

An analysis of policies to reduce sugar-sweetened beverage consumption in the United States

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Executive summary

Increasing consumption of sugary drinks in the United States over the past several decades has contributed to a rising prevalence of chronic diseases, including obesity, type 2 diabetes mellitus, and cardiovascular disease. Due to the deleterious health effects of excess sugar-sweetened beverage (SSB) consumption, multiple organizations have called for policies to reduce SSB consumption, prevent chronic diseases, and reduce health disparities. Three policy alternatives include a federal SSB excise tax, limitation of SSB marketing to youth, and SSB warning labels. When considering potential outcomes and tradeoffs, a federal SSB excise tax is the optimal policy alternative to mitigate the harms of SSB consumption in order to maximize public health and social welfare.

Measured and modeled outcomes of SSB taxes include changes in SSB price, sales, consumer spending, beverage consumption, and health outcomes. Based on limited evidence, a federal SSB tax in the United States would likely result in modest decreases in the prevalence of obesity and other chronic diseases, including diabetes and cardiovascular disease.

The cost to implement an SSB tax nationally is estimated to be between \$47.6 million to \$51 million in the first year and with a 10-year intervention cost of \$430 million. A federal SSB tax is expected to be cost-effective and would save between \$17.1 billion and \$23.6 billion in health care costs over 10 years. In addition, revenue from the tax could support a suite of public health and social interventions to address chronic diseases like obesity and type 2 diabetes mellitus. A federal SSB excise tax is feasible both legally and administratively. However, passage of a federal SSB tax may be challenging. Additional evidence and appropriate framing of the tax may lead to successful passage and implementation of a federal SSB tax in the United States.

I. Introduction

Problem definition and outline

Adults and children in the United States consume more than the recommended limits for sugary drinks, which has contributed to a rising prevalence of chronic diseases (1–7). Due to the harms of excess sugar consumption, half of which comes from sugar-sweetened beverages (SSBs), multiple policies have been proposed to curb SSB consumption to improve health outcomes (8,9).

In this policy analysis, the harms of excess SSB consumption and definitions of relevant terms will be described first. Next, policy alternatives to mitigate the detrimental effects of SSB consumption will be outlined. The criteria to evaluate policy alternatives will be presented. The outcomes and trade-offs of each policy alternative will be evaluated. Based on the outcomes and trade-offs, the optimal policy alternative will be selected. When considering the criteria and potential outcomes and tradeoffs, a federal SSB excise tax is the best choice, and will be described in detail.

Background

Excess consumption of SSB is associated with multiple chronic diseases. Specifically, soft drink and SSB consumption is associated with a greater caloric intake, increased body weight in children and adults, and greater risk of type 2 diabetes mellitus, the metabolic syndrome, and cardiovascular disease (4–7,10,11). SSB consumption also contributes to dental decay (12). Additionally, soft drink consumption has been shown to be associated with increased mortality in the United States, Canada, and Europe (13–15). In the United States and Canada, 26,946 deaths were estimated to be related to excess SSB consumption in 2010 (15).

Because SSB are a primary source of added sugars in the Western diet, multiple organizations have recommended limiting SSB intake, including the United States Department of Health and Human Services in their Dietary Guidelines (16), the World Health Organization (WHO) (17), and the American Heart Association (18).

Despite these recommendations, SSB consumption in the United States continues to be greater than the recommended limits. From 1977 to 1997, American per capita consumption of soda increased 61% to an average of 53 gallons annually in 1997 (1). Energy intake from SSBs, including soda, fruit drinks, sports drinks, and sweetened coffee drinks, increased 135% from 1977 to 2001 and rose from 70 calories per day to 190 calories per day (19). Despite a decrease in SSB consumption over the past decade, about half of adults in the United States still drink at least one SSB per day and nearly two-thirds of U.S. youth consume at least one SSB daily (20–22). As a result, about 7% of total daily calories come from SSBs in the American diet (6.9% for men, 6.1% for women, 7.3% for boys, and 7.2% for girls) (23). Among low-income households and minorities, a greater percentage of total daily calories come from SSBs (21–23).

II. Definitions

Cross-border shopping: purchasing a taxed product outside of the taxed jurisdiction in order to avoid a tax (24).

Elasticity, own-price: change in demand for a product in response to a change in price (24). If demand is completely inelastic, then consumer demand will not decrease in response to higher prices (24). Conversely, if prices are completely elastic, then demand will drop in response to an increase in prices (24).

Elasticity, cross-price: change in demand for one product that occurs in response to a change in price of another good (24).

Excise tax: a tax paid on a product, which is usually reflected in the shelf price (25).

Negative externality: a cost incurred by a third party who did not choose to experience that cost (26).

Negative internality: a long term cost incurred by an individual that he or she ignores when deciding to choose to consume a product (26).

Pass-through: amount of a tax that is passed on to the consumer in the form of higher prices for a product (24).

Sugar-sweetened beverage: any drink with an added caloric sweetener, including but not limited to soft drinks, sports drinks, energy drinks, fruit drinks, chocolate milk, and sweetened coffee or tea (26).

Social welfare: a comprehensive measure of wellbeing used by economists (26).

III. Policy alternatives

A federal SSB excise tax

Due to the deleterious health effects of excess SSB consumption, multiple organizations, including the Institute of Medicine, the WHO, the American Public Health Association, the British Medical Association, and the Society of Behavioral Medicine, have called for SSB excise taxes to curb SSB consumption, prevent chronic diseases, and reduce health disparities (27–32). An SSB tax efficiently imposes a fee on a large proportion of sugar intake resulting in potential public health and societal benefit (33).

An SSB excise tax is a sumptuary tax, or “sin” tax, like those imposed on tobacco and alcohol (26,34). Since tobacco and alcohol excise taxes have been successful public health interventions, an SSB tax is thought to be a viable policy to reduce sugar intake (35). Sin taxes correct for lack of consideration of the harms of consumption of a product by the consumer (26).

An SSB tax accounts for the actual cost of consumption since the shelf price of an SSB does not reflect its full cost to society (externalities) and to individuals (internalities) (33). Ideally, an SSB tax adds a cost to the price of the SSB equal to the marginal external costs (e.g., additional medical costs) that are imposed on society as a result of consumption (26,36). An SSB tax also counteracts internalities, in which an individual continues to consume a product despite harmful effects as a result of a lack of knowledge or incorrect beliefs of the consumer (26).

