

# MAKING A DENT IN THE OBESITY EQUATION VIA COUPLING SUGAR-SWEETENED BEVERAGE TAXES WITH FRUIT AND VEGETABLE SUBSIDIES

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## \* ABSTRACT

Obesity rates continue to rise in children and adults alike in the United States and represent a significant threat to public health and economic well-being. Many factors have contributed to the obesity equation, including the widespread availability and appeal of ultra-processed food and drink. Sugar-sweetened beverages (SSBs) represent one such drink, as a critical examination of the available evidence reveals a clear link between their consumption and increased risks of obesity and related conditions such as type 2 diabetes. Taxing SSB purchases therefore presents a potentially valuable means of making a dent in the contribution of one key risk factor to the obesity equation, though the beverage industry has fought against the enactment of these taxes and has instead promoted a generally unclear public health stance on SSBs. This paper explores existing SSB excise taxes that have been implemented in recent years, focusing especially on Philadelphia's tax as a case study for examining the behavioral changes associated with SSB taxes and the management of SSB tax revenue. It then suggests that SSB tax revenue be directly funneled into the subsidization of fruits and vegetables to maximize the obesity-fighting potential of these relatively novel excise taxes.

## 1 INTRODUCTION

Since the late 1970s, obesity has been steadily rising in the United States (Office of the Surgeon General, 2010; Dixon, 2020), with its prevalence reaching 42.4% among adults ages 20 and over from 2017-2018 (CDC<sup>3</sup>, 2022). Even amongst American children, 1 in 5 were obese as of 2018 (CDC, 2022). Obesity is a significant risk factor for a multitude of chronic health conditions, including type 2 diabetes, coronary heart disease, hypertension, high LDL cholesterol, low HDL cholesterol, dyslipidemia, gallbladder disease, and osteoarthritis (CDC<sup>1</sup>, 2022; Must et al., 1999). These chronic health conditions reduce the quality of life of millions of Americans and present an enormous economic burden, amounting to nearly \$173 billion annually in obesity-related medical costs (Ward et. al., 2021). Additional economic costs stem from the lost productivity associated with overweight and obese status (CDC<sup>1</sup>, 2022), though such costs pale in comparison to the medical costs of obesity.

Given the enormous cost of obesity to both the economic vitality and public health of America, addressing its complex causes is of paramount importance. Factors such as increasingly sedentary jobs and lifestyles, low levels of intentional physical activity, and the wide availability and popularity of calorie-dense, ultra-processed foods have been linked most consistently to obesity (Hruby & Hu, 2015; Dixon, 2020). Nonetheless, numerous other more biologically and socially complex factors — such as exposure to obesogenic endocrine-disrupting chemicals, sleep quantity and quality, psychological conditions, poverty, poor education, lack of access to healthy food, and genetics — also play a role (Hruby & Hu, 2015; Dixon, 2020). This overwhelming number of factors that cumulatively contribute to the overall risk and prevalence of obesity, forming the so-called “obesity equation,” as I call it, necessitates that the issue be addressed from multiple angles. Figure 1 depicts the multifactorial nature of obesity.



