summit Ending Childhood Obesity: Actions through Health and Food Equity. Uppsala, Sweden, 2016.

2. Key elements for SSB tax design and implementation

2.1 Tax type and structure

A tax applied to a defined set of products may be used as a policy instrument to increase the relative prices of such products and thereby influence individual-level consumption. Consumption taxes are considered indirect taxes which are passed on to the consumer; examples include excise taxes, value added taxes (VAT), general sales taxes (GST), and import tariffs and custom duties. Of these, excise taxes are of key importance when using fiscal policy to promote health, given that they are uniquely applied to specific products and thus will have a direct impact on the relative price of the taxed products, as opposed to general taxes on a broad range of goods and services. In other words, excise taxes change the prices of the targeted products relative to the rest of products and services, with other conditions remaining the same (ceteris paribus).

VAT and GST taxes generally apply broadly to all products, and therefore are not considered policy tools that would change the relative prices of specific products and related consumption behavior. While VAT tax is typically incorporated into the shelf price, which is important for impacting behavior decisions, a GST applied at the point of payment (at the cashier) is less salient and hence a less favorable tax instrument for impacting behaviors.

Import tariffs are used to raise revenue and can influence consumption (such as discouraging consumption of certain goods and products) and the balance of trade. Tariffs on products that do not have domestically produced substitutes may be effective in reducing overall consumption of such products. However, tariffs on imported products that are also produced domestically will raise the relative price of the imported products and induce tax substitution (tax avoidance) in favor of the domestically produced products. Import tariffs may also violate trade agreements. Thus, import tariffs are not considered a best practice as an effective policy tool aimed at reducing SSB consumption.

Excise taxes are applied to specific products and are often used as "Pigouvian" taxes implemented with the intent of inducing a behavior change to correct for the externalities/internalities associated with overconsumption. Typical examples include excise taxes on tobacco and alcohol products, gasoline and motor vehicles, and products packaged in plastic. Excise taxes are also used to tax luxury items and many other goods as a discriminatory means to raise revenue. Excise taxes apply equally to domestically produced and imported products and therefore do not violate the trade agreement principle of non-discrimination based on the origin of products.

Excise taxes may be applied as a specific tax or an ad valorem tax, or a mix of the two. A specific excise tax is applied as a specific amount per unit volume, or may be based on beverage characteristics (e.g., sugar content), while an ad valorem excise tax is applied as a percentage of the value of the product. As described in Box 1, specific excise taxes have a number of advantages and are generally preferred for a number of reasons to reduce consumption of specified products. It is important to keep in mind that specific excise taxes need to be periodically increased; otherwise they will be eroded by inflation and their effectiveness will be reduced. One way to solve this issue is for the law to mandate automatic adjustment of specific excise taxes for inflation. Finally, some view ad valorem excise taxes as more equitable than specific excise taxes, because the amount of the tax levied will be greater on the higher priced premium brands more likely to be chosen by more affluent consumers. However, ad valorem taxes widen the gap between cheaper and premium brands, incentivizing consumers to switch to cheaper brands and undermining the potential health benefits of the tax.

Specific and ad valorem excise taxes can be applied as either a uniform tax structure with one unique tax rate, or as a tiered tax structure where the tax rate varies based on price and/or product characteristics. Tiered tax structures based on price can have disadvantages of widening price gaps between brands and facilitating tax avoidance by producers who may manipulate the prices of their products to reduce the tax

Box 1: Example of advantages of specific versus ad valorem excise taxes

- **Since specific excise taxes are applied on a per unit volume or based on beverage characteristics (e.g., sugar content) rather than as a function of the value of the product, quantity discounts are still taxed.**
- **Specific excise taxes reduce the incentives to switch to less expensive brands.**
- **Ad valorem excise taxes have more variable impacts on prices; that is, ad valorem taxes levied on a value set early in the value chain will have a smaller impact on retail prices than if levied based on the retail price and this impact will vary based on differential markups.**
- **Ad valorem excise taxes levied earlier in the value chain are more subject to abusive transfer pricing, where producers and/or distributors set artificially low prices at the point where the tax is levied and then raise the price further along the distribution chain. This can be particularly problematic when the industry is highly vertically integrated.**
- **Specific excise taxes are relatively easier to administer and are not as susceptible to industry tax avoidance and evasion, such as under-invoicing in countries which use the Cost, Insurance and Freight (CIF) or ex-factory price as the base value for ad valorem excise taxes.**
- **Tax revenues from specific excise taxes are more stable revenues as they are not as subject to industry price manipulation.**

they face. However, uniform and tiered taxes based on product characteristics such as sugar content may induce product reformulation. This is similar to the practice of tiered tax structures for excise taxes on alcoholic beverages where the tax is based on ethanol content. The supply-side response of reformulation can add to the public health impact of the tax, but there may also be supply-side responses of increased marketing of unhealthy products. While most excise taxes on SSBs to date have generally used a uniform specific excise tax amount per unit volume (e.g. Berkeley, CA, Boulder, CO, and Suriname) or a uniform ad valorem tax rate (e.g. Barbados and Saint Vincent and the Grenadines) where all taxed beverage products are subject to the same tax irrespective of their beverage type (e.g., sugar-sweetened carbonated, energy, sports, and fruit drinks, etc.) or sugar content, some have implemented uniform or discrete tiered tax approaches based on sugar content (e.g. Chile, Ecuador, and Peru). Finally, two countries, El Salvador and Mexico, apply a mixed excise tax structure on energy drinks, taxing these beverages with both a specific excise tax and an ad valorem excise tax.

Additionally, in comparing specific versus ad valorem excise taxes, it is important to note that a specific excise tax will differentially change the relative price of different types of SSBs given that their per unit base prices differ. This point is illustrated in Table 1 which reports the mean price per ounce (and per 100 ml) of SSB prices by beverage category in Cook County, IL, USA, in 2017, ranging from a low of 2.68 cents per ounce (9.06 cents or $0.0906 per 100 ml) for soda to 13.6 cents per ounce (46 cents or $0.46 per 100 ml) for energy drinks. Example 1 shows that based on the different mean prices by beverage category a specific excise tax in the amount of one cent per ounce (3.38 cents or $0.0338 per 100 ml) would equate, on average, to an increase in the price of soda of 37% but only a 7% increase in the price of energy drinks (assuming full tax pass-through). Correspondingly, as shown in Example 2, a given ad valorem excise tax applied on the sale price corresponds to different per unit prices increase across beverage types.

Table 1: Sweetened beverage prices and examples of alternative specific versus ad valorem excise taxes

	Soda	Juice Drinks	Energy Drinks	Sports Drinks	Tea/ Coffee	Overall SSBs
Average beverage price in cents(¢)/ounce(oz) [¢/100 ml]	**2.68 [9.06]**	**3.52 [11.9]**	**13.60 [45.99]**	**3.88 [13.12]**	**4.42 [14.95]**	**3.45 [11.67]**
Example 1: Specific excise tax of 1¢/oz [3.38¢/100 ml]	**1.00 [3.38]**	**1.00 [3.38]**	**1.00 [3.38]**	**1.00 [3.38]**	**1.00 [3.38]**	**1.00 [3.38]**
Implied ad valorem excise tax rate on the sale price	**37%**	**28%**	**7%**	**26%**	**23%**	**29%**
Example 2: 20% ad valorem excise tax on the sale price	**20%**	**20%**	**20%**	**20%**	**20%**	**20%**
Implied ¢/oz specific excise tax [¢/100 ml]	**0.57 [1.93]**	**0.70 [2.37]**	**2.72 [9.2]**	**0.78 [2.64]**	**0.88 [2.98]**	**0.69 [2.33]**

Notes: Price data were based on Nielsen store scanner data from Cook County, IL, US, 2017.
Source: Data obtained from Powell LM, Leider J, Léger PT (2020). The impact of the Cook County, IL, Sweetened Beverage Tax on beverage prices. *Economics & Human Biology*. 37, 100855.

2.2 Tax base

A key consideration for policymakers is to define the tax base. That is, defining the specific products to which the tax will be applied. Within the context of SSBs, the public health objective to reduce intake of sugars suggests a tax on all SSBs, including all water-based sugar-sweetened drinks (carbonated drinks, energy drinks, sports/isotonic drinks, fruit or vegetable juices and drinks), sugar-sweetened coffee drinks, coffee substitutes, tea and herbal infusions (teas/coffees), sugar-sweetened milks and dairy based drink products (sugar-sweetened/flavored milks and yogurt drinks), and concentrates, powders, and syrups used to make SSBs by adding water or carbonated water. However, even though flavored or sweetened milk is a significant contributor to children's SSB intake *(33, 34, 35, 36)* it has generally been exempted from the tax base of most targeted beverage excise taxes on SSBs to date. However, all forms of free sugars are considered a risk factor as indicated in the WHO Guideline: Sugars Intake for Adults and Children *(37)*. For this reason, the tax base should also include 100% fruit juices. On the other hand, excise taxes should exempt bottled water. Taxing bottled water undermines the ability of excise taxes to generate a price differential between SSBs and non-SSBs and does not incentivize consumers to switch from consuming SSBs to a healthier alternative.

As noted above, excise taxes on SSBs to date have mostly been applied using a uniform tax rate either based on volume (specific tax) or on the value of the product (ad valorem) where the tax base includes all taxed beverage products subject to the same tax rate irrespective of their sugar content or beverage type. While a uniform ad valorem excise tax or a specific excise tax based on volume has the important advantage of simplicity in implementation, it does not provide incentives for consumers to switch to less sugar-sweetened beverages or for the beverage industry to reformulate products to reduce content of sugars per serving.

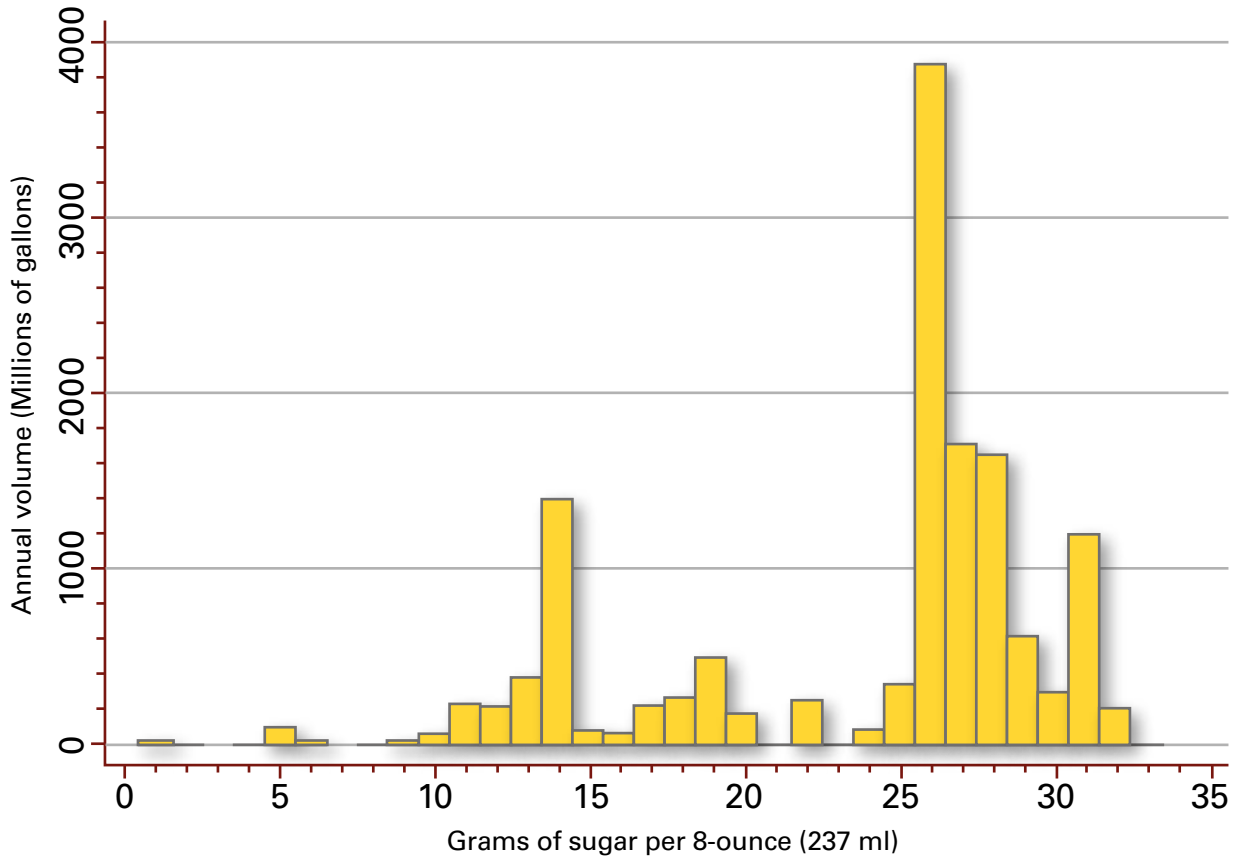
An approach where beverages are taxed at different rates depending on their content of sugars, i.e., grams (g) of sugar per unit of volume or serving, has been proposed and implemented in a limited number of countries. In the Region of the Americas, in 2014, Chile created a tiered tax by increasing their SSB tax rate from 13% to 18% on high-sugar SSBs (>6.25 g sugar/100 ml) and reducing it from 13% to 10% on low- or no-sugar sweetened beverages (<6.25 g sugar/100 ml, including all beverages with non-sugar sweeteners). A similar, tax structure is in place in Peru but with three different ad valorem excise tax rates (25%, 17%, and 12%) defined by sugar concentration thresholds (respectively: 6 g sugar/100ml, 0.5–6 g, and <0.5 g sugar/100 ml). Outside the Region of the Americas, the United Kingdom in April 2018 implemented a three-tiered soft drink industry levy (SDIL) with no tax on beverages with <5 g of sugar/100 ml, and 18 pence/

liter and 24 pence/liter on beverages with 5–8 g and >8 g of sugar/100 ml, respectively. Within two years following the SDIL announcement, there was an 11% reduction in the content of sugars of SSBs subject to the levy, and the caloric content of such SSBs fell by 6% *(38)*. And, recent evidence shows that between 2015 and 2018 sales volume sold of high-sugar (>8 g/100 ml) beverages fell 40% which stemmed from a combination of reformulation and reduced demand from the tax *(39)*. However, there has not been any evidence on the overall reduction of sugar available in all drinks, as extra increases in the intake of low-sugar drinks may compensate the reduction in high-sugar intake. It should be noted that low-sugar beverages are also SSBs and have the potential to promote weight gain and obesity. In order to prevent the increase in sugar intake from low-sugar beverages, it is important that these beverages are not exempted from taxes.