Limiting SSB marketing to children and adolescents

SSB companies spend substantial sums of money on advertising towards children and adolescents (9). For example, in 2009, carbonated beverage manufacturers spent \$395 million on youth-directed expenditures (9). Over the past decade, children and adolescents have seen increasing numbers of television advertisements for SSB (37). Both the WHO and the American Academy of Pediatrics have recommended reductions in the exposure of youth to advertising (9,38). In the United States companies are protected by commercial free speech rights, but their advertising is supported by the government since those companies are allowed to deduct advertising as a business expense (9). Therefore, the federal government could eliminate the subsidy for advertising of SSB beverages and other unhealthy foods to reduce the exposure (9,39,40).

Front-of-package warning labels on SSBs

Clear labeling on SSB packages that describe the health harms of consumption of excess added sugar is another policy option to reduce SSB consumption (9). Health warning labels have been shown to sway adolescents away from purchasing SSB (41). Labels also have the potential to influence parents and decrease their purchases of SSB for their children (42). However, these

warning labels have been ruled unconstitutional and in violation of commercial free speech (9,43).

IV. Evaluation of policy alternatives

Criteria for evaluation

Because SSBs are associated with multiple negative health outcomes, a key criterion for evaluation of policies is a policy's ability to reduce consumption in order to minimize the harmful effects of excess consumption of sugary drinks, such as obesity and other chronic diseases (27,28,44,45). The policy alternatives will also be evaluated on the basis of effects on disparities in health outcomes (45). The cost to implement a policy and the policy's cost-effectiveness will likely have an effect on the likelihood of its passage by policymakers so will be included as a criterion for evaluation (45). A final important objective upon which to base the selection of a policy is the political feasibility of the policy (45). For example, if there are going to be constitutional fights over the implementation of a policy (9), then it may not be worthwhile to select that policy alternative.

Projected outcomes

A federal SSB tax in the United States would likely result in modest decreases in obesity and other chronic diseases, including diabetes and cardiovascular disease, based on modeling data (8,46). An SSB tax could be an effective component of obesity prevention efforts in combination with other interventions (47–49). A federal SSB excise tax is expected to be financially regressive but with health benefits accruing to vulnerable and underserved groups including low-income individuals and minorities (24,26,50,51). In addition, the financial effects can be mitigated by earmarking tax revenue that benefit low-income groups to a greater degree (50). Regarding cost, a federal SSB excise tax has been estimated to cost \$51 million to

implement in the first year and \$430 million over 10 years (52). A federal SSB excise tax of 1 cent per ounce would be predicted to generate \$12.5 billion in annual tax revenue and is expected to be cost-effective (39,52).

Elimination of the federal tax subsidy for advertising of SSB beverages and other unhealthy foods has been estimated to reduce the prevalence of obesity among youth (9,39,53). One study estimated that elimination of the subsidy would prevent 129,000 cases of obesity among children over the course of a decade (39). In addition, this policy change would generate substantial tax revenue and reduce health care costs by about \$350 million (39,53). When considering equity, it is likely that there will be a greater health benefit for low socioeconomic position and minority children (53,54).

Though warning label legislation has been proposed in the United States, no legislation has passed yet (55). However, experimental and modeling data have estimated the potential impact of the labels. Warning labels on SSB have been shown to decrease SSB purchases in a randomized controlled trial in a life size replica of a convenience store (56). Agent-based models estimating the impact of warning labels in Baltimore, Philadelphia, and San Francisco showed that warning labels could reduce the prevalence of obesity in those cities due to decreased SSB consumption (57). Once implemented, the costs of the warning labels are expected to be relatively low (55). No studies have evaluated the potential health equity impacts, but like the other two policies, an SSB warning label is likely to benefit low socioeconomic position and minority individuals to a greater degree since SSB consumption is higher among those groups (21,22).

Table 1: Projected outcomes matrix

Criteria	Policy alternatives			
	Status quo	SSB tax	Ending SSB advertising tax subsidy	SSB warning labels
Health outcomes	0	++	+	+
Cost to implement	0	--	0	-
Cost-effectiveness	0	++	+	?
Health equity	0	+	+	+
Political feasibility	0	-	-	--

Legend: 0=no effect, “+” refers to a beneficial effect, “-” refers to a detrimental effect, and “?” refers to an unknown effect

Trade-offs and policy decision

There is a substantial body of evidence supporting the potential health benefits of an SSB excise tax, which favors it as a policy alternative compared to ending the tax subsidy and warning labels (8,58,59). However, there is no observational data on the health outcomes of an SSB tax and the health outcomes are estimated using models (8,46). An additional limitation is that it is unknown how SSB manufacturers in the United States would respond to a federal SSB excise tax with regard to price pass-through to the consumers, which would in turn affect consumption and therefore health outcomes (24). That being said, the same limitation exists for the other two policy options.

An SSB tax would cost substantially more than the other policy alternatives to implement, but would generate a large amount of tax revenue that could fund other public health or government programs, which favors it as a policy alternative (26). In addition, the precedent of the effectiveness of excise taxes in discouraging consumption of unhealthy products such as alcohol and tobacco supports the use of excise taxes to reduce SSB consumption (60). Both the

SSB tax and ending the subsidy have been predicted to be cost-effective, which favors those policy alternatives over warning labels (39).

All of the policy options are hampered by limited political feasibility. Multiple SSB taxes have been passed at the local level, but none have passed at the state or federal level in the United States (61,62). However, careful framing may lead to successful passage of a federal SSB tax (63). Ending the subsidy may be hindered by industry opposition (53), but is likely to be more politically feasible than implementing a federal SSB tax. Finally, constitutional concerns were raised when San Francisco passed legislation requiring an SSB warning label (43), making it the least politically feasible at this time.

Based on these criteria, implementation of an SSB excise tax is the preferred policy alternative compared to the alternatives.