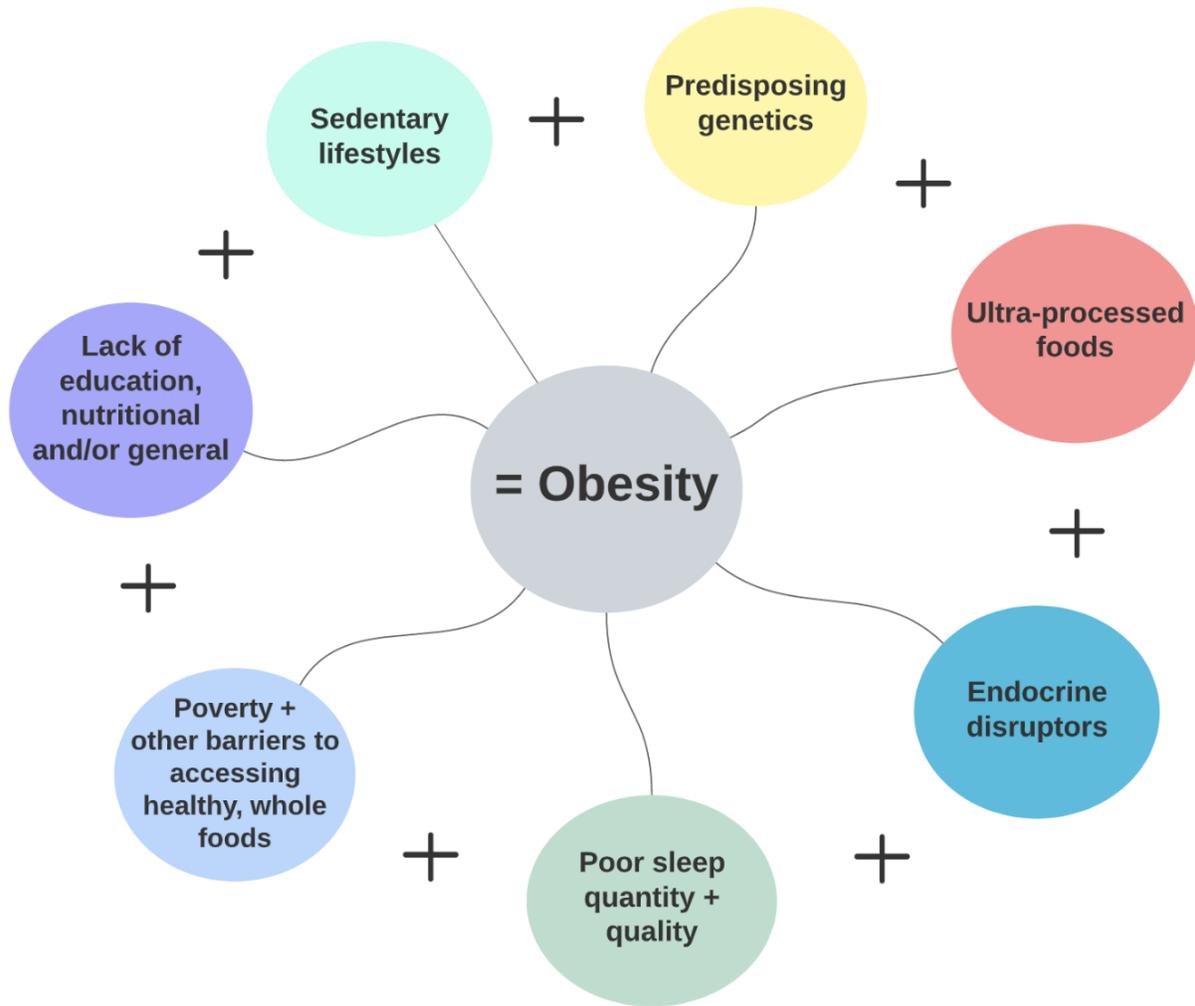


FIGURE 1: Several diverse factors that contribute to the "obesity equation".

In the sections of this exploratory synthesis paper that follow, I address one such angle whereby the obesity problem can be intercepted: the consumption of sugar-sweetened beverages (SSBs). First, I delineate the evidence linking consumption of SSBs to obesity and related chronic conditions. I subsequently discuss in the context of SSBs the use of excise taxes, or taxes waged at the distributor-end on specific goods and activities that tend to discourage purchases by resulting in higher prices at the consumer-end (Chaloupka et al., 2019), as a tactic to help make a dent in the obesity equation in the United States. Laced throughout is a discussion of

the soda industry's role in promoting increased SSB consumption and opposing public health initiatives to implement SSB excise taxes, despite strong evidence for the negative health effects of SSBs. Finally, I propose that revenue from existing SSB excise taxes such as Philadelphia's be funneled into initiatives that further fight obesity to maximize their public health efficacy and I highlight evidence of fruit and vegetable subsidization as one potentially suitable initiative.