SSB taxes can be designed with discrete tiers based on thresholds across which excise tax rates vary (e.g., Chile, Peru, and the United Kingdom) or can be based on a continuum (rather than discrete tiers) of content of sugars in SSBs. In the Region of the Americas, only Ecuador uses a tax structure with a specific excise tax of 18 cents in United States dollars or $0.18 per 100 g of sugar on beverages with >2.5 g of sugar/100 ml, and a lower tier for beverages with <2.5 g of sugar/100 ml on which an ad valorem excise tax of 10% is applied. Outside the Region, South Africa implemented a similar tax structure with introduction of the Health Promotion Levy in April 2018, consisting of a specific tax of South African rand ZAR 0.021 (approximately 15 cents or $0.15) for each gram of sugar over an initial threshold of 4 g of sugar/100 ml.

While the tiered tax approach has drawn growing interest globally, questions remain about the appropriate tax tier thresholds in terms of impacts on consumption, reformulation, and tax revenue. When considering the design of a tiered SSB tax, a recent study showed that evidence on the actual distribution of the most commonly consumed SSBs by sugar content can help inform the choice of meaningful thresholds for a tiered tax structure *(40)*. For example, Figure 3 reveals multiple clusters of SSB sales volume by content of sugars and suggested threshold tiers for differential tax rates at <20 g and <5 g of sugars per 8 ounces (corresponding to cut points at 5 g below the lower bounds of the clusters). This distance from the cut points to the lower bounds of the clusters should be determined based on a given jurisdictions' goals for reducing sugars intake and inducing reformulation.

Figure 3: Distribution of annual sugar-sweetened beverage (SSB) sales volume by sugar content for all SSBs, United States total, 2018



Source: Powell LM, Andreyeva T, Isgor Z (2020). Distribution of sugar-sweetened beverage sales volume by sugar content in the United States: implications for tiered taxation and tax. *Journal of Public Health Policy*. 41:125-138.

2.3 Tax rate

The size of the tax has implications for the expected impact on individuals' consumption. Price elasticity of demand is a common metric that measures the percentage change in quantity demanded arising from a one percent change in price. The price elasticity of demand for SSBs is estimated to be in the range of –0.8 to –1.3 *(41, 42, 43)*. Thus, based on an estimated average price elasticity value of –1.0, an excise tax that raises SSB prices by 25% is expected, on average, to reduce consumption of the taxed product by 25%.

The effective net change in prices for the taxed SSBs depends on the type of tax that is implemented. Assuming full pass-through of taxes to prices, an ad valorem excise tax of a given tax rate, applied on the retail price or the retail price excluding VAT, will by definition increase prices by the given rate. However, if the base value is set earlier

in the value chain, such as the producer price, assuming full pass-through, the tax will increase prices by a lower amount than the given rate. Finally, the percentage change in price resulting from a volume-based specific excise tax depends on the container size and the baseline price of the taxed SSBs.

Tax rates need to be sufficiently high to effectively disincentivize consumers from purchasing SSBs *(14)*. The tax rate will ultimately be determined as part of the country's target to reduce consumption.

2.4 Current SSB taxes in the Americas

As of December 2019, in the Region of the Americas, excise taxes on SSBs have been implemented in 21 PAHO/WHO Member States and in seven jurisdictions in the United States of America *(20, 21, 22)*. This includes all excise taxes applied on SSBs whether or not non-SSBs, such as bottled water or non-sugar sweetened beverages, are excluded. As described in Figure 4, the taxes vary considerably by country and, in the case of the United States, between jurisdictions, in terms of the types of taxes used, bases to which the taxes are applied, and the tax rates. In terms of tax design, 15 are specific excise taxes (Mexico has a mixed design on energy drinks with an additional ad valorem tax) and 11 are ad valorem excise taxes (El Salvador has a mixed design on energy drinks with an additional specific tax). Two countries, Dominica and Ecuador, apply a combined design with some products being subjected to an ad valorem tax and some to a specific tax but not to both. In terms of exclusions, dairy beverages, including those that are sugar-sweetened such as chocolate milk, along with 100% fruit juices, infant formulas, and medically-related beverages have generally been exempt from these taxes. However, other types of exclusions related to factors such as whether the beverages are sold in powder or liquid concentrate form or bottled versus prepared have varied. Similarly, some taxes are imposed on beverages with any amount of caloric sweetener while others have small thresholds above which the tax is applied. Appendix A provides an example of differences in sweetened beverage tax characteristics for the current seven local-level taxes in the United States.

Figure 4: Excise taxes on SSBs in the Region of the Americas, effective March 2019

*Combined: At least one type of SSB is taxed by an ad valorem excise tax and at least one other type is taxed by an amount-specific excise tax. No beverage type is taxed by both.

** The excise tax on SSBs is structured as an ad valorem tax applied on fixed tax base amounts – "precios fictos" – per volume varying per beverage type, effectively operating as an amount-specific tax and classified as such in this map.

3. Tax revenue and earmarking

3.1 Revenue generation

In order to project potential revenue from an SSB tax, the type of tax needs to be specified and a number of data sources and parameter assumptions are required. The type of excise tax levied has implications for whether one needs to use the volume sold (Q; quantity) or sales value (Price*Q) as the basis upon which to determine revenue. A specific excise tax applied per unit volume (e.g., one cent in United States dollars or $0.01 per 100 ml) requires estimates of volume of SSBs sold. An ad valorem excise tax applied on the sale price (e.g., 20%) requires an estimate of the sales value of SSBs sold. Sources of beverage volume data include domestic production data and import data. Details are needed on beverage types, brands and sugar content in order to determine tax applicability along with details on beverage package size to determine volume. Data are also needed on SSB prices in order to determine 1) the extent of the percentage increase in price of specific excise taxes, or 2) the sales value to which an ad valorem tax is applied. Data on SSB prices can be obtained from store audits or scanner data and, again, details on beverage types, brands, sugar content, and sizes are needed. Once one has an estimate of the tax base and the prices of the products in the base (to determine how much, for example, a specific excise tax would raise the prices), it is possible to estimate the extent to which the demand will change once the tax is implemented. In order to do this, the volume will need to be adjusted for the expected reduction in demand based on an assumption of the price responsiveness (i.e., the price elasticity of demand) of consumers. The estimation of tax revenue can then be derived from these data.

The following hypothetical example demonstrates the steps needed to estimate tax revenue from the introduction of a specific excise tax based on beverage volume. 1) The estimated pre-tax volume sold of SSB is 3.65 million liters (L); 2) The pre-tax price of SSBs (weighted average across SSB types) is estimated to be 55 CU (currency units of a given country); 3) A 10 CU per liter excise tax will be levied on SSBs; 4) Assuming 100% tax pass-through, the 10 CU per liter specific excise tax implies a 18.2% increase in the price of SSBs; 5) Assuming an elasticity of demand of –1.2, sales are projected to fall by 795,700 liters; 6) The estimated post-tax volume sold of SSBs is predicted to be 2.85 million liters; 7) Thus, the estimated tax revenue is estimated to be 28.5 million CU.

Table 2: Example of SSB tax revenue calculation

SSB specific excise tax of 10 currency units (CU) per liter (L)	
Pre-tax volume sold (L)	3,650,000
Pre-tax price per L	55 CU
Tax per L	10 CU
Effective tax rate	18.2%
% change in sales	–21.8%
Reduction in volume sold (L)	(795,700)
Post-tax volume sold (L)	2,854,300
Estimated tax revenue	28,543,000 CU

Notes: Assumptions include i) 100% tax pass-through; ii) Elasticity of demand, ED = –1.2.

3.2 Earmarking

Earmarking a portion of tax revenue for specific government programs toward health promotion or other public goods is an aspect of fiscal policies that may help to garner public support for the tax and leverage public health goals. Earmarking specifically for programs related to nutrition and physical activity can complement the intended health impact of the tax. Earmarking toward low-income and minority populations can help to address health disparities. Appendix A reports on the varied degree of earmarking of tax revenue across the SSB taxes implemented in the United States. Most of the other countries applying excise taxes on SSBs in the Region do not earmark tax revenues.

Examples of potential programs related to nutrition and physical activity and policies that could be supported by the tax revenues from an SSB tax include:

- Subsidizing drinking water infrastructure, including in schools;
- Subsidizing fruits and vegetables for low-income populations;
- Subsidizing healthy meals in schools;
- Promoting the implementation of school gardens as a learning tool and to improve access to fruits and vegetables;
- Implementing an integrated health communication campaign to promote the importance of reducing SSB consumption;
- Providing sponsorship for youth sports, including government-supported interschool competitions and sports events; and,
- Providing funding for increased activity facilities and spaces, particularly in underserved communities.

4. Evidence on the impact of SSB taxes

As policymakers consider the implementation of SSB taxes as a policy tool to reduce SSB consumption, it is important to have an understanding of the evidence of the extent to which 1) taxes will translate into an increase in prices faced by consumers; 2) taxes will reduce the demand for SSBs; and, 3) taxes will have cross-price effects on the demand for non-taxed and lower-taxed beverages and other food and beverage products.

4.1 Impact on SSB prices

Given that the goal of a public health-oriented tax policy is to reduce consumption of a particular good, in this case SSBs, then the tax must be passed on to consumers in the form of higher prices. The tax incidence, that is, the extent to which consumers versus producers/sellers bear the burden of the tax, depends on the responsiveness (price elasticity) of demand and supply. If demand is relatively price-insensitive (i.e., quite inelastic, price elasticity of demand close to zero) then the amount of the tax will be mostly passed on to consumers with limited impact on quantity demanded and sold. Although such a setting may be ideal for raising tax revenue, it is not conducive for reducing consumption. In practice, SSBs are normal goods, with either inelastic (i.e., price elasticity >0 but <1 in absolute value) or elastic (i.e., price elasticity >1 in absolute value) demand and supply. Therefore, excise taxes generally lead to some (but not necessarily 100%) pass-through (i.e., a sharing of the tax burden by consumers and producers) and lower consumption. In some settings (e.g., non- or little-competitive markets), taxes may also lead to over-shifting (i.e., pass-through >100%).

When interpreting the extent to which taxes are passed through to consumers in the form of higher prices, it is important to take note of several additional important factors. First, it is important to note the fact that the impact may be different for given statutory ad valorem excise tax rates depending on where they are applied in the value chain. For example, in Barbados, the ad valorem excise tax is applied to the producer price, which is a lower base value for taxation than the retail price or the retail price excluding VAT. In Chile, however, the 18% and 10% ad valorem excise taxes are applied to the retail price excluding VAT. Therefore, even in the cases where statutory ad valorem excise tax rates may be the same across two countries, if they are applied at different points in the value distribution chain, their effective impact on prices (and, hence demand) may be different.

A second point to keep in mind when comparing results across national versus local taxes is that the potential for cross-border shopping in jurisdictions with local taxes may increase price responsiveness and thereby dampen tax pass-through. Indeed, as noted below there is evidence from local jurisdictions in the United States showing that tax pass-through is relatively lower in stores located closer to the border of the taxing jurisdiction. Third, market structure and related profit margins can also impact the extent of tax pass-through where instances of larger profit margins will allow firms to absorb part of the tax. Overall, the extent of the tax pass-through depends on both consumer demand and market structure, including the opportunity for tax avoidance such as cross-border shopping, extent of profit margins, and factors related to the type of tax and where it is applied in the value chain; thus, it is an empirical question.

In terms of the available empirical evidence, as SSB taxes have emerged in the Americas, a number of studies have assessed the pass-through of these taxes to SSB prices. Of note is the fact that differences in the extent of tax pass-through exist not just across jurisdictions but also within jurisdictions across store type and across beverage type. In Mexico, studies found partial to full pass-through of the SSB tax including over-shifting for soda *(44, 45)*. In Barbados, the 10% tax, applied early on in the commercialization chain, was found to increase SSB prices by 5.9% *(46)*. In Chile, the increase in the tax rate on high-sugar SSBs from 13% to 18% was found to increase prices by approximately about 2-4% *(47, 48)*.

Among the local jurisdictions in the United States, short-run evaluations of the one cent per ounce SSB tax in Berkeley, CA, found that just under half of the tax was passed on to consumers, with slightly higher pass-through for soda, some differences by store type, and lower pass-through in stores located closer to the city limits *(49, 50)*. At one year post-tax in Berkeley, another study found varying pass-through across store types *(51)*. Two studies of the Cook County, IL, one cent per ounce tax which covered both SSBs and non-sugar sweetened beverages found slight over-shifting of the tax (114-119%) onto beverage prices *(52, 53)*. Two studies of the 1.5 cent per ounce tax in Philadelphia, PA,

which also covered both SSBs and non-sugar sweetened beverages found near to full tax pass-through *(54, 55)*. However, another Philadelphia study found heterogeneity by store type with full tax pass-through in pharmacies (104%) but partial pass-through in supermarkets (43%) and mass merchandise stores (58%) *(56)*. A report on the SSB tax in Seattle, WA, found that the 1.75 cents per ounce tax was almost fully (97%) passed through to consumers *(57)*; however, another study found a lower level of pass-through (59%) in Seattle *(58)*. Examining the largest SSB tax to date in the United States of two cents per ounce in Boulder, CO, the short-run estimated tax pass-through was 79% *(59)*.

4.2 Impact on demand for SSBs

The effect of an excise tax on SSB demand (measured by volume sold, sales, purchases or consumption) depends on multiple factors. First, as discussed above, it depends on the extent to which the tax is "passed through" to consumers in the form of higher prices. Following that, it depends on consumers' responsiveness to the increased price. Consumers' responsiveness to higher SSB prices is referred to in economic terms as the price elasticity of demand (i.e., the percentage change in quantity demanded as a result of a one percent change in price). A review of demand studies based on United States data found the average elasticity for SSBs to be –1.2 *(42)*. A systematic review with data from low- and middle-income countries has shown estimates for own-price elasticity ranged from –0.6 to –1.2 *(60)*. Other studies based on data across various countries in the Regions of the Americas have found in most cases that the demand for SSBs is price elastic (i.e., price elasticity of demand greater than one in absolute value). For example, studies from Brazil, Mexico, Ecuador, Chile, and Guatemala estimated price elasticities of SSB demand of –0.85, –1.06, –1.20, –1.37 (water-based SSBs only), and –1.39 (water-based SSBs only), respectively *(61, 62, 63, 64, 65)*. The mid-range of these price elasticities of about –1.2 implies that an SSB excise tax of 20% would be expected to reduce demand for SSBs by about 24%.