V. Development of a federal SSB excise tax

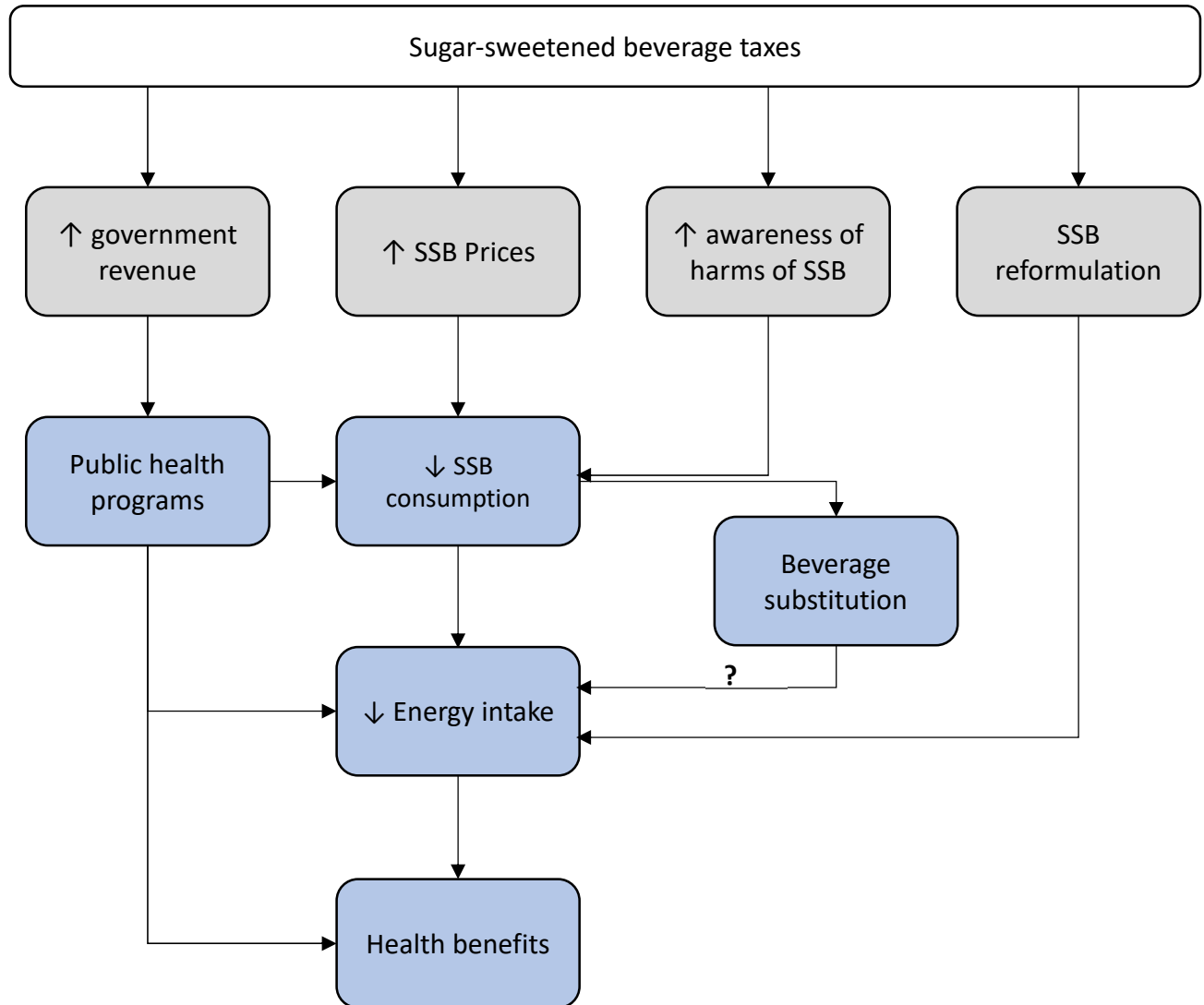
Objectives of an SSB tax

The economic objectives of an SSB are to increase SSB prices and to generate additional revenue for the federal government (36,64). A second objective of SSB taxes is to create government programs funded by the revenue generated from SSB taxes, referred to as progressive revenue recycling (26,36,44,64). Another objective is to incentivize reformulation of SSBs by companies to reduce sugar content (64). A final objective of SSB taxes is the denormalization of SSB consumption and increased awareness of the harms of SSB consumption (44,64) (**Figure 1**).

Overall, the goal from a public health perspective is to implement a tax that imposes a high enough price to result in a clinically meaningful reduction in consumption (33). The overarching societal goal of an SSB tax is to maximize social welfare, a comprehensive measure

of wellbeing used by economists (24,26). Increased social welfare would stem from economic, social, and information improvements that occur as a result of an SSB excise tax (48,64).

Figure 1: Objectives of SSB taxes (adapted from (48)).



Gray boxes indicate objectives and blue boxes indicate outcomes.

Governments can opt to tax only SSBs or all sweetened beverages (both naturally- and artificially-sweetened) (65). The objectives of the tax (i.e., whether for revenue generation, public health, or both), will influence what drinks will be subject to taxation (33,35,66). Ideally, a government would tax beverages with any added caloric sweeteners, including soft drinks,

sports drinks, fruit drinks, energy drinks, sweetened teas and coffees, and syrups and powders used to make sweetened beverages (32).

Three options for taxation of SSB include excise taxes, sales tax, and commercial production taxes (33,65). Based on experience from tobacco taxes, an excise tax would be the most effective for SSB taxation since the tax is reflected in increased shelf prices that the consumer sees, as opposed to a sales tax (28). An excise tax is applied before the point of purchase, so that the customer pays the tax in the form of an increased shelf price (65). An excise tax can either be specific (e.g., 1 cent per ounce) or *ad valorem* (e.g., 20% of the price) (65). Because excise taxes are collected prior to the distribution process, they are easier to implement and have lower administrative costs and less tax evasion (65). Additionally, an SSB excise tax is advantageous since excise taxes are easier to administer than other types of taxation, do not fluctuate with product price changes, produce stable revenue, and reduce product consumption if high enough (33,65). A potential disadvantage of an SSB excise tax is the need to regularly increase the tax with inflation (65).

Current SSB excise taxes

As of 2019, SSB taxes have been implemented in 42 jurisdictions worldwide, and 8 jurisdictions within the United States (Albany, California; Berkeley, California; Boulder, Colorado; Navajo Nation; Oakland, California; Philadelphia, Pennsylvania; San Francisco, California; and Seattle, Washington) (61).