## 2 SUGAR-SWEETENED BEVERAGES, OBESITY, AND RELATED CHRONIC DISEASE: THE EVIDENCE

Sugar-sweetened beverages include any beverage sweetened with a form of added sugar, such as sucrose or high-fructose corn syrup, including regular soda, sports drinks, and fruit drinks (CDC, 2022). While SSBs represent only one of many determinants of obesity, prospective cohort studies have consistently linked increased consumption of SSBs to weight gain and long-term risk of obesity and related conditions like type 2 diabetes (Hu, 2013; Malik et al., 2013). Increases in SSB consumption in recent decades have also directly paralleled increases in obesity (Hu & Malik, 2010), further suggesting a likely link between the two trends. Though some trials are limited by small sample sizes and relatively short intervention periods, a handful of clinical trials have solidified a likely causal relationship between SSBs and obesity. These studies demonstrate that in children, reducing SSB intake slows weight gain, and in adults, SSB consumption can promote weight gain (Wolff and Dansinger, 2008; de Ruyter et al., 2012). Moreover, studies showing no such apparent SSB-obesity connection should be analyzed critically. For instance, in a clinical trial of 47 overweight subjects randomly assigned to drink 1L per day of regular soda, semi-skim milk with an equivalent number of calories to regular soda, aspartame-sweetened soda, or water for 6 months, Maersk et al. (2012) found no significant differences in the changes in body weight and fat mass between groups over a 6-month period. On a smaller scale, however, the group consuming regular soda had significantly higher increases in liver fat mass, visceral fat mass, muscle fat mass, plasma triglycerides, and total cholesterol compared to the other 3 groups, indicating that SSBs impair cardiometabolic health with uncertain implications on long-term health, including body weight.

The most common mechanism to explain the link between SSBs and obesity is that the consumption of liquid calories does not yield proportional caloric reductions in solid food intake (Malik,

2010), thus leading to excess calorie intake that promotes weight gain. Lending support to this theory, DiMaggio and Mattes (2000) performed a crossover study in 15 normal-weight adults and found that 4 weeks of dietary supplementation with 450 calories of regular soda led to an increase in total caloric consumption and BMI, yet no such changes were found when diets were supplemented with 450 calories of jellybeans. Moreover, research has shown that the oversized portions of sugary drinks sold at many fast food chains and other outlets such as movie theaters not only cause people to consume more than they would from a smaller portion even if they do not finish the entire beverage, but these larger portion sizes also lead individuals to underestimate the amount of sugary drinks they actually consume (Flood et al., 2006; Nestle et al., 2015). Perhaps people believe that they have not consumed in excess simply because there is still soda left in their cups; whatever the rationalization, such a lack of awareness of one's consumption of a calorically -dense beverage surely undermines individuals' efforts to control their weight and may contribute to the failure of the consumption of liquid calories to reduce consumption of solid food calories (Malik, 2010). Given that 12 oz. of the average SSB contains about 140-150 calories (Malik, 2010), relatively small increases in consumption can yield significant increases in caloric intake.

Beyond promoting the excess consumption of calories that may lead to weight gain and obesity, SSBs may pose more nuanced chronic disease risks due to their ability to promote visceral adiposity (Ma, 2016; Odegaard, 2012; Maersk et al., 2012) as well as the high glycemic load associated with their consumption (Hu & Malik, 2010). In a recent longitudinal cohort study with 1003 adults of mean age 45.3 years, Jiantao Ma and colleagues (2016) found that six years after initial biometric measurements were recorded, increasing SSB consumption frequency correlated with increasing visceral adipose tissue (VAT) volume, or fat accumulation around the abdominal organs. Notably, no such correlation was found between diet soda consumption and VAT volume (Ma, 2016). Interestingly, SSB consumers were more likely to be engaged in slightly more