A number of studies have evaluated the impact of these taxes on measures of beverage volume sold, sales, purchases, or consumption. Appendix B provides an overview of the data sources, measures, methods, and results from 20 peer-reviewed published studies. A summary of the results by jurisdiction follows below along with a meta-analysis to summarize the overall impact for the Region of the Americas.

With regard to national taxes, assessing Mexico's one peso per liter SSB tax, a number of studies have consistently found declines (in the range 6-9%) in sales/purchases of taxed beverages *(66, 67, 68, 69)* with larger impacts found in some studies and, in particular, for low-income populations *(66, 68, 70)*, among high SSB consumers *(71)* and in urban areas and households with children and adolescents *(68)*. Further, it was found that the impact

of the Mexico SSB tax was sustained two years post-tax implementation (7.5% reduction) *(69)*. Evaluations of Chile's 2014 tiered tax small increase from 13% to 18% on high-sugar SSBs and small reduction from 13% to 10% on sweetened beverages with lower or no sugar content (including non-sugar sweetened beverages), found small reductions in purchases of high-sugar SSBs, with either no change or small increases in purchases of sweetened beverages with lower or no sugar content *(47, 48)*. An evaluation of the 10% SSB tax in Barbados found a 4.3% reduction in SSB sales volume *(72)*.

Eight SSB taxes (two among them applied to both SSBs and non-sugar sweetened beverages) have been implemented since 2015 in the United States, with one subsequently repealed. These excise taxes are specific and range from one to two cents per ounce. A number of United States evaluations of these taxes have been published. Early evidence from the penny per ounce tax in Berkeley, CA, based on a sample from low-income areas, found that SSB consumption fell 21% compared to a 4% increase in comparison cities, while relative water consumption increased 63% compared to 19% in the same comparison cities *(73)*. Another study found that Berkeley supermarket volume sold of taxed beverages fell 9.6% compared with an increase of 6.9% in non-Berkeley stores and that sales of untaxed beverages rose 3.5% in Berkeley versus 0.5% in non-Berkeley stores *(51)*. Although, this same study found no significant changes in SSB intake when using individual-level data *(51)*, a recent Berkeley study based on individual-level data three years post-tax found that SSB consumption fell by 0.55 times per day relative to changes in comparison areas *(74)*. A study in Seattle, WA, where SSBs are taxed 1.75 cents per ounce, found that in the first year post-tax implementation volume sold of taxed SSBs fell by 22% and there was no evidence of this impact being offset by cross-border shopping *(58)*. A study for Oakland's one cent per ounce SSB tax found no statistically significant effects for either purchases (except for soda) or consumption of taxed SSBs *(75)*.

Box 2: Methods for meta-analysis of SSB tax impacts

Figure 5 presents results based on a meta-analysis of 23 estimated SSB tax effects on outcomes of changes in SSB sales, purchases or consumption based on evaluations of SSB taxes in the Region of the Americas from 20 peer-reviewed papers (three papers included estimates from two different data sets) published from January 2015 through March 2020.

For each study included, one summary outcome was extracted as the main effect except where the study used multiple data sets which occurred in three studies. Measures were selected which estimated the broadest category of taxed beverages available. The most fully controlled model specifications were selected, and effects net of cross-border shopping were taken where available. Relative measures were selected over absolute measures, objective measures over self-reported, and frequency measures over likelihood measures. When only individual post-tax time period effects were reported, the final period compared to baseline was selected. And, when only subgroup effects were reported they were combined *(79)*. When necessary, variance was estimated from the p-value and degrees of freedom *(79)*. Absolute effects were converted into relative effect measures by dividing both the effect size and the confidence intervals by the baseline.

To estimate each policy's impact in terms of the percentage change in impact relative to the percentage change in the price of taxed beverages that occurred post-tax, a baseline pre-tax price was obtained for each jurisdiction in the pre-tax year of the policy using reported prices from published literature, or from the UN Comtrade database for national studies *(80, 81)*. A random effects inverse-variance weighted meta-analysis of peer-reviewed published study price effects was conducted, stratified by jurisdiction, and these local pass-through rates were used to create estimates of each policy's effective change in price.

Finally, each study's main policy effect was then converted into an elasticity by dividing it by the policy's effective percentage price change. These elasticities (percentage change demand [volume sold, sales, purchases, or consumption] due to a one percent change in price) were then combined in one final summary random effects inverse-variance weighted meta-analysis.

This analysis generated an overall elasticity estimate of the tax elasticity of demand for SSB for the Region of the Americas. All meta-analyses were undertaken using Stata 15.1 *(82)*.

With regard to local jurisdictions in the United States that impose excise taxes applicable to both SSBs and non-sugar sweetened beverages, an evaluation of the 1.5 cents per ounce tax on both SSBs and non-sugar sweetened beverages in Philadelphia, PA, found a reduction in the odds of daily regular soda (–40%) and energy drink (–64%) consumption *(76)*. Another Philadelphia study found that purchases of taxed beverages fell, but found no significant changes in consumption measures *(55)*. A study based on sales data from food stores found a 48% reduction in the dollar sales of taxed beverages *(77)*. A study

based on store scanner data for Philadelphia found a 51% reduction in volume sold of taxed beverages in the taxed jurisdiction with a net decrease of 38% when accounting for cross-border shopping *(56)*. A study of the Cook County, IL, one cent per ounce tax on SSBs and non-sugar sweetened beverages (repealed after four months) found a 27% reduction in sales volume of taxed beverages with a net reduction of 21% after accounting for increased sales volume in Cook County's 2-mile border area *(78)*.

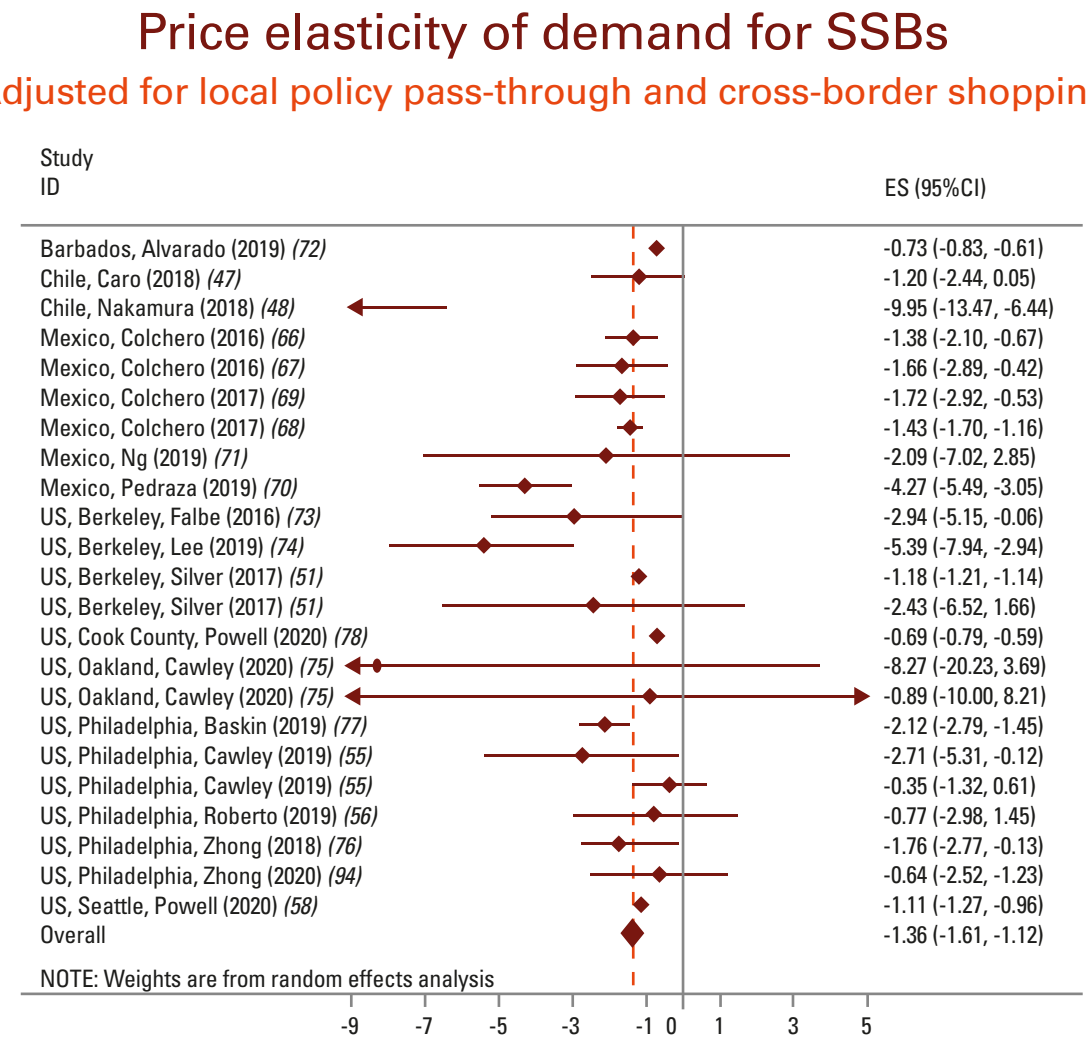
In order to help interpret and summarize these estimated changes in volume sold, sales, purchases and consumption (referred to as "demand") following the implementation of SSB taxes across the various jurisdictions, a meta-analysis of these impacts has been undertaken. Specifically, for ease of interpretation, the estimated impacts have been converted into relative impacts based on changes in SSB prices that occurred in response to the new taxes. This report presents results based on a meta-analysis of 23 estimated SSB tax effects on demand outcomes based on evaluations of SSB taxes in the Region of the Americas from 20 peer-reviewed papers (three papers included multiple estimates based on different data sets) published from January 2015 through March 2020 (papers described in Appendix B). The impacts of these taxes are summarized in terms of a calculated price elasticity of demand (% change in quantity demanded resulting from a 1% change in price). Details of the methods of the meta-analyses are provided in Box 2 *(79, 80, 81, 82)*. Figure 5 provides a summary of the elasticity measures for each taxing jurisdiction and shows that on average across all study findings, the price elasticity of demand for SSBs is estimated to be –1.36. Thus, based on the peer-reviewed tax evaluation studies reviewed herein, a tax that raises SSB prices faced by consumers by 25%, for example, is expected to reduce demand for SSBs by 34%.

4.3 Impact on substitution

It is important to understand substitution patterns that follow the introduction of an SSB tax. Consumers might substitute away from taxed products toward untaxed products as a result of changes in relative prices. Indeed, there may be cross-price/tax substitution to products outside of the taxed product category that would represent an unintended consequence. However, if the tax base captures the full range of targeted products then, for example, substitution of the form from taxed SSBs to untaxed water or milk would represent an intended consequence and, increase the positive health impact of the tax.

Consumers might also substitute across taxed products and aim to avoid the tax. For example, in the presence of an ad valorem excise tax, to minimize the impact of the tax, consumers may substitute down to cheaper brands or cheaper (per volume)

Figure 5: Meta-analysis of impact of SSB taxes in the Americas, peer-reviewed tax evaluation papers published from January 2015 to March 2020



Source: Prepared by Keith B. Marple (Brandeis University), Lisa M. Powell (University of Illinois at Chicago) and Tatiana Andreyeva (University of Connecticut).

package sizes of taxed products. More generally, due to their affordability, consumers may substitute down to lower cost products. Finally, consumers may substitute the location where they purchase their products as part of tax avoidance strategies (e.g., outside of the border of a jurisdiction for local tax).The extent to which consumers may undertake various tax avoidance behaviors will change the net impact of a given tax.

With respect to substitution across beverage types, based on studies that have estimated models of beverage demand, there is generally consistent evidence of substitution across different types of beverages in response to changes in relative prices, such

as substituting for bottled water and milk in response to higher SSB prices *(83, 84)*. This also reinforces the need for tax design to cover all SSB categories to avoid undesirable substitutions from taxed to untaxed SSBs, where reductions in soda consumption could be offset by increases in consumption of other high-calorie drinks, for instance. With respect to results from tax evaluation studies, several studies have found increases in demand for untaxed beverages, particularly bottled water, following the introduction of SSB taxes. For example, results from evaluations from Mexico found that sales of untaxed beverage increased 2.1% and plain water increased 5.2% over a 2-year post-tax period *(69)* and purchases of water increased by 16.2% *(68)*. Evidence from the 10% ad valorem SSB excise tax in Barbados found a 5.2% increase in sales volume for non-SSBs *(72)*. In the United States, evidence from local tax evaluations has been mixed in terms of the extent of substitution to untaxed beverages. Studies have reported increases in consumption/sales of water for Berkeley, CA *(51, 73)* and Philadelphia, PA *(76)*. However, evaluations in Cook County, IL, and Philadelphia, PA, that drew on large samples of Universal Product Codes (UPC) found no significant increases in volume sold of untaxed beverages *(56,78)*.

Because SSB tax evaluations to date have mostly used aggregated sales scanner data or cross-sectional individual-level purchase/consumption, there is still little evidence on the extent to which consumers may be brand switching to lower cost brands or switching to different volume sizes, such as the one from Barbados, which found substitutions for cheaper beverages *(72)*. Further, evidence is lacking from tax evaluations on the extent to which consumers may be substituting to other sources of "sugars" such as purchasing more sweets or other unhealthy food and drink products, such as salty snacks or alcohol. A few studies have examined substitution between beverages and other sources of calories, concluding that increases in SSB prices will lead to some substitution to various foods, partially offsetting the reductions in the intake of sugars and/or calories from reduced consumption of the higher priced SSBs *(85, 86)*. Such substitutions may offset the intended health benefits of SSB taxes. Tax evaluations are needed to understand these tax avoidance behaviors and potential unintended consequences.