Table 2: SSB taxes in cities in the United States

<i>Location</i>	<i>Date Implemented</i>	<i>Tax rate (cents per ounce)</i>	<i>Notes</i>
Albany, California	April 2017	1	Exempts milk-based drinks, 100% fruit juice, beverages distributed from retailers with revenue

			<\$100,000 USD per annum
Berkeley, California	March 2015	1	Exempts meal-replacement and dairy drinks, diet sodas, fruit juice, and alcoholic beverages
Boulder, Colorado	July 2017	2	Exempts milk-based drinks and 100% fruit juice
Navajo Nation	April 2015	2% tax on junk food	Includes SSBs
Oakland, California	July 2017	1	Exempts milk-based drinks, 100% fruit juice, beverages distributed from retailers with revenue <\$100,000 USD per annum
Philadelphia	January 2017	1.5	Includes diet soda, exempts milk-based drinks and 100% fruit juice
San Francisco, California	January 2018	1	Includes syrup and powder concentrates; exempts milk-based drinks, 100% fruit juice, artificially sweetened beverages, and alcoholic beverages
Cook County, Illinois	Implemented August 2017, repealed October 2017	1	Included artificially-sweetened drinks.

This table is based on data from the Global Food Research Program (61).

In addition to these eight U.S. jurisdictions with SSB taxes, 23 states and the District of Columbia do not categorize SSB as groceries and tax them at a higher rate (67).

Table 3: SSB taxes globally

<i>Europe</i>	<i>Western Pacific</i>	<i>Africa, Mediterranean, and Southeast Asia</i>	<i>Americas</i>
Belgium (2016)	Brunei (2017)	Bahrain (2017)	Barbados (2015)
Catalonia, Spain (2017)	Cook Islands (2013)	India (2017)	Bermuda (2018)

Finland (Implemented 1940, updated 2011)	Fiji (Implemented 2007, updated 2017)	Malaysia (2019)	Chile (2014)
France (2012)	French Polynesia (2002)	Maldives (2017)	Colombia (2019)
Hungary (2011)	Kiribati (2014)	Mauritius (implemented 2013, updated 2016)	Dominica (2015)
Ireland (2018)	Nauru (2007)	Morocco (2019)	Mexico (2014)
Latvia (Implemented 2004, increased 2016)	Palau (2003)	Qatar (2019)	Panama (passed 2019)
Norway (1981)	Philippines (2018)	Saudi Arabia (2019)	Peru (2018)
Portugal (2017)	Samoa (1984)	South Africa (2018)	
St. Helena (2014)	Tonga (2013)	Sri Lanka (2017)	
United Kingdom (2018)	Vanuatu (2015)	Thailand (2017)	
		United Arab Emirates (2017)	

The year of implementation is in parentheses. This table is based on data from the Global Food Research Program (61).

At a recent WHO Technical Meeting, representatives from several countries, including Finland, France, Hungary, Mauritius, Mexico, and the Philippines, shared their country's experience with implementation of SSB excise taxes (28). Generally, when countries have implemented SSB taxes, the focus has been on economic benefits rather than public health gains (28). Within Europe, excise taxes have generally been well accepted and have achieved their intended goals (28). Finland's excise tax on sugar-sweetened non-alcoholic beverages implemented in 2011 had the primary goal to generate revenue, along with an acknowledged potential benefit for public health (28). Anecdotally, the tax has led to a decrease in sales and consumption of taxed beverages, and as a result, has raised concern among the food and beverage industry (28). France's SSB tax has been met with little opposition and has raised a substantial amount of revenue (e.g., €300 million in 2014), which has been allocated to the National Social Health Insurance (28). Hungary implemented a tax on products containing sugar, salt, or methylxanthine implemented with goals for revenue and public health, which have been

monitored since implementation (28). The Hungarian National Institute for Health and Development has reported beneficial effects, including decreased SSB consumption, increased consumer awareness, and product reformulation (28).

In North America, Mexico is the only country to have implemented a national SSB tax (61). In response to a high prevalence of obesity and diabetes, Mexico implemented a national SSB tax of 1 peso per liter with the aim of mitigating the effects of SSB on the country's health (28). Successful passage and implementation of the tax came from public health evidence, strategic advocacy and information campaigns by a broad-based coalition, and conveying a sense of urgency about the high prevalence of obesity and diabetes in Mexico (28,68).

Similar public health concerns in the Philippines prompted a politician and an advocate to introduce and pass a bill for an SSB tax (28). Like other SSB taxes, the two main aims were to reduce consumption in order to reduce the prevalence of noncommunicable diseases and to generate revenue that could be allocated to new government initiatives (28). Three key factors in successful passage of the tax were visible government support, a simple policy to reduce opportunities for tax evasion, and an emphasis on both health and non-health benefits of the tax (69). Understanding the political context was important; for example, reducing SSB consumption in order to prevent obesity was not a compelling argument for Filipino politicians, while preventing dental caries garnered more support (69).

Within the United States, California has been a leader in SSB taxes, with four cities having implemented an SSB tax as of 2019 (28,61). Berkeley, California passed the first SSB tax in the United States in March 2015 (61). Philadelphia, Pennsylvania was the next major city in the United States to pass an SSB tax in January 2017 (61). Philadelphia's SSB tax was unique in that it framed the tax as an opportunity to generate revenue to provide needed public services in

the city rather than a strictly public health intervention (70). Mayor Jim Kenney was a key advocate of the tax and presented the transparent earmarking of potential revenue from an SSB for universal pre-kindergarten, health and social services in schools, and improvements to public parks, recreation centers, and libraries (70,71). His approach differed from the two prior attempts to pass an SSB tax in the city, which had framed the tax as an opportunity to improve public health and address a budget deficit, and had failed (70,71).

Effect of SSB excise taxes on prices

The change in SSB price to customers as a result of an excise tax, also referred to the pass-through of the tax, depends on the response of manufacturers and retailers to a tax, and may vary among jurisdictions (8,24). Berkeley's SSB tax has been found to have various degrees of pass-through. Three months after the implementation of an SSB tax in Berkeley, 69% of the tax was passed through to higher soda prices and 47% to SSB prices overall (72). Another study found an average pass-through of 43.1% three months after the implementation of the tax (73). One year after implementation, SSB prices rose in most retail settings in Berkeley with 67% pass-through of the tax across all settings (74). However, one study estimated the pass-through of the Berkeley tax to be only 24.4% for all SSBs (75). In another study, pass-through ranged from 18-25% in supermarkets and was not significant in pharmacies (76).