physical activity than SSB-non-consumers, yet this nuance did not protect them from the BMI increases and VAT volume increases observed at the end of the six-year interval of time (Ma, 2016). The significantly higher increase in VAT mass found in the regular soda group in the aforementioned clinical trial by Maersk et al. (2012) further validates that SSBs induce a VAT phenotype. VAT cells are known to secrete a variety of the pro-inflammatory type of small cell-signaling proteins known as cytokines (Alexopoulos et al.; 2014, Alvehus et al., 2010; Ohman et al., 2009). Such cytokines may increase the risk of atherosclerosis and associated cardiac events, given that cardiac events are associated with increased circulating levels of inflammatory markers (Ohman et al., 2009). Proinflammatory cytokines are also capable of causing insulin resistance in adipose, muscle, and liver tissues due to their inhibitory effects on insulin signaling pathways (de Luca & Olefsky, 2008) which may explain reported associations between proinflammatory, cytokine-releasing VAT and type 2 diabetes (Hanley et al., 2009). Additionally, the high glycemic loads associated with SSB consumption—which reflect a high content of simple carbohydrates capable of quickly raising blood sugar in standard portion sizes—are further linked to rises in inflammatory markers (Cerf, 2013). These high glycemic loads are further associated with pancreatic beta cell dysfunction and insulin resistance, both of which are implicated in the pathogenesis of type 2 diabetes (Cerf, 2013; LeRoith, 2002).

Unfortunately, methodological issues often inhibit the confidence with which one can draw conclusions from the results of studies addressing a possible link between SSBs and obesity (Bucher Della Torre et al., 2016; Pereira, 2006). Such issues may accordingly explain why a complete consensus on the relationship between SSBs and obesity is lacking despite the large body of evidence that suggests a positive correlation. In a meta-analysis addressing the bias, generalizability, rigor of data analysis, and the conclusions drawn from 32 studies focused on SSBs and obesity in children and adolescents, Bucher Della Torre and colleagues (2016)

found that 23 of these studies had at least one methodological issue. These methodological issues most commonly reflected incomplete or confounded study definitions of SSBs, unreliable measurements of exposure, or participant loss before follow-up in cohort studies. While only 9 of the analyzed studies had no methodological issues, all studies reported either a positive correlation between SSBs and obesity or mixed results. On the other hand, the studies with methodological issues gave more inconsistent findings with some supporting the hypothesized link between SSBs and obesity, some reporting mixed results, and some finding no link at all.

Moreover, industry funding may also contribute to poor study quality. Following an analysis of 133 articles published between 2001 and 2013 on the health effects of SSBs, Litman and colleagues reported that 82% of independently funded articles found strong evidence that SSBs have adverse effects on health, whereas only 7% of industry-funded articles reached such a conclusion (2018). Industry-funded articles were more likely to report a weak or absent correlation between SSBs and adverse health effects, potentially owing to the non-experimental basis of most of the industry-funded studies, which allows more room for bias (Litman et al., 2018). Litman et al. acknowledge that no conclusions about the quality of any individual article included in the study can be drawn, as they did not analyze the scientific quality of the articles against any objective standards (2018). Nonetheless, the findings of Litman et al. (2018) and Bucher Della Torre et al. (2016) highlight the importance of scanning for elements of potential bias and carefully analyzing the methodology behind SSB studies before drawing conclusions, and further suggest that biases and flaws in the methodology of some past studies may understate the true contribution of SSBs to obesity and other adverse health effects.

Taken altogether, the consensus becomes quite clear: SSBs are not health-promoting but health-harming, contributing to obesity and related chronic diseases. Given the economic and quality of life costs of obesity-related health conditions, public health initiatives to reduce consumption of SSBs are of vital importance. Unfortunately, however, existing

initiatives aimed at reducing consumption have generally been weak. The following section explores a possible reason for the lack of strong anti-SSB action, briefly surveying the soda industry's monetary involvement in perpetuating SSB consumption.