5. Frequent questions and responses about economic impacts of SSB taxation

A number of different arguments are often used in opposition to the implementation of SSB taxes. These arguments usually come from industry or retail groups associated with the taxed beverages. The SSB industry often claims that the taxes will not work—that is, they will not increase prices or have the intended impacts of changes in consumption. However, as demonstrated above, there is clear evidence that recent SSB taxes have increased prices faced by consumers and have reduced the demand for taxed products. In addition to claims that taxes will not work, arguments are repeatedly made with regard to a number of negative unintended consequences including that SSB taxes will adversely hurt the poor given regressivity of consumption taxes, that there will be extensive tax avoidance through cross-border shopping (for local taxes), and that SSB taxes will lead to job losses. The following sub-sections draw on empirical evidence to address each of these areas of concern.

5.1 Distributional impact of SSB taxes

Consumption taxes are generally a regressive form of taxation for raising tax revenue since lower-income individuals spend a relatively higher proportion of their income on consumption and allocate a relatively smaller portion to savings. However, from a public health vantage, such taxes may actually be progressive. It is important to keep in mind the following key points. First, the public health purpose of an SSB tax is to reduce consumption of these products. Second, the burden of health expenditures (e.g. out-of-pocket expenditures) may be relatively higher for low-socioeconomic status households and therefore the economic burden associated with SSB-related diseases becomes higher for them. Where SSB consumption tends to be higher among lower socioeconomic status groups (SES), the health burden associated with consumption would be higher for these groups. Third, lower-SES individuals tend to be more price sensitive and therefore are expected to respond to SSB taxes with larger reductions in consumption. For example, price studies have demonstrated higher SSB price responsiveness among lower- versus higher-SES populations in Brazil, Mexico, and the United States *(61, 87, 88, 89)*. As a specific example, in Brazil, a 10% increase in the price of SSBs was estimated to reduce calories consumed from SSBs by 10% among the poor and by only 6.3% among the non-poor *(61)*. Additionally, recent tax evaluations have demonstrated larger reductions in SSB demand among lower versus higher-SES populations following SSB tax implementation *(66, 68, 71)*. Fourth, tax revenues could contribute to correcting inequities when channeled to support low-SES populations. Thus, with all of this taken into account, the health benefits, and the reduction in health care costs from a tax on SSBs is likely to be progressive.

5.2 Cross-border shopping

The SSB industry and related businesses argument of tax avoidance related to cross-border shopping is only pertinent to the implementation of local area taxes where opportunities are present for consumers to easily shop in adjacent jurisdictions without SSB taxes. In that regard, the argument has primarily been made within the United States. Several evaluations of the local-level sweetened beverage taxes in the United States have examined the extent of cross-border shopping associated with those taxes. A study of the Philadelphia, PA, tax found that cross-border shopping in the neighboring zip codes offset the decrease in volume sold of taxed beverages in Philadelphia by 24% *(56)*. Another paper that examined cross-border shopping patterns found that although there was no evidence that Philadelphia residents were more likely to travel outside of Philadelphia to shop as a result of the tax, those who already shopped outside of the city increased their purchases of taxed beverages *(55)*. Further, a study of the Cook County, IL, sweetened beverage tax found cross-border shopping in the 2-mile border area of Cook County offset the reduction in volume

sold of taxed beverages by 22% such that the gross effect from the tax fell from a 27% reduction to a net effect of a 21% reduction in volume sold *(78)*. However, unlike the local taxes in Philadelphia and Cook County, a recent study of the local SSB tax in Seattle, WA, found no significant change in volume sold of taxed beverages in the 2-mile border area *(58)*. These mixed results suggest that when cross-border shopping does occur, it somewhat offsets part of the tax impact but by no means does it fully wipe it out. Geographic context and the proximity with which the population lives to the borders are important considerations for whether in fact it will occur and by how much. Cross-border shopping is not expected to be an issue for countries that are considering national-level SSB taxes.

5.3 Impact on employment

The SSB industry and related businesses have argued that the reduction in demand for taxed SSBs will lead to significant job losses. However, it is important to keep in mind that money not spent on taxed beverages is likely to be spent on other non-taxed beverages and other products and services in the economy. That is, while there may be lower demand for the taxed beverages and some related job losses in the SSB industry, as consumers reallocate their spending to non-taxed beverages and other goods and services, new jobs will be created in the economy. Additionally, it should be noted that some of the lost sales for taxed SSBs will be made up in part from substitution by consumers to untaxed beverages, often made by the same companies. Thus, there will be a structural shift in the economy similar to what occurs as consumer preferences shift over time for a number of given reasons. Job losses are expected to be made up by job gains in other sectors as consumers shift their spending away from taxed SSBs to other goods and services. Government spending from the additional tax revenue will also generate new jobs. A recent systematic review of the macroeconomic impacts of diet-related fiscal policy highlighted the fact that industry-sponsored work has tended to report job losses associated with SSB taxes whereas non-industry funded research has not (see quotation from the review's conclusions in Box 3) *(90)*.

An economic simulation study of the impact of SSB taxes on employment for two states (California and Illinois) in the United States showed no net reduction in jobs *(91)*. Recent evaluations of SSB taxes in Mexico and the United States have reached similar conclusions. An evaluation study from Mexico revealed no significant changes in employment associated with the SSB and nonessential food taxes in their respective manufacturing industries or in commercial establishments, nor did they find an increase in unemployment following tax implementation *(92)*. An evaluation study for Philadelphia, PA, found no statistically significant pre- to post-tax changes in monthly unemployment claims in Philadelphia relative to claims in adjacent counties *(93)*.

Box 3: No robust evidence that SSB taxes lead to job losses

A study by Mounsey, Veerman, Jan and Thow (2020) analyzed policy and prevention: "We found no robust, high-quality evidence for a negative macroeconomic impact from implementing diet-related fiscal policies. Policy makers must be aware that the majority of the limited evidence available for the macroeconomic impact of diet-related taxes was from industry-funded reports. Similar to the introduction of tobacco and alcohol taxes, we question if industry has sought to influence health-related fiscal policies through the sponsorship of studies. This is because we found their reports to be based on selected outcomes providing partial measures of the gross economic impact across sectors and based on questionable assumptions such as over-shifting of pass through rate or the products used in the analysis. In contrast, the three non-industry supported peer-reviewed academic studies found none of the significant job losses industry reports suggested, but found instead, no significant net decline in employment and job creation" *(90)*.

To the extent that there are concerns about job losses within the taxed or related sectors, governments can dedicate some of the additional tax revenues to programs to facilitate needed job transitions. For example, funds could be dedicated to assist agricultural transition from sugarcane production to other types of farming. Also, for example, tax revenue allocated in the form of subsidies to fruits and vegetables would increase the demand for those products to the benefit of farmers, distributors, and retailers.

6. Conclusions

SSB excise taxes are an effective evidence-based NCD prevention policy. Along with tobacco and alcohol excise taxes, they are a tool to attain the Sustainable Development Goals, and are recommended by the World Health Organization to modify behavioral risk factors associated with obesity and NCDs, as featured in the WHO Global Action Plan. Indeed, these taxes represent a triple win for governments as they improve population health by reducing the consumption of SSBs, generate tax revenue, and have the potential to reduce long-term associated healthcare costs. In addition, in synergy with other regulatory measures on marketing, labeling, and school and other settings, SSB excise taxes create an enabling environment for effective, systemic, and sustained improvement of diets, health, and food systems.

As expressed in this document, SSB excise taxes are likely to have a progressive net effect as low-income individuals tend to be more price responsive and their positive health impact and related reductions in healthcare costs will reduce associated burdens to a greater extent among low-SES individuals. In addition, scientific evidence shows that SSB excise taxes have no proven adverse impact on employment.

While the number of excise taxes on SSBs in the Region of the Americas is promising, some of these taxes have been implemented to increase tax revenue, without considering the design of the tax as a health policy instrument. There is a high diversity in tax design across the Region and most of these taxes could be further leveraged, in terms of tax structure, tax base or tax rates, to improve their impact on SSB consumption and health. Finally, several excise taxes have not been evaluated and future research should aim to address this gap.

7. References

1. Pan American Health Organization. (2019). Noncommunicable diseases in the Region of the Americas: facts and figures [Internet]. Washington, D.C.: Pan American Health Organization. Available from: https://iris.paho.org/handle/10665.2/51483

2. Bloom D, Cafiero E, Jané-Llopis E, Abrahams-Gessel S, Bloom L, Fathima S, et al. (2011). The Global Economic Burden of Non-communicable Diseases. Geneva: World Economic Forum. Available from: http://www3.weforum.org/docs/WEF_Harvard_HE_GlobalEconomicBurdenNonCommunicableDiseases_2011.pdf

3. World Health Organization. (2017). WHO Global Health Estimates. Available from: www.who.int/healthinfo/global_burden_disease/en/

4. Pan American Health Organization. (2019). Core Indicators 2019: health trends in the Americas. Washington, D.C.: Pan American Health Organization. Available from: https://iris.paho.org/handle/10665.2/51542

5. Pan American Health Organization. (2014). Plan of action for the Prevention of Obesity in Children and Adolescents. 53rd Directing Council, 66th Session of the Regional Committee of WHO for the Americas, Washington, D.C., USA, 29 September-3 October 2014. Washington, D.C.: Pan American Health Organization. Available from: https://www.paho.org/nutricionydesarrollo/wp-content/uploads/2014/09/Plan-of-Action-for-the-prevention-of-Obesity-in-Children-and-Adolescents.pdf

6. World Health Organization. (2018). Healthy diet. Fact sheet no. 394. Available from: https://www.who.int/publications/m/item/healthy-diet-factsheet394

7. World Health Organization. (2003). Diet, nutrition and the prevention of chronic diseases: report of a joint WHO/FAO expert consultation. Geneva, Switzerland. 28 January - 1 February 2002. WHO technical report series 916. Geneva: World Health Organization. Available from: https://www.who.int/nutrition/publications/obesity/WHO_TRS_916/en/

8. Hirahatake KM, Jacobs Jr DR, Shikany JM, et al. (2019). Cumulative intake of artificially sweetened and sugar-sweetened beverages and risk of incident type 2 diabetes in young adults: the Coronary Artery Risk Development in Young Adults (CARDIA) Study. *American Journal of Clinical Nutrition.* 110(3):733-741. Available from: https://doi.org/10.1093/ajcn/nqz154

9. Malik VS, Pan A, Willett WC, Hu FB. (2013). Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *American Journal of Clinical Nutrition.* 98(4), 1084-1102. Available from: https://doi.org/10.3945/ajcn.113.058362

10. Malik VS, Popkin BM, Bray GA, Després JP, Hu FB (2010). Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. *Circulation*. 121(11), 1356-1364. Available from: https://doi.org/10.1161/CIRCULATIONAHA.109.876185

11. Vartanian LR, Schwartz MB, Brownell KD (2007). Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *American Journal of Public Health*. 97(4), 667-675. Available from: https://doi.org/10.2105/AJPH.2005.083782

12. World Health Organization. (2019). Health taxes: a primer (a WHO/UHC/HGF/Policy brief 19.7). Geneva: World Health Organization. Available from: https://www.who.int/publications/i/item/health-taxes-a-primer

13. Thow AM, Downs SM, Mayes C, Trevena H, Waqanivalu T, Cawley J. (2018). Fiscal policy to improve diets and prevent noncommunicable diseases: from recommendations to action. *Bulletin of the World Health Organization.* 96(3):201–10. Available from: http://doi.org/10.2471/BLT.17.195982

14. World Health Organization. (2015). Fiscal policies for diet and prevention of noncommunicable diseases: Technical meeting report. 5-6 May 2015. Geneva, Switzerland. Geneva: World Health Organization. Available from: https://www.who.int/dietphysicalactivity/publications/fiscal-policies-diet-prevention/en/

15. World Health Organization. (2013) Global action plan for the prevention and control of noncommunicable diseases 2013-2020. Geneva: World Health Organization. Available from: www.who.int/nmh/events/ncd_action_plan/en/

16. World Health Organization. (2017). Tackling NCDs: "Best buys" and other recommended interventions for the prevention and control of noncommunicable diseases. Geneva: World Health Organization. Available from: www.who.int/iris/handle/10665/259232

17. World Health Organization. (2016). Report of the Commission on Ending Childhood Obesity. Geneva: World Health Organization. Available from: https://apps.who.int/iris/handle/10665/204176

18. World Health Organization. (2017). Technical Annex: Updated Appendix 3 of the WHO Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020. Geneva: World Health Organization. Available from: www.who.int/ncds/governance/technical_annex.pdf?ua=1

19. United Nations. (2018). Political declaration of the third high-level meeting of the General Assembly on the prevention and control of non-communicable diseases. Time to deliver: accelerating our response to address non-communicable diseases for the health and well-being of present and future generations. A/RES/73/2. Seventy-third session. Agenda item 119. Resolution adopted by the General Assembly on 10 October 2018. Available from: https://digitallibrary.un.org/record/1648984?ln=en

20. World Health Organization. (2020). Assessing national capacity for the prevention and control of noncommunicable diseases: report of the 2019 global survey. Geneva: World Health Organization, p. 13. Available from: www.who.int/publications-detail/ncd-ccs-2019

21. Shekar M, Popkin B, eds. (2020). Obesity: Health and Economic Consequences of an Impending Global Challenge. Human Development Perspectives series. Washington, D.C.: The World Bank.

22. Sandoval RC, Roche M, Belausteguigoitia I, et al. (2021) Excise taxes on sugar-sweetened beverages in Latin America and the Caribbean. *Pan American Journal of Public Health.* In press.