Pass-through has been examined in Boulder and Philadelphia as well. In Boulder, the pass-through of the SSB tax was 79% for all SSB (77). In Philadelphia, pass-through of the SSB tax was found to be 55% two months after the tax was implemented (78). In another study examining prices 12 months after tax implementation, there was 100% pass-through of the tax to consumers in Philadelphia (79). Similar to the case in Berkeley, a recent study found that the

pass-through varied with retailer with the highest pass-through seen in pharmacies (104%) and the lowest pass-through in chain supermarkets (43.1%) (80).

Internationally, pass-through of SSB taxes varies substantially. France implemented their 11 euro cent per 1.5 liter SSB tax in 2012, which was estimated to be fully passed through for sodas and less so for other SSB (81). However, another study estimated an overall pass-through of 40% for SSB (82). The Catalonian SSB tax required a 100% pass-through of the tax to consumers (83). The effect of the SSB excise tax in Mexico is difficult to isolate since the country implemented multiple interventions simultaneously (24). That being said, two studies found price increases for soda and less pass-through for non-carbonated SSB (84,85).

Table 4: Pass-through of implemented SSB taxes

Jurisdiction	Pass-through	Data Source
Berkeley, California	47%	Primary data (72)
	43.1%	Primary data (73)
	67%	Secondary scanner data from retailers (74)
	24.4%	Secondary scanner data from retailers (75)
	18%-25% in supermarket chains	Secondary scanner data from retailers (76)
Boulder, Colorado	79%	Primary data (77)
Philadelphia, Pennsylvania	55%	Primary data (78)
	100%	Primary data (79)
	43.1% in supermarkets, 57.8% in merchandise stores, and 104% in pharmacies	Secondary scanner data (80)
Mexico	Varied by region; on average close to 1 peso per liter. Greater pass-through for soda	Primary data (84)
	Soda price increase of 12-14%, no significant change for other beverages	Primary data (85)
France	100% for sodas	Secondary data (81)
	40% for all SSB	Secondary scanner data from retailers (82)
Catalonia, Spain	100%	Required by law (83)

Effect on SSB excise taxes on purchases and cross-border shopping

Changes in purchasing depends both upon own-price elasticity and cross-price elasticity (8). Own-price elasticity refers to how much an individual decreases purchases based on a price increase and cross-price elasticity refers to what other beverages an individual will purchase in response to an increase in SSB price (8). The own-price elasticity of SSB has been shown to range from -1 to -1.26, indicating a decrease in purchases in response to a price increase (8,47,86). In addition, price elasticity is higher among low-income individuals, signifying that their consumption will decrease greater in response to a price increase (28,87).

Cross-price elasticity varies depending on the substituting or complementing beverage (8,24). Generally, the narrower the tax, the more likely an unhealthy substitution will occur and substitutions can occur with either other beverages or non-beverage food items (24,88). Bottled water has a cross-price elasticity of 0.75, making it a strong substitute for SSB, while milk was a weak substitute with a cross-price elasticity of 0.2 (8). Diet drinks have been shown to be complementary, and a cross-price elasticity of -0.46 was found, indicating that a higher price for SSB would result in a drop of diet beverage purchases (8).

Several studies have examined the effect of SSB taxes on purchases. In Berkeley, studies using retail scanner data found a decreases in purchases ranging from 7 to 12% (74,76). One study found no significant decrease in sales (75). In Philadelphia, a survey of shoppers leaving stores found that after implementation of the SSB tax, shoppers purchased 8.9 fewer ounces of taxed beverages per shopping trip (79). Another study found a total volume decrease of taxed beverage sales of 51.0% (80). In Mexico, the SSB tax resulted in a decrease ranging from 6.1% to 7.3% (89,90). In Catalonia, Spain, the SSB excise tax led to a 22% decrease in sales of taxed

beverages in a supermarket chain (83). France’s tax resulted in a 6.7% decrease in demand for regular soft drinks during the first two years (91).

In addition, the effect of SSB taxes on purchases depends on the ease of cross-border shopping (24). In the example of a local SSB excise tax, an individual could easily go outside of the taxed jurisdiction to purchase taxed beverages (24). The effect of cross-border shopping can be assessed by searching for geographic variation in the pass-through of the tax, and there may be higher pass-through of the tax in stores further from the border (24). In Berkeley and Philadelphia, this variation was seen (73,79). However, that pattern was not seen in Boulder (77). In a survey of Berkeley residents, 2% of respondents reported buying SSB outside of the city as a result of the excise tax (92). Another study examining a supermarket close to the Berkeley city limits found that roughly 50% of the decrease in sales of SSB within Berkeley were transferred to outside the city (76). Similarly, in zip codes bordering Philadelphia, there was an increase in SSB sales, which offset 24.4% of the sales decrease within Philadelphia (80).

Table 5: Change in purchases after implementation of SSB taxes

Jurisdiction	Change in purchases	Data Source
Berkeley, California	7-12% decrease in SSB sales at supermarket chains	Secondary scanner data (76)
	No decrease	Secondary scanner data (75)
	9.6% decrease	Secondary scanner data (74)
Philadelphia, Pennsylvania	8.9-ounce purchase decrease per store trip	Individual purchase data (79)
	51% decrease in volume sales (offset by cross-border shopping of 24.4% increase)	Sales data (80)
Mexico	6.1% decrease	Household purchase data (89)
	7.3% decrease in per capita SSB sales	Manufacturer data (90)
Catalonia, Spain	22% decrease in supermarket chains	Sales data (83)

Effect of SSB excise tax on consumption

In order to have a meaningful impact on SSB consumption, an SSB excise tax of at least 20% is needed (28,33). As a point of reference, in the United States, a one cent per ounce tax on SSBs would raise the price of a 20 ounce soda by 15-20% (59).