### 3 THE SODA INDUSTRY'S LIKELY ROLE IN PROMOTING GROWTH IN SSB CONSUMPTION & UNCLEAR PUBLIC HEALTH STANCES

While the need to reduce SSB consumption to better protect against obesity and related health conditions is clear, industry opposition has made this reduction a challenging task. Indeed, SSB consumption has not increased independently of industry involvement. Coca-Cola, for instance, was originally sold in 6.5 oz. bottles, and in 1934, Pepsi-Cola made the first move in inflating portion sizes when it introduced a 12 oz. Pepsi for the same price of a nickel as its competitor's 6.5 oz. drink, inflating its profits in the process (Dough, 2006). Today, the minimum size soda can is 7.5 oz. and bottle sizes range up to 2 liters (Nestle et al., 2015). Moreover, the standard soda size sold at gas stations and in vending machines is approximately 20 oz. and while one must account for the lost soda volume due to the addition of ice in fountain drinks, even a kid-size soda from a fast-food restaurant is twelve ounces (Nestle et al., 2015). Citing nationwide surveys of the portions of food Americans consume as justification for the change, the U.S. Food and Drug Administration even raised its soda serving size from 8 to 12 ounces in 2014 (Center for Food Safety and Applied Nutrition, 2022). While the agency states that "the serving size is not a recommendation of how much to eat or drink," (Center for Food Safety and Applied Nutrition, 2022) one must question why a nutrition-focused branch of government would not speak about soda in less ambiguous terms given that the large body of research suggests that it is not a health-promoting beverage. Unsurprisingly, the food industry has been known to spend millions in political lobbying to influence government nutrition

regulations and recommendations (Gostin, 2016; Nestle et al., 2015), suggesting a possible cause for the ambiguity in the FDA's stance on soda and other SSBs. Perhaps further complicating the interests served by the FDA is the so-called "revolving door" between the food industry and related government agencies by which executives from the food industry transition to high-power positions in government or vice versa, with little time in between. (Nestle et al., 2015; Piller, 2018; Hyman, 2020). Since 2009, the year a since-dropped federal soda tax was proposed, annual lobbying expenditures from the soda industry alone have sat at \$60 million (Du et al., 2018). Clearly, the soda industry seems to have a vested interest in retaining its profits at the potential expense of the larger health interest of Americans.

### 4 UNITED STATES SUGAR-SWEETENED BEVERAGE EXCISE TAXES: PROGRESS DESPITE INDUSTRY OPPOSITION

Despite the dropped proposal to institute a nationwide SSB excise tax in 2009 and continued industry lobbying and opposition against SSB taxes (Nestle et al., 2015; McGranahan & Whitmore Schanzenbach, 2011; Gostin, 2017), several city-level SSB excise taxes have since passed. In 2014, Berkeley, California became the first U.S. city to pass an excise tax of \$0.01 per ounce on SSBs on account of public health interests (Falbe et al. 2016; Kane & Malik, 2019). November 2016 proved to be a remarkable month, with five new SSB excise taxes ranging from \$0.01 to \$0.02 passed in Cook County, Illinois; Boulder, Colorado; and three cities in California's Bay Area: San Francisco, Albany, and Oakland (Gostin, 2017; Kane & Malik, 2019). Stockton, California and Philadelphia, Pennsylvania joined this growing list in June 2016, and Seattle, Washington in June 2017 (Kane & Malik, 2019). Unsurprisingly, however, the American Beverage Association and the big soda companies it represents have fought many such taxes, spending \$19 million to fight the tax proposal in San Francisco alone (Gostin, 2017). The soda industry is known to fight excise tax proposals through claims that such taxes hurt small businesses and establish a "nanny state,"