23. Brownell KD, Farley T, Willett WC, et al. (2009). The public health and economic benefits of taxing sugar-sweetened beverages [published correction appears in *New England Journal of Medicine.* 362(13):1250]. *New England Journal of Medicine.* 361(16):1599-1605. Available from: https://doi.org/10.1056/NEJMhpr0905723

24. Cawley J, Meyerhoefer, C. (2012). The medical care costs of obesity: An instrumental variables approach. *Journal of Health Economics.* 31:219-230. Available from: https://doi.org/10.1016/j.jhealeco.2011.10.003

25. Trasande L, Chatterjee S. (2009). The Impact of Obesity on Health Service Utilization and Costs in Childhood. *Obesity*. 17:1749–1754. Available from: https://doi.org/10.1038/oby.2009.67

26. Finkelstein EA, DiBonaventura M, Burgess SM, Hale BC. (2010). The Costs of Obesity in the Workplace. *Journal of Occupational and Environmental Medicine.* 52(10):971-6. Available from: https://doi.org/10.1097/JOM.0b013e3181f274d2

27. Goettler A, Grosse A, Sonntag D. (2017). Productivity loss due to overweight and obesity: a systematic review of indirect costs. *BMJ Open.* 7(10):e014632. Available from: https://doi.org/10.1136/bmjopen-2016-014632

28. Guerrero-López CM, Colchero MA. (2018). Productivity loss associated with the consumption of sugar-sweetened beverages in Mexico. *Preventive Medicine*. 115:140-4. Available from: https://doi.org/10.1016/j.ypmed.2018.08.014

29. Barceló A, Aedo C, Rajpathak S, Robles S. (2003). The cost of diabetes in Latin America and the Caribbean. Bulletin of the World Health Organization. 81(1): 19-27. Available from: https://www.scielosp.org/article/bwho/2003.v81n1/19-27/

30. Lobstein T, Jackson-Leach R. (2006). Estimated burden of paediatric obesity and co-morbidities in Europe. Part 2. Numbers of children with indicators of obesity-related disease. *International Journal of Pediatric Obesity*. 1(1):33-41. Available from: https://doi.org/10.1080/17477160600586689

31. Pizzi MA, Vroman K. (2013). Childhood obesity: effects on children's participation, mental health, and psychosocial development. *Occupational Therapy in Health Care*. 27(2):99-112. Available from: https://doi.org/10.3109/07380577.2013.784839

32. Miller AL, Lee HJ, Lumeng JC. (2015). Obesity-associated biomarkers and executive function in children. *Pediatric Research.* 77(1):143-147. Available from: https://doi.org/10.1038/pr.2014.158

33. Azaïs-Braesco V, Sluik D, Maillot M, Kok F, Moreno LA. (2017). A review of total & added sugar intakes and dietary sources in Europe. *Nutrition Journal.* 16(1):6. Available from: https://doi.org/10.1186/s12937-016-0225-2

34. Bailey RL, Fulgoni VL, Cowan AE, Gaine PC. (2018). Sources of Added Sugars in Young Children, Adolescents, and Adults with Low and High Intakes of Added Sugars. *Nutrients.* 10(1):102. Available from: https://doi.org/10.3390/nu10010102

35. Araneda J, Bustos P, Cerecera F, Amigo H. (2015). Ingesta de bebidas azucaradas analcohólicas e índice de masa corporal en escolares chilenos. *Salud Pública de México.* 57(2):128-34. Available from: https://www.scielosp.org/article/spm/2015.v57n2/128-134/es/

36. Pan American Health Organization. (2019). Ultra-processed food and drink products in Latin America: Sales, sources, nutrient profiles, and policy implications. Washington, D.C.: Pan American Health Organization. Available from: https://iris.paho.org/handle/10665.2/51094

37. World Health Organization. (2015). Guideline: sugars intake for adults and children. Geneva: World Health Organization. Available from: https://www.who.int/publications/i/item/9789241549028

38. Public Health England. (2018). Sugar reduction and wider reformulation programme: Report on progress towards the first 5% reduction and next steps. London: Public Health England. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/709008/Sugar_reduction_progress_report.pdf

39. Bandy LK, Scarborough P, Harrington RA, Rayner M, Jebb SA. (2020). Reductions in sugar sales from soft drinks in the UK from 2015 to 2018. *BMC Medicine.* 18(1):20. Available from: https://doi.org/10.1186/s12916-019-1477-4

40. Powell LM, Andreyeva T, Isgor Z. (2020). Distribution of sugar-sweetened beverage sales volume by sugar content in the United States: implications for tiered taxation and tax. *Journal of Public Health.* 41:125-138. Available from: https://doi.org/10.1057/s41271-019-00217-x

41. AndreyevaT, Long M, Brownell KD. (2010). The impact of food prices on consumption: a systematic review of research on price elasticity of demand for food. *American Journal of Public Health*. 100(2):216-222. Available from: https://doi.org/10.2105/AJPH.2008.151415

42. Powell LM, Chriqui JF, Khan T, Wada R, Chaloupka FJ. (2013). Assessing the potential effectiveness of food and beverage taxes and subsidies for improving public health: a systematic review of prices, demand and body weight outcomes. *Obesity Reviews.* 14(2):110-128. Available from: https://doi.org/10.1111/obr.12002

43. Cabrera Escobar MA, Veerman JL, Tollman SM, Bertram MY, Hofman KJ. (2013). Evidence that a tax on sugar sweetened beverages reduces the obesity rate: a meta-analysis. *BMC Public Health*. 13(1):1072. Available from: https://doi.org/10.1186/1471-2458-13-1072

44. Colchero MA, Salgado JC, Unar-Munguía M, Molina M, Ng S, Rivera-Dommarco JA. (2015). Changes in prices after an excise tax to sweetened sugar beverages was implemented in Mexico: evidence from urban areas. *PLoS ONE.* 10(12):e0144408. Available from: https://doi.org/10.1371/journal.pone.0144408

45. Grogger J. (2017). Soda taxes and the prices of sodas and other drinks: evidence from Mexico. *Journal of Agricultural Economics.* 99(2):481-498. Available from: https://doi.org/10.1093/ajae/aax024

46. Alvarado M, Kostova D, Suhrcke M, Hambleton I, Hassell T, Samuels T, et al. (2017). Trends in beverage prices following the introduction of a tax on sugar-sweetened beverages in Barbados. *Preventive Medicine.* 105:S23-S25. Available from: https://doi.org/10.1016/j.ypmed.2017.07.013

47. Caro JC, Corvalán C, Reyes M, Silva A, Popkin B, Taillie LS. (2018). Chile's 2014 Sugar-sweetened Beverage Tax and changes in prices and purchases of sugar-sweetened beverages: an observational study in an urban environment. *PLoS Medicine.* 15(7):e1002597. Available from: https://doi.org/10.1371/journal.pmed.1002597

48. Nakamura R, Mirelman A, Cuadrado C, Silva N, Dunstan J, Suhrcke ME. (2018). Evaluating the 2014 Sugar-sweetened Beverage Tax in Chile: an observational study in urban areas. *PLoS Medicine.* Available from: https://doi.org/10.1371/journal.pmed.1002596

49. Falbe J, Rojas N, Grummon AH, Madsen KA. (2015). Higher retail prices of sugar-sweetened beverages 3 months after implementation of an excise tax in Berkeley, California. *American Journal of Public Health.* 105(11):2194-2201. Available from: https://doi.org/10.2105/AJPH.2015.302881

50. Cawley J, Frisvold D. (2017). The pass-through of taxes on sugar-sweetened beverages to retail prices: the case of Berkeley, California. *Journal of Policy Analysis and Management.* 36(2):303-326. Available from: https://doi.org/10.1002/pam.21960

51. Silver LD, Ng SW, Ryan-Ibarra S, Taillie LS, Induni M, Miles DR, et al. (2017). Changes in prices, sales, consumer spending, and beverage consumption one year after a tax on sugar-sweetened beverages in Berkeley, California, US: a before-and-after study. *PLoS Medicine.* 14(4):e1002283. Available from: https://doi.org/10.1371/journal.pmed.1002283

52. Leider J, Pipito AA, Powell LM. (2018). The impact of the Cook County, Illinois Sweetened Beverage Tax on prices, 2017. Retrieved from Chicago, IL: https://illinoisprc.org/wp-content/uploads/2018/10/Tax-Pass-Through_Cook-County-IL-Illinois-PRC-Brief-No.-105-Sept-2018-5.pdf

53. Powell LM, Leider J, Léger PT. (2020). The impact of the Cook County, IL, Sweetened Beverage Tax on beverage prices. *Economics & Human Biology.* 37:100855. Available from: https://doi.org/10.1016/j.ehb.2020.100855

54. Cawley J, Willage B, Frisvold, D. (2018). Pass-through of a tax on sugar-sweetened beverages at the Philadelphia International Airport. *Journal of the American Medical Association.* 319(3):305-306. Available from: https://doi.org/10.1001/jama.2017.16903

55. Cawley J, Frisvold D, Hill A, Jones D. (2019). The impact of the Philadelphia Beverage Tax on purchases and consumption by adults and children. *Journal of Health Economics.* 67:102225. Available from: https://doi.org/10.1016/j.jhealeco.2019.102225

56. Roberto CA, Lawman, HG, LeVasseur, MT, Mitra, N., Peterhans, A, Herring, B, & Bleich, SN. (2019). Association of a beverage tax on sugar-sweetened and artificially sweetened beverages with changes in beverage prices and sales at chain retailers in a large urban setting. *Journal of the American Medical Association. 321(18):1799-1810*. Available from: https://doi.org/10.1001/jama.2019.4249

57. Public Health-Seattle and King County. (2019). 6 Month Report: Store audits-the evaluation of Seattle's Sweetened Beverage Tax. Retrieved from www.seattle.gov/Documents/Departments/CityAuditor/auditreports/6%20Month%20Store%20Audit%20Report%20.pdf

58. Powell LM, Leider J. (2020). The impact of Seattle's sweetened beverage tax on beverage prices and volume sold. *Economics & Human Biology.* 37:100856. Available from: https://doi.org/10.1016/j.ehb.2020.100856

59. Cawley J, Crain C, Frisvold D, Jones D. (2018). The pass-through of the largest tax on sugar-sweetened beverages: the case of Boulder, Colorado. National Bureau of Economic Research, NBER Working Paper No. 25050. Available from: https://doi.org/10.3386/w25050

60. Nakhimovsky SS, Feigl AB, Avila C, O'Sullivan G, Macgregor-Skinner E, Spranca M. (2016). Taxes on sugar-sweetened beverages to reduce overweight and obesity in middle-income countries: a systematic review. *PLoS ONE.* 11(9):e0163358. Available from: https://doi.org/10.1371/journal.pone.0163358

61. Claro RM, Levy RB, Popkin BM, Monteiro CA. (2012). Sugar-sweetened beverage taxes in Brazil. *American Journal of Public Health.* 102(1):178–83. Available from: https://doi.org/10.2105/AJPH.2011.300313

62. Colchero MA, Salgado JC, Unar-Munguía M, Hernández-Ávila M, Rivera-Donmarco JA. (2015). Price elasticity of the demand for sugar sweetened beverages and soft drinks in Mexico. *Economics & Human Biology.* 19:129-137. Available from: https://doi.org/10.1016/j.ehb.2015.08.007

63. Paraje G. (2016). The effect of prices and socio-economic level on the consumption of sugar-sweetened beverages (SSBs): The case of Ecuador. *PLoS ONE.* 11(3):e0152260. Available from: https://doi.org/10.1371/journal.pone.0152260

64. Guerrero-López CM, Unar-Munguía M, Colchero MA. (2017). Price elasticity of the demand for soft drinks, other sugar-sweetened beverages and energy dense food in Chile. *BMC Public Health.* 17(1):1-8. Available from: https://doi.org/10.1186/s12889-017-4098-x

65. Chacon V, Paraje G, Barnoya J, Chaloupka FJ. (2018). Own-price, cross-price, and income elasticities on milk and soft drinks in Guatemala. *PLoS ONE.* 13(10):e0205931. Available from: https://doi.org/10.1371/journal.pone.0205931

66. Colchero MA, Popkin BM, Rivera JA, Ng SW. (2016). Beverage purchases from stores in Mexico under the excise tax on sugar sweetened beverages: observational study. *BMJ. 352:h6704.* Available from: https://doi.org/10.1136/bmj.h6704

67. Colchero MA, Guerrero-López CM, Molina M, Rivera JA. (2016). Beverages sales in Mexico before and after implementation of a sugar sweetened beverage tax. *PLoS ONE.* 11(9):e0163463. Available from: https://doi.org/10.1371/journal.pone.0163463

68. Colchero MA, Molina M, Guerrero-Lopez CM. (2017). After Mexico implemented a tax, purchases of sugar-sweetened beverages decreased and water increased: difference by place of residence, household composition, and income level. *The Journal of Nutrition. 147(8):1552-1557. Available from:* https://doi.org/10.3945/jn.117.251892

69. Colchero MA, Rivera-Dommarco J, Popkin BM, Ng SW. (2017). In Mexico, evidence of sustained consumer response two years after implementing a sugar-sweetened beverage tax. *Health Affairs.* 36(3):564–71. Available from: https://doi.org/10.1377/hlthaff.2016.1231

70. Pedraza LS, Popkin BM, Batis, C. et al. (2019). The caloric and sugar content of beverages purchased at different store-types changed after the sugary drinks taxation in Mexico. *International Journal of Behavioral Nutrition and Physical Activity.* 16:103. Available from: https://doi.org/10.1186/s12966-019-0872-8

71. Ng SW, Rivera J, Popkin B, Colchero MA. (2019). Did high purchasers respond differently to the excise tax on sugar-sweetened beverages in Mexico? *Public Health Nutrition.* 22(4):750-756. Available from: https://doi.org/10.1017/S136898001800321X

72. Alvarado M, Unwin N, Sharp SJ, Hambleton I, Murphy MM, Samuels TA, Suhrcke M, Adams J. (2019). Assessing the impact of the Barbados Sugar-sweetened Beverage Tax on beverage sales: an observational study. *International Journal of Behavioral Nutrition and Physical Activity.* 16(1):13. Available from: https://doi.org/10.1186/s12966-019-0776-7

73. Falbe J, Thompson HR, Becker CM, Rojas N, McCulloch CE, Madsen KA. (2016). Impact of the Berkeley excise tax on sugar-sweetened beverage consumption. *American Journal of Public Health.* 106(10):1865-71. Available from: https://doi.org/10.2105/ajph.2016.303362

74. Lee MM, Falbe J, Schillinger D, Basu S, McCulloch CE, Madsen KA. (2019). Sugar-sweetened beverage consumption 3 years after the Berkeley, California, sugar-sweetened beverage tax. *American Journal of Public Health*. 109(4):637-9. Available from: https://doi.org/10.2105/AJPH.2019.304971

75. Cawley J, Frisvold D, Hill A, Jones D. (2020). Oakland's sugar-sweetened beverage tax: Impacts on prices, purchases and consumption by adults and children. *Economics & Human Biology.* 37:100865. Available from: https://doi.org/10.1016/j.ehb.2020.100865

76. Zhong Y, Auchincloss AH, Lee BK, Kanter GP. (2018). The short-term impacts of the Philadelphia Beverage Tax on beverage consumption. *American Journal of Preventive Medicine.* 55(1):26-34. Available from: https://doi.org/10.1016/j.amepre.2018.02.017

77. Baskin E, Coary SP. (2019). Implications of the Philadelphia beverage tax on sales and beverage substitution for a major grocery retailer chain. *Journal of International Food & Agribusiness Marketing*. 31(3):293-307. Available from: https://doi.org/10.1080/08974438.2018.1520180

78. Powell LM, Leider J, Leger PT. (2020). Impact of a sweetened beverage tax on beverage volume sold in Cook County, IL, and its border area. *Annals of Internal Medicine.* 172(6):390-397. Available from: https://doi.org/10.7326/M19-2961

79. Higgins J, Green S. (2011). Cochrane Handbook for Systematic Reviews of Interventions (Version 5.1.0 [updated March 2011]; The Cochrane Collaboration). Available from: https://handbook-5-1.cochrane.org/front_page.htm

80. Teng, AM, Jones AC, Mizdrak A, Signal L, Genç M, Wilson N. (2019). Impact of sugar-sweetened beverage taxes on purchases and dietary intake: Systematic review and meta-analysis. *Obesity Reviews.* 20(9):1187-1204. Available from: https://doi.org/10.1111/obr.12868

81. United Nations. (2019). United Nations Commodity Trade Statistics Database, Department of Economics and Social Affairs/Statistics Division. UN Comtrade Data. Available from: http://comtrade.un.org

82. Sterne JAC. (2009). Meta-analysis in Stata: an updated collection from the Stata Journal. College Station, TX: StataCorp LP.