Observational data examining the impact of the Berkeley SSB tax show mixed effects on SSB consumption. In a study examining SSB consumption in low-income neighborhoods of Berkeley four months after implementation of the tax, consumption of SSB was found to have decreased by 21% in Berkeley and to have increased by 4% in comparison cities (Oakland and San Francisco, California) (92). During that time period, water consumption was found to have increased by 63% in Berkeley compared to an increase of 19% in comparison cities (92). However, in another study examining changes after one year after the implementation of the SSB tax in Berkeley, there was no significant reduction in self-reported mean daily SSB when comparing baseline to post-tax (74). Finally, in a study examining changes in SSB consumption 3 years after implementation of the Berkeley tax, there was a significant decrease of consumption of SSBs by 0.55 times per day in diverse Berkeley neighborhoods compared to comparison city neighborhoods (93). There is limited data on Philadelphia's recently implemented 1.5 cent per ounce tax on SSB and diet beverages, but the tax has resulted in a 40% lower odds of consuming regular soda and a 58% higher odds of consuming water for city residents (94).

Models of a one cent per ounce federal SSB tax generally estimate decreased consumption. One model estimating the impact of a penny per ounce federal SSB tax predicted a 24% reduction in SSB consumption (58). When considering a hypothetical 20% SSB federal excise tax in the United States, another model estimated a net calorie reduction of 37 calories

from beverages per day among adults and a reduction of 43 calories per day for children (8). However, substitutions can mitigate the potential effectiveness of an SSB tax, and when considering the possibility of substitution to non-beverage food items, one study estimated a daily decrease of 24.3 calories for adults (88,95).

Health outcomes of an SSB excise tax

No observational data exists to assess the effects of SSB taxes on health outcomes, including obesity, type 2 diabetes, and cardiovascular disease. However, SSB have been modeled to decrease overweight and obesity prevalence in several lower middle and upper middle income countries including Colombia (96), India (97), Mexico (98), South Africa (99). A systematic review that identified nine studies from Brazil, Ecuador, India, Mexico, Peru, and South Africa found that taxing SSB increases their prices, which is modeled to reduce net energy intake to stabilize obesity prevalence but does not result in enough of a reduction of consumption to reduce obesity prevalence (100). Models have shown that SSB would decrease the prevalence of type 2 diabetes in India (97), South Africa (101), and Mexico (98,102). Finally, models have shown a predicted benefit for reducing cardiovascular disease in South Africa (103) and Mexico (102).

Models have estimated the effect of an SSB tax implemented at different levels of government in the United States. At the local level, a model estimating the effects of an SSB tax in New York City predicted that decreased consumption of SSB would result in 0.46 kilogram weight loss per person in the first year and 0.92 kilograms by year 10, with a non-significant decrease in the prevalence of obesity in the city (104). At the state level, a simulation of the effects of a 10-20% reduction in SSB consumption as a result of a 1 cent per ounce SSB excise tax in California predicted a decrease in 1.8-3.4% in incidence of diabetes, a decline of 0.5-1% in

incidence of coronary heart disease, and a 0.5-0.9% drop in myocardial infarctions (46). At the federal level, a 20% price increase of SSB as a result of an excise tax would result in a decrease in the prevalence of overweight among adults by 4.5% and a decrease in the prevalence of obesity among adults by 3% (8). Among children, the overweight prevalence would decrease by 2.9% and the at-risk-of-overweight prevalence would drop by 5.3% (8).

Models have yielded similar results for European countries and Australia. The UK tax is estimated to have a notable benefit for obesity among youth younger than 18 years and for diabetes incidence among individuals older than 65 years (105). A model of a 20% SSB excise tax in the UK estimated fewer cases of diabetes, cardiovascular disease, and cancer, and a reduction in the prevalence of obesity, with a particular benefit for younger populations (105,106). Similarly, models of the effects of a 20% SSB excise tax in Germany predict a decrease in the prevalence of overweight and obesity, with the greatest benefit for individuals between the ages of 20 and 29 (107). Health benefits, including decreased prevalence of type 2 diabetes and cardiovascular disease, have been modeled for Australia (108). Finally, models of the effect of a proposed 10% SSB excise tax in Ireland predict modest decreases in overweight and obesity, mostly among adults 18-24 years of age (109).

Overall benefits and harms of a federal SSB tax in the United States

A primary objective is to improve population health, and based on a systematic review examining the impact of an SSB tax based on an individual's socio-economic position, there would be either similar benefits across socio-economic strata or greater benefits for lower SEP compared to higher SEP groups (51). In addition, multiple studies have predicted greater health benefits for low-income individuals and racial/ethnic minorities (26,33,46,50,60).

A federal SSB excise tax is expected to be financially regressive (24,26,50,51). Based on National Health and Nutrition Examination Survey (NHANES) data from 2009-2016, Americans consume 154 calories per day from sugar-sweetened beverages on average (26). In addition, SSB consumption varies by income; individuals with a household income below \$25,000 annually consume 200 calories per day of SSB compared to individuals with a household income above \$75,000 annually consume 117 calories (26). Therefore, a federal excise tax on SSB will affect lower-income individuals to a greater degree (26). Similarly, in a study examining the effect of an SSB tax in the UK, there was a greater percentage of low-income households among the high SSB consumption group, and that group spent a larger proportion of their money on SSB, increasing the regressive nature of the tax (110). The financially regressive nature of an SSB excise tax can be mitigated with progressive revenue recycling in which tax revenue is earmarked for public programs (e.g., universal pre-kindergarten programs in Philadelphia) (26,71).

Despite enthusiasm for the opportunity to improve health equity with an SSB tax, concerns have been raised about the potential harms of an SSB tax on vulnerable populations (111). Tobacco taxation has been used as an example of the potential benefits of SSB taxation, but tobacco taxation has not led to equitable distribution of benefits (111). For example, tobacco taxation led to greater decreases in smoking among higher socioeconomic status individuals compared to lower socioeconomic status individuals, which has resulted in widened disparities in the prevalence of smoking and the health consequences of smoking (111). Similarly, SSB taxes could increase disparities related to the harms of excess SSB consumption if more advantaged individuals derive greater benefits from decreased SSB consumption (111,112). Additionally,

SSB taxes could further stigmatize obesity, which may disproportionately affect vulnerable populations (111).

Substitution of other unhealthy beverages for SSBs is another potential unintended consequence. While SSB taxes would reduce consumption of SSB beverages like regular sodas and fruit drinks, some of that consumption will be substituted with an increased consumption of fruit juices, low-fat milk, coffee, and tea (113). Therefore, the decrease in caloric intake from SSB will be tempered to some degree by an increased consumption of fruit juices (113). In addition, in an experimental study, researchers found increased substitution for alcoholic beverages in alcohol consuming households as a result of a 10% SSB excise tax (114).