in which the government infringes on the personal freedom individuals have to make their own choices as consumers (Gostin, 2017; Brownell & Warner, 2009). Ironically, companies from this same industry often aggressively market their products to children and teens through television ads and digital media, hooking them at a young age and denying the addictive nature of the sugar and caffeine they contain (Brownell & Warner, 2009; Nestle et al., 2015; Falbe et al., 2019; Sylvetsky et al., 2020). Surely this very practice interferes with the ability of individuals to make their own autonomous decisions about whether or not to purchase SSBs, making the soda industry's stance against SSB excise taxes hypocritical. Yet, while funding from philanthropists offered sufficient support to fight back and uphold the tax proposal in San Francisco (Gostin, 2017), proposals in other cities such as New York City, New York have nonetheless been dropped due to industry opposition of this sort (Kansagra et al., 2015). To examine the efficacy of SSB excise taxes more closely, Philadelphia's tax will be examined in further detail.

## 5 PHILADELPHIA AS A CASE STUDY FOR EVALUATING THE EFFICACY OF SSB EXCISE TAXES

Officially known as the Philadelphia Beverage Tax (City of Philadelphia<sup>1</sup>, 2022), Philadelphia's tax is particularly interesting, as the primary motive behind its proposal was to provide funding to support Mayor Jim Kenney's initiative to make access to pre-kindergarten education universal (Kane & Malik, 2019). Moreover, the tax was not only restricted to SSBs but also included any sweetened beverages (SBs), regardless of whether or not the sweetener contained calories (City of Philadelphia<sup>1</sup>, 2022; Kane & Malik, 2019). Examples of taxed beverages include both diet and regular soda, non-100%-fruit drinks, pre-sweetened tea and coffee drinks, and other pre-packed beverages sweetened with natural or artificial sweeteners (City of Philadelphia<sup>1</sup>, 2022). The tax sits at \$0.015 per ounce and is charged to all distributors of SBs, including restaurants, grocery stores, schools, hospitals, and even

non-profit organizations (City of Philadelphia<sup>1</sup>, 2022).

Distributors have passed 43-104% of the Philadelphia SB excise tax onto consumers, depending on the outlet of purchase (Madsen et al., 2019). The cost of SBs increased by \$0.0065 per ounce in supermarkets, \$0.0087 per ounce in mass merchandiser outlets, and \$0.0156 per ounce in pharmacies (Roberto et al., 2019). Just one year after the excise tax was implemented on January 1, 2017 (Madsen et al., 2019), an analysis of retail sales from January 1, 2014, to December 31, 2017, revealed that total volume retail sales of SBs in Philadelphia had declined by 51% compared to sales prior to tax implementation (Roberto et al., 2019). However, it should be noted that sales of SBs in Pennsylvania zip codes surrounding Philadelphia increased, offsetting 24.4% of this 51% decline (Roberto et al., 2019). The net decline in SB sales brought about by implementation of the excess tax therefore appears to be approximately 38% (Roberto et al., 2019). However, data on SB sales were not evaluated in New Jersey and could have further offset this decline, despite the disincentive of toll charges to travel across the border (Roberto et al., 2019). Nonetheless, the effectiveness of the SB tax in deterring SB purchases is promising. Henceforth, the following question arises: Do reduced purchases equate to significantly reduced consumption across the population in Philadelphia?

One longitudinal survey-based study examined soda drinking in one adult and one child from several hundred households in Philadelphia and comparison areas in Delaware; Montgomery County, Pennsylvania; or Bucks County, Pennsylvania before and after implementation of the Philadelphia Beverage Tax. The study revealed that 10 to 11 months after implementation of the tax, Philadelphian adults consumed about 1 less regular soda every 3 days (Cawley et al., 2019). Amongst African American adults in particular, the SB tax resulted in the consumption of 1 less regular soda every 2 days, suggesting that the effects of the tax may differ amongst sociodemographic groups (Cawley et al., 2019). Interestingly, however, Cawley et al. did not