83. Smith TA, Lin BH, Lee JY. (2010). Taxing caloric sweetened beverages: potential effects on beverage consumption, calorie intake, and obesity. ERR-100. Washington, D.C.: United States Department of Agriculture. Available from: http://dx.doi.org/10.2139/ssrn.2118636

84. Fletcher JM, Frisvold DE, Tefft N. (2010). The effect of soft drink taxes on child and adolescent consumption and weight outcomes. *Journal of Public Economics.* 84(11-12):967-974. Available from: https://doi.org/10.1016/j.jpubeco.2010.09.005

85. Finkelstein EA, Zhen C, Bilger M, Nonnemaker J, Farooqui AM, Todd JE. (2013). Implications of a sugar-sweetened beverage (SSB) tax when substitutions to non-beverage items are considered. *Journal of Health Economics.* 32(1):219-239. Available from: https://doi.org/10.1016/j.jhealeco.2012.10.005

86. Zhen C, Finkelstein EA, Nonnemaker JM, Karns SA, Todd JE. (2014). Predicting the effects of sugar-sweetened beverage taxes on food and beverage demand in large demand systems. *Am J Agric Econ.* 96(1):1-25. Available from: https://doi.org/10.1093/ajae/aat049

87. Finkelstein E, Zhen C, Nonnemaker J, Todd JE. (2010). Impact of targeted beverage taxes on higher- and lower-income households. *Archives of Internal Medicine.* 170(22):2028–2034. Available from: https://doi.org/10.1001/archinternmed.2010.449

88. Wada R, Han E, Powell LM. (2015). Associations between soda prices and intake: evidence from 24-h dietary recall data. *Food Policy*. 55:54-60. Available from: https://doi.org/10.1016/j.foodpol.2015.05.009

89. López-Olmedo N, Popkin BM, Taillie LS. (2018). The socioeconomic disparities in intakes and purchases of less-healthy foods and beverages have changed over time in urban Mexico. *The Journal of Nutrition.* 148(1):109-116. Available from: https://doi.org/10.1093/jn/nxx007

90. Mounsey S, Veerman L, Jan S, Thow AM. (2020). The macroeconomic impacts of diet-related fiscal policy for NCD prevention: A systematic review. *Economics and Human Biology.* 37:100854. Available from: https://doi.org/10.1016/j.ehb.2020.100854

91. Powell LM, Wada R, Persky JJ, Chaloupka FJ. (2014). Employment impact of sugar-sweetened beverage taxes. *American Journal of Public Health.* 104(4):672-7. Available from: https://doi.org/10.2105/AJPH.2013.301630

92. Guerrero-Lopez CM, Molina M, Colchero MA. (2017). Employment changes associated with the introduction of taxes on sugar-sweetened beverages and nonessential energy-dense food in Mexico. *Preventive Medicine.* 105S:S43-S9. Available from: https://doi.org/10.1016/j.ypmed.2017.09.001

93. Lawman HG, Bleich SN, Yan J, LeVasseur MT, Mitra N, Roberto CA. (2019). Unemployment claims in Philadelphia one year after implementation of the sweetened beverage tax. *PLoS ONE.* 14(3):e0213218. Available from: https://doi.org/10.1371/journal.pone.0213218

94. Zhong Y, Auchincloss AH, Lee BK, McKenna RM, Langellier BA. (2020). Sugar-sweetened and diet beverage consumption in Philadelphia one year after the beverage tax. *International Journal of Environmental Research and Public Health.* 17(4):1336. Available from: https://doi.org/10.3390/ijerph17041336

Appendix A: Characteristics of sweetened beverage taxes: Examples from eight local-level taxes in the United States

Site and bill/ ordinance	Effective date	Type of tax	Tax rate	Applicability	Beverage exemptions	Revenue allocation
Berkeley, CA Measure D Ordinance No. 7,388-N.S.	March 1, 2015	Excise (Specific)	$0.01 per ounce	SSBs (>2 calories per fluid ounce) Any beverage intended for human consumption to which one or more added caloric sweeteners has been added, which includes caloric sweeteners used to produce SSBs (e.g., premade syrup, powder).	Exempted drinks: • beverage in which milk is primary ingredient • natural fruit and vegetable juice • alcoholic beverages • beverages for medical use • infant/baby formula • liquid used for weight reduction and meal replacement	City of Berkeley's General Fund Expert Advisory Committee to recommend funding for programs targeting SSB consumption
Philadelphia, PA Bill No. 160176	January 1, 2017	Excise (Specific)	$0.015 per ounce	SSBs and non-sugar sweetened beverages Any form of caloric sugar-based sweetener, including but not limited to, sucrose, glucose or high-fructose corn syrup or any form of artificial sugar substitute, including stevia, aspartame, sucralose, neotame, acesulfame potassium (Ace-K), saccharin, and advantame. This includes syrups and concentrates.	SSBs do not include: • baby formula • medical food • products >50% (by volume) milk • product >50% (by volume) fresh fruit, vegetable, or a combination of the two • unsweetened drinks that upon request can have added sugar at point of sale • syrup or concentrate that customer combines with other ingredients to create beverage	Quality Pre-K Program Community schools Rebuild program for parks, recreation centers, and libraries Healthy beverages tax credit By 2021, 100% of tax will go to the above programs.
Albany, CA Measure 01 Ordinance No. 2016-02	April 1, 2017	Excise (Specific)	$0.01 per ounce	SSBs (>2 calories per fluid ounce) Any beverage for human consumption, with one or more added caloric sweetener. Includes premade SSBs or mixes/compounds (e.g., syrup, powders).	SSBs do not include: • beverage with milk as primary ingredient • natural fruit and vegetable juice • beverage for medical use • liquids for weight loss and meal replacement • infant or baby formula • alcoholic beverages	City of Albany's General Fund
Oakland, CA Measure HH Resolution No. 86161 C.M.S	July 1, 2017	Excise (Specific)	$0.01 per ounce	SSBs (>25 calories per 12 fluid ounces) Any beverage for human consumption with one or more added caloric sweeteners; this includes powders and syrups used to mix and make SSBs.	Exemptions include: • infant and baby formula • beverages for medical use • beverage as supplemental, meal replacement, or sole source nutrition • milk products • 100% natural fruit or vegetable juice with no added caloric sweetener • alcoholic beverages	City of Oakland's General Fund

Site and bill/ ordinance	Effective date	Type of tax	Tax rate	Applicability	Beverage exemptions	Revenue allocation
Boulder, CO Measure 2H Ordinance No. 8181, Chapter 3-16, B.R.C.	July 1, 2017	Excise (Specific)	$0.02 per ounce	SSBs (>5 grams of caloric sweetener per 12 fluid ounces) Beverages with added calories and perceived as sweet when consumed including but not limited to sucrose, dextrose, fructose, glucose, other mono and disaccharides; corn syrup or high-fructose corn syrup; or any other caloric sweetener designated by the City. Includes bottled SSBs or SSBs made from the dilution of syrup or powder.	Exemptions include: • beverages where milk is the primary ingredient • beverages for medical use • infant or baby formula • alcoholic beverages • 100% natural fruit or vegetable juice beverages, with no added caloric sweetener (original liquid with or without water added) • sweetened medications • products used exclusively to mix alcohol >5 grams or more per serving of caloric sweetener per 12 ounces (e.g., margarita mix)	Funds must be used to improve health equity in Boulder through the support of health promotion, general wellness programs, and chronic disease prevention. Additionally, funds will cover the administrative cost of the tax.
Cook County, IL 16-5931 Ordinance Chapter 74 Taxation, Article XXII Sweetened Beverage Tax, Sections 74-850 through 74-859	August 2, 2017 Repealed November 30, 2017	Retailer's Sales Tax (Specific)	$0.01 per ounce	SSBs and non-sugar sweetened beverages Sweetened beverage means any nonalcoholic beverage, carbonated or non-carbonated intended for human consumption and contains any caloric sweetener or non-caloric sweetener and is available for sale in a bottle or produced for sale through the use of syrup and/or powder.	Exemptions include: • 100% fruit/vegetable juice • beverages in which milk, or soy, rice, or similar milk substitute is >50% • beverages to which purchaser can add, or request retailer to add, caloric sweetener or non-caloric sweetener • infant formula • medical beverages • liquids sold as therapeutic meal replacements or for weight loss • any syrup or powder purchaser combines with other ingredients to make beverage	Not specified

Site and bill/ ordinance	Effective date	Type of tax	Tax rate	Applicability	Beverage exemptions	Revenue allocation
Seattle, WA CB 118965 Ordinance No. 125324	January 1, 2018	Excise (Specific)	$0.0175 per ounce	SSBs (>40 calories per 12 fluid ounces) Sweetened beverage includes all drinks and beverages with added caloric sweeteners including but not limited to juice with added caloric sweetener, flavored water with added caloric sweetener, and nonalcoholic mix beverages that may or may not be mixed with alcohol or any other common names that are derivations thereof.	Exemptions include: • milk products where natural milk is the primary ingredient (the ingredient listed first or in which water and grains, nuts, legumes, or seeds constitute the first two ingredients) • 100% natural fruit or vegetable juice with no added sweetener (i.e., the original liquid resulting from pressing fruits and vegetables) • concentrate that consumer combines with other ingredients to create beverage • infant or baby formula • medical beverages • liquids sold as meal replacements or for weight loss • sweetened medication such as cough syrup	Birth to Five programs Programming to provide healthy food access to low-income residents Job training for industries potentially affected One-time or time-limited projects (preschool classrooms, water bottle filling stations, health education programs) Evaluation of the tax; Administration of the tax; Community Advisory Board
San Francisco, CA Measure V Business and Tax Regulations Code Article 8: Sugary Drinks Distributor Tax Ordinance, Sections 550-560	January 1, 2018	Excise (Specific)	$0.01 per ounce	SSBs Any nonalcoholic beverage intended for human consumption that contains added caloric sweeteners and contains more than 25 calories per 12 fluid ounces of beverage.	Exemptions include: • infant or baby formula • medicinal beverages • supplemental, meal replacements, or sole source of nutrition • milk products, and • 100% fruit/vegetable juice	City of San Francisco's General Fund Advisory Committee

SSB: sugar-sweetened beverage

Appendix B:
Impact of sweetened beverage excise taxes on beverage volume sold, sales, purchases, and consumption in the Americas based on evaluation studies published from January 2015 to March 2020, by tax jurisdiction

Author(s), year	Study design	Data source and time period	Population/ sample (n)	Tax measure/ implementation date	Outcome(s)	Results
BARBADOS						
Alvarado, Unwin, Sharp, Hambleton, Murphy, Samuela, Suhrcke, Adams, 2019	Interrupted time series; controls for seasonality, tourism, inflation; no comparison group; sensitivity with comparison site; within-country sensitivity with non-beverage product.	Electronic point-of-sale data from major chain grocery store (estimated to represent 32% of grocery store market). Data available weekly from Jan 1, 2013 to Oct 31, 2016 (141 pre-intervention weeks and 59 weeks post-tax).	Major chain grocery store scanner data weekly (1,161 unique, size-specific beverage products).	Ad valorem excise tax of 10% on SSBs. Effective June 2015.	Volume sold of SSBs. Sub-category outcome measures included carbonated SSBs, other SSBs (incl. sweetened fruit drinks), waters and other non-SSBs (incl. no-added sugar (NAS) fruit juices).	Weekly volume sold of SSBs decreased by 4.3%. Volume sold of carbonated SSBs fell by 3.6%. Volume sold of non-SSBs increased by 5.2%; bottled water increased by 7.5%.
CHILE						
Caro, Corvalán, Reyes, Silva, Popkin, Taillie, 2018	Longitudinal random effects tobit model; household RE; seasonal (quarters) FE; counterfactual post-tax trend; estimates by household SES; no comparison group. Study also included price analysis.	Kantar WorldPanel Chile, Jan 2013 to Dec 2015. Longitudinal (weekly) food purchases (interviewers collected data using bar code scanner, receipts, code book, inventory). Bar code products linked to nutrition facts panel.	Households (urban) n=1,795 Two subgroups: high SES (high and mid-high) and low SES (mid-low and low)	Increase in SSB tax rate from 13% to 18% on high-sugar SSBs (>6.25 g of sugar/100 ml); reduction in SSB tax rate from 13% to 10% on low- or no-sugar sweetened beverages (<6.25 g of sugar/100 ml, including all non-sugar sweetened beverages). Effective October 1, 2014.	Monthly per capita high-sugar SSBs (carbonated and non-carbonated) beverage volume and monthly per capita low- or no-sugar sweetened beverages (concentrates and ready-to-drink (RTD)) beverage volume purchased by households. Monthly per capita volume of untaxed beverages.	Higher taxed high-sugar SSBs fell by 3.4% (–6.4% for high-SES; low-SES NS). • Carbonated high-sugar SSBs NS overall (–7.2% for high-SES; low-SES NS). • Non-carbonated high-sugar SSBs fell 8.2% (NS for high-SES; –10.1% for low-SES). Reduced taxed low- or no-sugar sweetened beverages increased by 10.7% (9.5% for low-SES and 10.8% for high-SES). • Low- or no-sugar sweetened concentrates increased 9.4% (10.7% for low-SES and 7.1% for high-SES. • Low- or no-sugar sweetened RTDs increased 12.3% (12.2% for low-SES and 14.3% for high-SES).