Feasibility

A federal SSB excise tax is expected to be feasible both legally and administratively (115). However, the likelihood of successfully passing a tax at this time is unlikely and previously introduced legislation at the state and federal level have failed to pass (62,115,116). Several contributing factors include tax structure in the United States, framing of the issue, and stakeholder opposition (40,116).

The United States has a high degree of fiscal decentralization and 33.7% of total tax revenue comes from sub-central government tax revenue (116). In fact, the only two countries to have passed SSB taxes at the sub-central government level are Spain and the United States, both countries with a higher degree of fiscal decentralization (116). In addition, the United States tends to impose consumption taxes and retail sales tax at the local and state government level (116).

In the United States, the framing of an SSB tax tends to focus on public health benefits and what can be done with additional tax revenue and has become a partisan issue (63,116–118).

A pro-tax public health argument has been shown to be a weak argument on its own (63). In addition, calling out the actions of “Big Soda” garners support among Democrats, but is likely to be ineffective for Republicans (63). Among adults in a mid-Atlantic state, the most persuasive message among respondents was on the goal of a tax to reduce SSB consumption among children (118). The most effective message is the relationship between SSB consumption and health and the opportunity to use tax revenue for health programs and interventions (119). Finally, determining how tax revenues will be allocated can affect public support for SSB taxes (33,35). Allocating tax revenue in a progressive manner (e.g., universal pre-kindergarten) can mitigate the concern of some policymakers regarding the financially regressive nature of an SSB excise tax (33,35,71).

Stakeholders and opposition

Key stakeholders include consumers and the beverage industry (33). Among the public, perception of a potential SSB taxes is generally unfavorable. A 2011 national public opinion survey found that there was greater opposition than support for SSB taxes (120). Similarly, in a 2012 survey in the United States, only 36% of respondents supported a potential SSB tax (121). Among respondents to a telephone survey of adults in Kansas, 40% supported a potential SSB tax, with greater support among women, younger individuals, and liberals (117). A slightly higher percentage (50%) of adult respondents to a telephone survey in a mid-Atlantic state supported a potential penny per ounce SSB tax (118). Democrats were more supportive of the potential SSB tax as well (118). Despite lukewarm reception of an SSB tax, news coverage of SSB taxes in the United States includes more pro-tax than anti-tax arguments (122).

Common opposition arguments include concern that an SSB excise tax would harm businesses and lead to a loss of jobs (119,122). The fiscally regressive nature of the tax is also

brought up as a concern by those who oppose the tax and by advocates who express concern that it will further harm low-income individuals (119). Some opposition state that the tax will not result in the intended goal of reduced consumption and improved health (119). The beverage industry has attempted to cast doubt on the scientific evidence of the harms of excess sugar intake (123). Specifically, they have sought to link obesity with lack of physical activity rather than excess calorie intake (123). For instance, a 2011 report from Coca-Cola described 45 studies that highlight excess calories from food as a causative factor in development of obesity (119). Finally, some opposition raises concern of an overly paternalistic government (119,122).

Table 6: Common arguments against SSB taxes

Opposing arguments
SSBs do not contribute a significant amount of calories to the average diet (44)
The focus on SSB is unjustified and arbitrary (40,44)
There is little support for an SSB tax (44)
An SSB tax is regressive and will harm the poor the most (40,44)
An SSB tax will hurt small businesses and cause job losses (40,44)
The beverage industry will be part of the solution by promoting physical activity (44,123)
Regulations like SSB represent a limitation on individual autonomy (40)

Coinciding with SSB tax proposals, SSB manufacturers have offered charitable donations to cities or non-profits to garner support; for example, the soft drink industry pledged to donate \$10 million to the Children’s Hospital of Philadelphia if the city council did not pass the SSB tax being considered at the time (123). Similarly, Coca-Cola donated \$3 million for fitness programs in Chicago when an SSB tax was proposed in the city (123). Finally, the beverage industry often

creates well-funded anti-tax campaigns to combat SSB taxes (123). From 2011 to 2015, the beverage industry spent substantial sums of money opposing SSB taxes; Coca-Cola spent \$6 million per year, PepsiCo spent \$3 million per year, and the American Beverage Association spent \$1 million per year, and as a whole, greatly outspent tax proponents (123). Large amounts are spent in individual cities and the American Beverage Association spent more than \$9 million in Philadelphia alone opposing an SSB tax (44). Their efforts consisted of anti-tax advertising, political lobbying, and forming alliances with other businesses that may be affected by SSB taxes (44).

Other considerations

Another consideration is the effect of an SSB tax on the use of the Supplemental Nutrition Assistance Program (SNAP) benefits (124). Typically, recipients of SNAP do not pay state or local sales tax on food and beverage purchases made with SNAP benefits (124). The United States Department of Agriculture prohibits taxation of items purchased with SNAP benefits in order to preserve food purchasing power (124). However, based on a regulatory analysis, those regulations do not apply to potential SSB excise taxes since those taxes are administered prior to reaching the consumer (124).

Economic and budgetary impacts

Costs to administer a federal SSB tax in the United States arise from government administration, compliance time costs, field audits, a tax certification system operating cost, salaries for Department of Revenue Officers, salaries for Industry Auditors, and beverage industry compliance costs (52,125). The cost to implement a sugar-sweetened beverage tax nationally is estimated to be between \$47.6 million to \$51 million in the first year and with a 10 year intervention cost of \$430 million (39,52).

Benefits from a budgetary perspective include increased tax revenue and reduced health care expenditures (52,125,126). Models of a national 1 cent per ounce SSB tax have estimated tax revenue of \$79 billion over a 5 year period (58). Other estimates from a 0.5 cent per ounce SSB federal excise tax predict revenue of \$5.8 billion per year (127). Another study estimating a federal penny per ounce federal excise tax predicted tax revenue of \$13 billion in annual tax revenue (126). A smaller tax of 3 cents per 12 ounces of SSB was estimated to generate \$50 billion in revenue over a 10 year period (128).