report any statistically significant differences between socioeconomic groups (2019) despite the fact that SSB consumption tends to be higher amongst low-income individuals (CDC<sub>2</sub>, 2022). While no significant differences in soda consumption were reported amongst all Philadelphia children after the tax, children who consumed the amount of sugar equivalent to that in a 20 oz. regular soda on a daily basis, or 67 grams per day, consumed 22% less added sugar after implementation of the tax (Cawley et al., 2019), suggesting that the tax may have a more significant impact on individuals who were preexisting high-sugar consumers. It should be noted that Cawley et al. used different samples of participants to make pre- and post-tax comparisons, potentially blurring the true, unadulterated effects of the tax of SB consumption.

Another cross-sectional survey-based study conducted at Drexel University used random-dialing phone call data from 899 Philadelphia participants and 878 nearby-comparison-area participants to determine that Philadelphians were 40% less likely to consume regular soda, 64% less likely to consume energy drinks, and 58% more likely to consume bottled water following implementation of the SB tax. However, this reported change was based on data collected only 1-2 months after the tax had been put into practice and therefore may not accurately reflect its long-term effects (Zhong et al., 2018). Notably, a recent, more long-term study with a similar random-dialing phone call survey design conducted by some of the same Drexel University researchers revealed that there were no significant overall differences in either SSB or diet SB consumption before and 12 months after tax implementation (Zhong et al., 2020). Further, there were no significant differences in such consumption between Philadelphians (n=357) and non-Philadelphians (n=158), though a slightly higher percentage of Philadelphia participants decreased their SSB consumption compared to the non-Philadelphians participants (Zhong et al., 2020). Yichen Zhong and colleagues do however acknowledge that the sample size for this study was small (2020). Moreover, the

survey-based design of the study carries risk of bias, though accurately measuring changes in soda consumption (rather than purchases) via other methods would likely prove difficult. Table 1 summarizes the basic characteristics of the aforementioned studies, examining the effect of Philadelphia's excise tax on SB consumption.

Studies examining the impact of the SSB tax instituted in Berkeley, California on SSB consumption have reported a similar mix of findings, thus supplementing the relatively small pool of studies on Philadelphia's SB tax to strengthen the degree to which conclusions can be drawn about the general effects of SSB/SB taxes on purchasing behavior. One short-term study found that the tax in Berkeley brought about a 21% reduction in SSB consumption in low-income neighborhoods (Falbe et al., 2016), and another longer-term study reported no significant difference in self-reported SSB consumption one-year after tax implementation despite significant declines in SSB sales (Silver et al., 2017). On the other hand, the results of one exceptionally long-term study that surveyed differences in consumption before and after implementation of the tax amongst individuals from demographically diverse Berkeley neighborhoods (n = 1513) and comparison neighborhoods in San Francisco and Oakland (n = 3712) revealed that the frequency of SSB consumption in Berkeley decreased by 0.55 times per day after tax-implementation based on a comparison of pre-tax consumption to a weighted average of consumption during the first 3 years post-tax-implementation. Water consumption comparably increased by 1.02 times per day during the same time period (Lee et al., 2019). While it should be noted that the cities from which the comparison neighborhoods were selected both passed SSB taxes in 2016, only a portion of the final 2017 surveys in Oakland were collected after these taxes were implemented (Lee et al., 2019). Table 2 summarizes the basic characteristics of the aforementioned studies examining the effect of Berkeley's excise tax on SSB consumption.