Author(s), year	Study design	Data source and time period	Population/ sample (n)	Tax measure/ implementation date	Outcome(s)	Results
CHILE						
Nakamura, Mirelman, Cuadrado, Silva-Illanes, Dunstan, Suhrcke, 2018	Longitudinal FE model (log of per capita volume); household FE; seasonal (quarter) FE; no comparison group.	Kantar WorldPanel Chile, Jan 2011 to Dec 2015. Longitudinal (weekly) household food purchases (interviewers collected data using bar code scanner, receipts, code book, inventory). Bar code products linked to nutrition information.	Households (urban) n=2,836 Three subgroups: low, middle and high SES	Increase in SSB tax rate from 13% to 18% on high-sugar SSBs (>6.25 g of sugar/100 ml); reduction in SSB tax rate from 13% to 10% on low- or no-sugar sweetened beverages (<6.25 g of sugar/100 ml, and all non-sugar sweetened beverages). Effective October 1, 2014.	Soft drinks were coded in three categories as: monthly per capita volume of high-sugar SSBs, low- or no-sugar sweetened beverages, and untaxed (nonsugary, nonflavored, noncolored products) beverages.	Higher taxed high-sugar SSBs fell by 21.6% (–31.3% for high-SES; –16.4% for middle-SES and low-SES NS). Reduced taxed low- or no-sugar sweetened beverages had no significant changes including by SES. Untaxed soft drink beverage volume fell by 23.7% for high-SES (NS for overall and other SES).
MEXICO						
Colchero, Popkin, Rivera, Ng, 2016	DID model; household FE; seasonal (quarter) FE; counterfactual post-tax trend; no comparison group.	Nielsen Mexico's Consumer Panel Services, monthly, Jan 2012 to Dec 2014. Household scanner data.	Households n=6,253 Three subgroups: low, middle and high SES	Specific excise tax of 1 peso/liter on SSBs; (~10% tax based on 2013 prices). Effective: January 1, 2014.	Beverage purchases; volume per capita. Taxed beverages: carbonated SSBs, non-carbonated SSBs. Untaxed beverages: non-SSB carbonated beverages, water (plain/sparkling), other (dairy, juice).	Purchases of taxed beverages fell by 6.1% in 2014. • Larger effects for low SES: –9.1% for low-SES; –5.5% for middle-SES; and –5.6% for high-SES. Purchases of untaxed beverages increased 3.9% in 2014.
Colchero, Guerrero-López, Molina, Rivera, 2016	OLS regression model with post (2014–2015) vs. pre (2007–2013) tax indicator; seasonal (quarter) FE; no comparison group.	Monthly Surveys of the Manufacturing Industry (EMIM), monthly, Jan 2007 to Dec 2015. Sales from domestic production, including exports.	NA	Specific excise tax of 1 peso/liter on SSBs; (~10% tax based on 2013 prices). Effective: January 1, 2014.	Per capita sales drawn from NAICS 312111 – Soft Drink Manufacturing. Taxed beverages: SSBs: cola and non-cola carbonates (incl. diet and sports drinks) and fruit drinks (<100%). Untaxed beverages: Plain water.	Sales of SSBs fell 7.3% for the 2-year (2014-2015) post-tax versus pre-tax period; –6.2% for 2014; –8.7% for 2015. Sales of plain water increased 5.2% over the 2-year post period; NS in 2014; +11.8% in 2015.

Author(s), year	Study design	Data source and time period	Population/ sample (n)	Tax measure/ implementation date	Outcome(s)	Results
MEXICO						
Colchero, Molina, Guerrero-López, 2017	2-part estimation model of purchases; comparison of changes of adjusted predicted values for 2014 and predicted values of previous round for 2014 (counterfactual); no comparison group.	National Income and Expenditure Survey (ENIGH), 2008, 2010, 2012, and 2104. National household survey.	Households 2008 n=35,146 2010 n=30,169 2012 n=10,062 2014 n=21,427 Analytic sample: 85,118 Three subgroups: low, middle and high SES	Specific excise tax of 1 peso/liter on SSBs; (~10% tax based on 2013 prices). Effective: January 1, 2014.	Weekly per capita household purchases of SSBs and water (plain and sparkling). SSBs included diet or low-calorie sodas but not 100% fruit juice.	Purchases of SSBs fell by 6.3% • Larger effects for low-SES: –10.3% for low-SES; –3.7% for middle-SES; and –5.8% for high-SES. Purchases of water increased by 16.2% • Larger effects for low and middle SES: +21.7% for low-SES; +20.3%% for middle-SES; and +9.6%% for high-SES.
Colchero, Rivera-Dommarco, Popkin, Ng, 2017	DID model; household FE; seasonal (quarter) FE; counterfactual post-tax trend; no comparison group.	Nielsen Mexico's Consumer Panel Services, monthly, Jan 2012 to Dec 2015. Household scanner data.	Households n=6,645	Specific excise tax of 1 peso/liter on SSBs; (~10% tax based on 2013 prices). Effective: January 1, 2014.	Beverage purchases; volume per capita. Taxed beverages: carbonated SSBs, non-carbonated SSBs. Untaxed beverages: non-SSB carbonated beverages, water (plain/sparkling), other (dairy, juice).	Purchases of taxed beverages fell 7.6% over the 2-year 2014-2015 study period; –5.5% for 2014; –9.7% for 2015. Sales of untaxed beverages increased 2.1% over the 2014-2015 period; +5.3% in 2014; –1.0% in 2015.
Ng, Rivera, Popkin, Colchero, 2018	DID model; household FE; seasonal (quarter) FE; counterfactual post-tax trend; no comparison group.	Nielsen Mexico's Consumer Panel Services, monthly, Jan 2012 to Dec 2015. Household scanner data.	Households n=6,089 HTLU: n=1,479 HTHU: n=1,787 LTLU: n=1,437 LTHU: n=1,386	Specific excise tax of 1 peso/liter on SSBs; (~10% tax based on 2013 prices). Effective: January 1, 2014.	Mean per-capita purchases of taxed and untaxed beverages. Taxed beverages included carbonated soft drinks, fruit drinks, flavored waters, sport drinks, teas, and other beverages with added sugar (excluding sweetened dairy). Untaxed beverages included diet sodas and bottled water.	By 2015, HT beverages purchasers (HTLU and HTHU) had the largest reductions in purchases of taxed beverages [16.1% and 20.0%, respectively; compared with small increases for LTLU (1.9%) and LTHU (+0.6%)]. HT purchasers also increased purchases of untaxed beverages. LU beverage purchasers had highest increases in untaxed beverages: 11.3% for HTLU and 14.0% for LTLU.

Author(s), year	Study design	Data source and time period	Population/ sample (n)	Tax measure/ implementation date	Outcome(s)	Results
MEXICO						
Pedraza, Popkin, Batis, Adair, Robinson, Guilkey, Taillie, 2019	Estimate means for volume, calories, and sugar of households; household FE adjusted for household SES and composition, geographic area controls, seasonality; no comparison group or counterfactual. Analyses by store type.	Nielsen Mexico's Consumer Panel Services, monthly, Jan 2012 to Dec 2016. Household scanner data.	Households n=7,038 (338,187 household-month observations)	Specific excise tax of 1 peso/liter on SSBs; (~10% tax based on 2013 prices). Effective: January 1, 2014.	Mean per capita household purchases of taxed and untaxed beverages: volume, calories, and sugar.	Year-over-year changes were provided. Change from 2013 (pre-tax) to 2014 (first year post-tax) Tax beverages: • Volume: –49 ml; –19% (p<0.05) • Calories: –5 kcal; –6% (p<0.05) • Sugars: –1 g of sugar; –6% (p<0.05) Untaxed beverages: • Volume: +93 ml; +11% (p<0.05) • Calories and sugar: minimal.
UNITED STATES OF AMERICA Berkeley, CA						
Falbe, Thompson, Becker, Rojas, McCulloch, Madsen, 2016	Repeated cross-section, pre-post DID design of change in adjusted mean consumption of intervention versus comparison site.	Interview-administered intercept surveys near highest foot-traffic intersection in low-income neighborhoods. Pre-tax data collection: April to July 2014. Post-tax: April to Aug 2015.	Adults n=990 pre-tax and n=1,689 post tax. Intervention site: Berkeley, CA. Comparison sites: Oakland and San Francisco, CA.	Specific excise tax of $0.01-per-oz on SSBs (soda, energy, sports, and fruit-flavored drinks, sweetened water, coffee, tea, and, syrups). Effective March 1, 2015.	Consumption of SSBs based on beverage frequency questionnaire modified from the BRFSS 2011 module. Measure of times of SSB daily intake was derived.	SSB consumption in Berkeley decreased by 21% and increased by 4% in the comparison cities. (The figures for soda were: –26% for Berkeley and +10% for comparison cities; for sports drinks: –36% in Berkeley and +21% in comparison cities). Water consumption increased by 63% in Berkeley and by 19% in comparison cities.

Author(s), year	Study design	Data source and time period	Population/ sample (n)	Tax measure/ implementation date	Outcome(s)	Results
UNITED STATES OF AMERICA Berkeley, CA						
Silver, Ng, Ryan-Ibarra, Smith Taillie, Induni, Miles, Poti, Popkin, 2017	OLS DID models (log transformed) for volume; store ID, day, month, holidays, and year FE. Cross-sectional pre-post tax 2-part consumption models; no comparison group.	Point-of-sale scanner data from 2 large chain supermarkets. Jan 2013 through Feb 2016. Individual-level random digit dial telephone survey. Nov- to Dec 2014; Nov to Dec 2015.	Scanner data: 3 stores in Berkeley; 6 Bay area comparison stores. Covered 5,631 unique beverage barcodes used. Individual-level survey: Adults in Berkeley; n=623 at baseline; n=613 at 1-year post tax.	Specific excise tax of $0.01-per-oz on SSBs (soda, energy, sports, and fruit-flavored drinks, sweetened water, coffee, tea, and syrups). Effective March 1, 2015.	Volume of taxed and untaxed beverages sold (oz per transaction) and revenue from all sales. Usual intake of kcals/ day and g/day of taxed and untaxed beverages (based on National Cancer Institute (NCI) data collection method).	1. Estimates for sales volume: Volume of taxed beverages fell 9.6% in Berkeley and rose 6.9% in non-Berkeley stores. Sales of untaxed beverages rose 3.5% in Berkeley and 0.5% in non-Berkeley stores. Sales of water rose by 15.6% in Berkeley; untaxed fruit, vegetable, and tea drinks rose by 4.4% and plain milk by 0.6%. Sales of diet soft drinks and energy drinks fell by 9.2%. 2. Estimates for consumption: Mean daily SSB volume (g) and kcal intake of taxed beverages fell but not significantly. Mean volume intake of untaxed beverages rose but NS. Mean kcal intake of untaxed beverages rose 27.6%.
Lee, Falbe, Schillinger, Basu, McCulloch, Madsen, 2019	Pre-post intervention-comparison site DID model. Controlled for time FE and vector of individual-level characteristics.	Repeated annual cross-sectional questionnaires. Berkeley n=1,513 San Francisco and Oakland n=3,712. Pre-tax data collection: April to July 2014. Post-tax: April to Oct 2015, 2016, and 2017.	Adults: Berkeley: n=2,435 Comparison: n=5,141 Sample from 2 large neighborhoods with highest proportion Black and/or Hispanic residents. Matched to comparison.	Specific excise tax of $0.01-per-oz on SSBs (soda, energy, sports, and fruit-flavored drinks, sweetened water, coffee, tea, and syrups). Effective March 1, 2015.	Beverage frequency (BEVQ-15) for taxed SSB consumption.	Consumption frequency of taxed SSBs in Berkeley declined by 0.55 times per day over 3-years post-tax relative to no change in comparison sites. Consumption frequency for water increased by 1.02 times per day over 3-years post-tax relative to no change in comparison sites.

Author(s), year	Study design	Data source and time period	Population/ sample (n)	Tax measure/ implementation date	Outcome(s)	Results
UNITED STATES OF AMERICA Cook County, IL						
Powell, Leider, Leger, 2020	Pre-post intervention-comparison site DID model. Analysis of changes in border area.	Store scanner data obtained from Nielsen. Pre-tax data collection: 4-month period Aug 2018 to Nov 2018. Post-tax period: Aug 2019 to Sept 2019. Data at the UPC level.	Data obtained from supermarkets and mass merchandise, grocery, convenience, drug, and dollar stores. 2,840 taxed and 1,613 untaxed UPCs.	Retailer tax of $0.01-per-ounce on sugar and non-sugar sweetened beverages. Effective August 2, 2018, repealed effective Nov 30, 2018.	Volume sold in oz. SSBs classified as taxed (soda, energy, sports, juice and tea/ coffee drinks) and non-taxed (100% juice, milk, water). Beverages classified by size: individual (≤1 L) vs family (>1 L and multipacks).	DID estimates: Volume sold of SSBs fell by 27%. Net reduction in volume sold was 21% after accounting for cross-border shopping. Implied price elasticity from study is: –0.8. Change in volume sold of untaxed beverages: NS.
UNITED STATES OF AMERICA Oakland, CA						
Cawley, Frisvold, Hill, Jones, 2020	Cross-sectional pre-post DID two-part model (logistic; GLM Poisson); Household controls; day/ time. Longitudinal differences in outcomes linear regression on treatment and controls.	1. Store exit interview survey; 2. Longitudinal household survey. Pre-tax data collection: April to June 2017. Post-tax data collection: April to June 2018.	Adults with ≥ child aged 2-17 Oakland: n=785 pre-tax; n=786 post-tax. Comparison: n=741 pre-tax; n=766 post-tax. Longitudinal: Oakland n=193 Comparison n=218	Specific excise tax of $0.01-per-oz on SSBs with ≥ 25 calories per 12 fluid oz. Effective July 1, 2017.	Purchases: volume of taxed and untaxed beverages purchased by consumers on that shopping trip. Consumption: Beverage frequency (BEVQ-15) for taxed SSB consumption; daily added sugar (grams) intake based on NCI DSQ.	1. Purchases: Any purchases of taxed beverages: –4.2 percentage points (–16.7%) NS; Regular soda: –10.6 percentage points Untaxed beverages: 10.8 percentage points (52.9 %) oz purchased: –11.33 for taxed purchases (–58.8%), NS; NS effects for taxed or untaxed. 2. Change in consumption and sugar intake: NS.