Total health care costs are estimated to be substantially reduced as a result of a federal SSB tax and a 1 cent per ounce federal excise tax is predicted to be cost-effective (39,52,125,126). Specific estimates include \$17.1 billion health care cost savings over 10 years for adults 25-64 years old (126). Another model predicts \$23.6 billion cost savings for individuals 2 years and older over 10 years (52). In a model specifically examining cardiovascular disease costs, \$45 billion cost savings over the course of 65 years are predicted for adults aged 35 to 85 years old (125). That same model estimated total savings of \$106.56 billion for the U.S. government over that time frame (125). In the study examining the benefits for the U.S. population 2 years and older, 101,000 disability adjusted life years (DALY) are averted and 871,000 quality adjusted life years are gained (52). One study examined the incremental cost effectiveness ratio (ICER) from the perspective of various stakeholder groups and all ICERs were calculated to be less than the \$50,000 per quality-adjusted life year (QALY) willingness to pay threshold set by the American College of Cardiology and American Heart Association (125,129).

Table 7: Estimated costs and benefits of SSB taxes

<i>Proposed tax</i>	<i>Key assumptions</i>	<i>Annual tax revenue</i>	<i>Health care cost savings</i>	<i>Cost to implement</i>	<i>Additional notes</i>
1 cent per ounce federal excise tax (126)	15% reduction in SSB consumption	\$13 billion	\$17.1 billion for adults 25-64 over 10 years	Not described	
1 cent per ounce federal excise tax (52)	16% increase in SSB prices, with own-price elasticities used for several age groups	\$12.5 billion	\$23.6 billion for U.S. population \geq 2 years old over 10 years	\$51 million in the first year, \$430 million over 10 years	101,000 DALY averted, 871,000 QALY gained
1 cent per ounce federal excise tax (125)	Modeled 100% pass-through (16.9% price increase) and 50% pass-through (8.5% increase)	\$91.9 billion over 65 years	Assuming 100% pass-through, \$45 billion savings in treatment of cardiovascular disease over the lifetime of adults 35-85 years old	Implementation costs of \$1.85 billion (combined cost of government tax collection and beverage industry compliance costs) over 65 years	Incremental cost effectiveness ratio less than \$50,000 per QALY saved for all consumer groups
1 cent per ounce federal excise tax (39)		\$12.5 billion annually	\$14.169 billion net cost savings in obesity related costs	\$47.6 million per year	

Other economic effects

A federal SSB excise tax of 1 cent per ounce would affect several sectors (125).

Excluding the beverage industry, the private sector could expect cost savings of \$15.6 billion in health care costs related to cardiovascular disease over the course of 65 years assuming 100% pass-through of the tax (125). The beverage industry could expect lifetime costs of \$970 million, for tax compliance, assuming 100% pass-through, and \$48.74 billion assuming 50% pass-

through (due to absorbing the excess cost of the tax) (125). Finally, an SSB tax is unlikely to cause job losses as argued by the beverage industry (33,40,44,60). Generally, excise taxes cause job losses in the taxed industry, which are often offset by job creation in other industries (60). For instance, a macroeconomic simulation model predicted a net job increase in California and Illinois if those states implemented a 20% SSB tax (130).

Limitations and gaps in the data/evidence base

Major limitations of these modeling studies is that they rely on a set of assumptions and do not include industry response to SSB excise taxes, which will affect the potential health benefits of a tax (8,33,131). There is a lack of observational data on the effect of SSB taxes on weight and other health outcomes (28). Smaller soda taxes in the past have not substantially improved health and recently passed or proposed large SSB taxes likely overestimate potential effects due to inaccurate assumptions (132). In addition, studies may assume a static 3,500 calorie per pound, which overestimates weight loss since calorie reduction results in a dynamic weight loss pattern (127). Additional research is needed to better understand the response of manufacturers and retailers to the tax, cross-price elasticities and product substitution behavior of consumers, and the long-term effect of SSB taxes on health outcomes including obesity and diabetes (24). Additional evidence is needed to understand in how consumers will respond to an excise tax in the restaurant market (8). Finally, additional data on the macroeconomic effects of SSB taxes, such as their effect on jobs, is needed (35).

Considerations for optimal SSB tax design

An SSB tax is an initial step to reduce the prevalence of obesity and associated chronic diseases including type 2 diabetes and cardiovascular disease in the United States (59). Observational data and models suggest modest benefits of an SSB tax, and, on their own, will be

of limited effect on obesity and other health outcomes (47–49). Therefore, an SSB tax should be combined with other interventions to inform consumers that SSBs are unhealthy products, to reduce excess sugar consumption, to improve diet quality (33,59). Revenue generated from a federal SSB tax could be used to fund new public health and social programs (59).

There are several considerations for the optimal design of a federal SSB excise tax. First, taxes implemented in the U.S. have been taxed per ounce of beverage; however, a calorie-based excise tax is likely to be more effective than an ounce-based excise tax since it will result in a greater reduction in caloric intake by consumers (26,133). An ingredient tax on grams of sugar added to the beverage also highlights the harm of consuming excessive amounts of sugar (60). Lastly, a calorie-based excise tax incentivizes manufacturers to reformulate products with less sugar (133). However, a sugar-based tax may create administrative challenges that limit the feasibility of implementation (60).

The size of the tax should be enough to raise prices of SSB by at least 20%, as recommended by the WHO (28). Since the higher shelf price caused by excise taxes reduces consumption, governments like that of Catalonia, Spain have required a certain amount of pass-through (24,83). A minimum price clause in SSB excise tax legislation may be worth including in a potential federal SSB tax in the United States (134). Similarly, it may be beneficial to include a clause prohibiting discounting of SSB by manufacturers (134). Regardless of the details of the tax, a component should include regular increases to match inflation so that the tax maintains relevancy (60).

In conclusion, a federal SSB excise tax could potentially be passed with careful framing of the issue, reduce the health harms of SSB consumption, and generate additional revenue to fund other public health programs (8,26,119). A federal SSB tax would likely result in modest

health benefits and while not being a panacea for obesity and other chronic disease, could support other interventions through progressive revenue recycling (26).

How this capstone addresses competencies I want to strengthen

In my MPH Goals Analysis, I set the goal of learning more about health policy and the design of effective policy. I chose to do a policy analysis for my capstone project in order to strengthen my ability to analyze and design policy. By completing this project, I am more confident in several competencies, including collecting, analyzing, and synthesizing information about policy formulation and recognizing key stakeholders for health policy.

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