Author(s), year	Study design	Data source and time period	Population/ sample (n)	Tax measure/ implementation date	Outcome(s)	Results
UNITED STATES OF AMERICA Philadelphia, PA						
Zhong, Auchincloss, Lee, Kanter, 2018	Repeated cross-section, pre-post DID logit and negative binomial regression estimation model; propensity score weights.	Random-digit-dial phone survey; modified BEVQ-15 survey. Pre-tax data collection: Dec 6 to 31, 2016. Post-tax: Jan 15 to Feb 31, 2017.	Adults: n=899 from Philadelphia, PA; n=878 from comparison sites: Trenton and Camden, NJ, Wilmington, DE	Specific excise tax of $0.015-per-oz on SSBs and non-sugar sweetened beverages. Effective January 1, 2017.	Daily consumption (≥30 times during past 30 days), 30-day total consumption volume (oz), and 30-day total consumption frequency. Beverage categories: SSBs (regular soda, fruit and energy drinks); non-sugar sweetened beverages (diet soda, fruit and energy drinks); bottled water.	2-months post-tax, odds of daily soda and energy drink consumption was 40% and 64% lower, respectively. 30-day soda consumption frequency was 38% lower. Odds of bottled water consumption was 58% higher. No other consumption outcomes by beverage types were significant.
Roberto, Lawman, LeVasseur, Mitra, Peterhans, Herring, Bleich, 2019	Pre-post intervention-comparison site DID model. Analysis of changes in border area.	Store scanner data obtained from IRI (Information Resources, Inc.). Retail sales data reported in 4-week periods from Jan 1, 2014 to Dec 31, 2017. Data at the UPC level.	Scanner data: 291 stores (54 supermarkets, 20 mass merchandise stores, 217 pharmacies). 17,153 unique beverage UPC (9,325 SSBs; 1,781 non-sugar sweetened beverages; 6,047 unsweetened).	Specific excise tax of $0.015-per-oz on SSBs and non-sugar sweetened beverages. Effective January 1, 2017.	Volume sold in ounces. Beverages classified as taxed (SSBs and non-sugar sweetened beverages) and non-taxed. Beverages classified by size: individual vs family (>36oz).	DID estimates: volume sold of SSBs fell by: • 58.7% in supermarkets • 40.4% in mass merchandise stores • 12.6% in pharmacies Descriptive: overall volume of SSBs fell by 51.0% (offset 24.4% by cross-border shopping) for a net reduction of 38%. Implied price elasticity from study is: –1.7 NS changes in volume sold of non-taxed beverages.
Coary & Baskin, 2018	Pre-post intervention-comparison site DID model. Analysis of changes in border area.	Sales data from 4-week periods pre-tax in Nov 2015 and Feb 2016, and post-tax Nov 2016, and Feb 2017.	Sales data from 5 stores in Philadelphia and 4 stores outside of Philadelphia within 5 miles. High volume items n=931 products.	Specific excise tax of $0.015-per-oz on SSBs and non-sugar sweetened beverages. Effective January 1, 2017.	Sales ($) of taxed and untaxed beverages.	DID estimates of change in sales ($) of taxed beverages found a statically significant reduction of $131,295 (~48%); NS change in non-taxed beverages.

Author(s), year	Study design	Data source and time period	Population/ sample (n)	Tax measure/ implementation date	Outcome(s)	Results
UNITED STATES OF AMERICA Philadelphia, PA						
Cawley, Frisvold, Hill, Jones, 2019	Pre-post intervention-comparison site DID model. Cross-sectional model of changes in purchases at stores controlled for a vector of consumer and interview variables. Longitudinal model of consumption estimates OLS of change in consumption on tax jurisdiction controlling for baseline consumption and individual characteristics.	1. Cross-sectional data on purchases from store exit surveys based on stratified store types from retailer list. Pre-tax: Nov to Dec, 2016; Post-tax Nov to Dec 2017. 2. Longitudinal follow-up survey from Dec 2016 store exit survey.	1. Store exit surveys: adults>18y with at least one child 2-17y in household. n=600 in Philadelphia; n=705 comparison. 2. Longitudinal n=241 Philadelphia; n=199 comparison	Specific excise tax of $0.015-per-ounce on SSBs and non-sugar sweetened beverages. Effective January 1, 2017.	1. Volume of taxed and untaxed beverages purchased. Sub-categories: soda and water. 2. i) 30-day frequency of taxed and non-taxed beverage consumption based on the National Health and Nutrition Examination Survey (NHANES) dietary screener; ii) total amount of added sugar consumed from beverages based on NCI algorithm.	1. DID estimates of changes in beverage purchases from stores: • fell 31 oz per shopping trip • no significant change in purchases of untaxed beverages 2. Frequency of consumption: • adults: NS change for taxed beverage • adults: significant reduction in soda consumption frequency • children: NS change in frequency of taxed beverage consumption or by beverage category • adults and children: NS change in consumption frequency 3. Sugar intake: • adults and children: NS change in sugar intake from beverages • children: significant reduction in beverage sugar intake among children who had high pre-tax consumption of added sugars

Author(s), year	Study design	Data source and time period	Population/ sample (n)	Tax measure/ implementation date	Outcome(s)	Results
UNITED STATES OF AMERICA Philadelphia, PA						
Zhong, Auchincloss, Lee, McKenna, Langellier, 2020	Longitudinal pre-post DID linear and logistic regression estimation models. Analyses adjusted for demographic and SES characteristics and health behaviors, conditions and status; week/ month.	Random-digit-dial phone survey; modified BEVQ-15 survey; pre-tax Dec 2016 to Feb 2017; post-tax Dec 2017 to Feb 2018.	Adults: n=357 from Philadelphia, PA; n=158 from comparison sites: Trenton and Camden, NJ, Wilmington, DE.	Specific excise tax of $0.015-per-oz on SSBs and non-sugar sweetened beverages. Effective January 1, 2017.	1-year changes in 30-day consumption frequency; changes in 30-day total consumption volume (oz). Beverage categories: SSBs (regular soda, fruit and energy); non-sugar sweetened beverages (diet soda, fruit and energy); bottled water.	DID estimates found NS effects for 30-day consumption frequency for SSBs (–3.03 times), non-sugar sweetened beverages (0.40) and bottled water (–15.79) and also NS changes in mean monthly ounces for SSBs (–51.65), non-sugar sweetened beverages (21.62) and bottled water (–315.81).
UNITED STATES OF AMERICA Seattle, WA						
Powell & Leider, 2020	Pre-post intervention-comparison site DID model. Analysis of changes in border area.	Store scanner data obtained from Nielsen; 8-month pre-tax period (Feb 2018 to Sept 2018) and post-tax period (Feb 2019 to Sept 2019). Data at the UPC level.	Scanner data from supermarkets and mass merchandise, grocery, convenience, drug, and dollar stores. 1,600 taxed and 2,203 untaxed UPCs.	Specific excise tax of $0.0175-per-oz on SSBs with ≥ 40 calories per 12 fluid ounces. Effective January 1, 2018.	Volume sold in ounces. SSBs classified as taxed (soda, energy, sports, juice and tea/ coffee drinks) and non-taxed (SSBs<40 kcal/12 oz; 100% juice, milk, water). Beverages classified by size: individual (≤1 L) vs family (>1 L and multipacks).	DID estimates: Volume sold of SSBs fell by 22%. Volume sold of untaxed beverages increased by 4%. NS changes in cross-border shopping. Implied price elasticity from study is: –1.1.

BEV-Q: beverage intake questionnaire
DID: difference-in-difference
DSQ: dietary screener questionnaire
FE: fixed effects
GLM: generalized linear model
HTHU: higher purchases of taxed beverages and higher purchases of untaxed beverages
HTLU: higher purchases of taxed beverages and lower purchases of untaxed beverages
LTHU: lower purchases of taxed beverages and higher purchases of untaxed beverages
LTLU: lower purchases of taxed beverages and lower purchases of untaxed beverages
NS: non-statistically significant
OLS: ordinary least square
RE: random effects
SES: socioeconomic status
UPC: universal product code
g: grams
L: liters
kcal: kilocalories
oz: ounces

References

Alvarado M, Unwin N, Sharp SJ, Hambleton I, Murphy MM, Samuels TA, Suhrcke M, Adams J. (2019). Assessing the impact of the Barbados sugar-sweetened beverage tax on beverage sales: an observational study. *Int J Behav Nutr Phys Act.* 16(1):13.

Caro JC, Corvalan C, Reyes M, Silva A, Popkin B, Taillie LS. (2018). Chile's 2014 sugar-sweetened beverage tax and changes in prices and purchases of sugar-sweetened beverages: an observational study in an urban environment. *PLoS Med.* 15(7):e1002597

Cawley J, Frisvold D, Hill A, Jones D. (2020). Oakland's sugar-sweetened beverage tax: impacts on prices, purchases and consumption by adults and children. *Economics & Human Biology.* 37:100865.

Cawley J, Frisvold D, Hill A, Jones D. (2019). The impact of the Philadelphia beverage tax on purchases and consumption by adults and children. *Journal of Health Economics.* 67:102225.

Coary SP, Baskin E. (2018). Sweetened beverages excise tax passthrough rates: a case study in Philadelphia. *Journal of International Food & Agribusiness Marketing.* 30(4):382-91.

Colchero MA, Guerrero-López CM, Molina M, Rivera JA. (2016). Beverages sales in Mexico before and after implementation of a sugar sweetened beverage tax. *PloS One*. 11(9).

Colchero MA, Molina M, Guerrero-López CM. (2017). After Mexico implemented a tax, purchases of sugar-sweetened beverages decreased and water increased: difference by place of residence, household composition, and income level. *The Journal of Nutrition.* 147(8):1552-7.

Colchero MA, Popkin BM, Rivera JA, Ng SW. (2016). Beverage purchases from stores in Mexico under the excise tax on sugar sweetened beverages: observational study. *BMJ Open.* 352:h6704.

Colchero MA, Rivera-Dommarco J, Popkin BM, Ng SW. (2017). In Mexico, evidence of sustained consumer response two years after implementing a sugar-sweetened beverage tax. *Health Affairs*. 36(3):564-71.

Falbe J, Thompson HR, Becker CM, Rojas N, McCulloch CE, Madsen KA. (2016). Impact of the Berkeley excise tax on sugar-sweetened beverage consumption. *American Journal of Public Health*. 106(10):1865-71.

Lee MM, Falbe J, Schillinger D, Basu S, McCulloch CE, Madsen KA. (2019). Sugar-sweetened beverage consumption 3 years after the Berkeley, California, sugar-sweetened beverage tax. *American Journal of Public Health*. 109(4):637-9.

Nakamura R, Mirelman AJ, Cuadrado C, Silva-Illanes N, Dunstan J, Suhrcke M. (2018). Evaluating the 2014 sugar-sweetened beverage tax in Chile: an observational study in urban areas. *PLoS Medicine*. 15(7):e1002596.

Ng SW, Rivera JA, Popkin BM, Colchero MA. (2019). Did high sugar-sweetened beverage purchasers respond differently to the excise tax on sugar-sweetened beverages in Mexico?. *Public Health Nutrition.* 22(4):750-6.

Pedraza LS, Popkin BM, Batis C, Adair L, Robinson WR, Guilkey DK, Taillie LS. (2019). The caloric and sugar content of beverages purchased at different store-types changed after the sugary drinks taxation in Mexico. *International Journal of Behavioral Nutrition and Physical Activity.* 16(1):103.

Powell LM, Leider J, Léger PT. (2020). The impact of a sweetened beverage tax on beverage volume sold in Cook County, Illinois, and its border area. *Annals of Internal Medicine.* 172(6):390-7.

Powell LM, Leider J. (2020). The impact of Seattle's sweetened beverage tax on beverage prices and volume sold. *Economics & Human Biology*. 37:100856.

Roberto CA, Lawman HG, LeVasseur MT, Mitra N, Peterhans A, Herring B, Bleich SN. (2019). Association of a beverage tax on sugar-sweetened and artificially sweetened beverages with changes in beverage prices and sales at chain retailers in a large urban setting. *JAMA.* 321(18):1799-810.

Silver LD, Ng SW, Ryan-Ibarra S, Taillie LS, Induni M, Miles DR, Poti JM, Popkin BM. (2017). Changes in prices, sales, consumer spending, and beverage consumption one year after a tax on sugar-sweetened beverages in Berkeley, California, US: A before-and-after study. *PLoS Medicine.* 14(4).

Zhong Y, Auchincloss AH, Lee BK, Kanter GP. (2018). The short-term impacts of the Philadelphia beverage tax on beverage consumption. *American Journal of Preventive Medicine.* 55(1):26-34.

Zhong Y, Auchincloss AH, Lee BK, McKenna RM, Langellier BA. (2020). Sugar-sweetened and diet beverage consumption in Philadelphia one year after the beverage tax. *International Journal of Environmental Research and Public Health.* 17(4):1336.

Sugar-sweetened beverage excise taxes are an effective evidence-based noncommunicable diseases (NCD) prevention policy. Along with tobacco and alcohol excise taxes, they are a tool to attain the Sustainable Development Goals, and are recommended by the World Health Organization to modify behavioral risk factors associated with obesity and NCDs, as featured in the WHO Global Action Plan. Taxes on sugar-sweetened beverages have been described as a triple win for governments, because they 1) improve population health, 2) generate revenue, and 3) have the potential to reduce long-term associated healthcare costs and productivity losses.

Taxation of sugar-sweetened beverages has been implemented in more than 73 countries worldwide. In the Region of the Americas, 21 PAHO/WHO Member States apply national-level excise taxes on sugar-sweetened beverages and seven jurisdictions apply local sugar-sweetened beverage taxes in the United States of America. While the number of countries applying national excise taxes on sugar-sweetened beverages in the Region is promising, most of these taxes could be further leveraged to improve their impact on sugar-sweetened beverages consumption and health.

This publication provides economic concepts related to the economic rationale for using sugar-sweetened beverage taxes and the costs associated with obesity; key considerations on tax design including tax types, bases, and rates; an overview of potential tax revenue and earmarking; evidence on the extent to which these taxes are expected to impact prices of taxed beverages, the demand for taxed beverages, and substitution to untaxed beverages; and responses to frequent questions about the economic impacts of sugar-sweetened beverage taxation.

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