TABLE 1: Population Characteristics and Methodology for Studies Evaluating Post-Taxation Changes in SB Consumption in Philadelphia, PA

Authors, Year	Participant Recruitment	Analytic Sample Characteristics	Data Collection Method	Length of Time Between Tax Implementation & Evaluation
Cawley et al., 2019	Separate groups of participants recruited outside of grocery stores at baseline and follow-up timepoints.	Baseline 2016 data for N=600 Philadelphian households, N=705 comparison households from Delaware and other Pennsylvania areas; Follow-up 2017 data for N=763 Philadelphian households, N=738 comparison households from Delaware and other Pennsylvania areas	Online survey (by phone for those who could not complete online)	10-11 months
Zhong et al., 2018	Part of the Drexel University Beverage Choice Research Study. Recruitment via random-digit phone dialing.	N=899 Philadelphian households, N=878 comparison households from cities in New Jersey and Delaware	Phone survey	1-2 months
Zhong et al., 2020	Participants from the Drexel University Beverage Choice Research Study recontacted 1 year after recruitment via random-digit phone dialing for initial surveying. Participants paid \$20 for follow-up survey only.	N=479 Philadelphian households, N=384 comparison households from cities in New Jersey and Delaware	Phone survey	1 year

The similarly varied findings of the studies in Berkeley and Philadelphia and the limitations of the survey-based studies generally used to measure SSB consumption necessitate that further long-term studies with larger sample sizes be conducted before more conclusive claims are drawn on the true efficacy of SSB or SB excise taxes on SSB consumption. Nonetheless, the existing evidence suggest that such taxes likely have some degree of efficacy.

Setting conclusions about the true efficacy of SSB and SB excise taxes aside, the Philadelphia Beverage Tax has generated an impressive amount of revenue despite the significant reductions in soda volume purchased in the city after tax implementation (Roberto et al., 2019). As of the end of the fourth fiscal quarter of 2021, the tax had generated \$333.9 million since its enactment in 2017 (Rhynhart, 2022).

Taking annual revenue to be consistent for the purposes of generating an average, the tax has generated roughly \$66.8 million annually (Rhynhart, 2022). \$122 million, or 37% of the tax’s overall revenue, has been spent on pre-kindergarten education, and significantly smaller amounts have gone towards community schools, the city’s Office of Education and Rebuild, the city’s new program focused on rebuilding community parks, libraries, and recreation centers (Rhynhart, 2022; City of Philadelphia2, 2022). While the city claims that Rebuild will devote hundreds of millions of dollars to its initiatives thanks to the SB tax (City of Philadelphia2, 2022), \$179 million, or 54%, of Philadelphia’s SB tax revenue still remains in the city’s General Fund (Rhynhart, 2022). Despite City Controller Rebecca Rhynhart’s repeated pushes for SB tax funds to be

separated from the General Fund to ensure transparent spending, no changes have been made (McCrystal, 2019; Rhyhart, 2022). The spending timeline and specific allocation of remaining revenue remains unclear, with only vague commentary from Mayor Jim Kenney’s office claiming that it would take time for the rate of revenue influx from the SB tax to become outpaced by the rate at which programs intended to be supported by such revenue can utilize the funds to develop (McCrystal,

2019). In the meantime, of course, tax revenue will continue to accumulate so long as the tax remains in effect. In the final section to follow, I propose the allocation of at least a portion of the revenue generated by the Philadelphia SB excise to fund consumer-level fruit and vegetable subsidies as a possible means of not only ensuring that tax revenue is spent in a timely manner, but also enhancing the tax’s potential to combat obesity.

**TABLE 2:** *Population Characteristics and Methodology for Studies Evaluating Post-Taxation Changes in SB Consumption in Berkeley, CA*

<b>Authors, Year</b>	<b>Participant Recruitment</b>	<b>Analytic Sample Characteristics</b>	<b>Data Collection Method</b>	<b>Length of Time Between Tax Implementation &amp; Evaluation</b>
Falbe et al., 2016	Separate groups of participants recruited via intercept surveying at high-traffic intersections at baseline and follow-up timepoints.	Baseline 2014 data for N=285 Berkeley participants, N=606 comparison participants from Oakland and San Francisco, CA; Follow-up 2015 data for N=501 Philadelphian participants, N=1045 comparison participants from Oakland and San Francisco, CA. Participants recruited from low-income neighborhoods with large minority populations.	In-person interview	4 months
Silver et al., 2017	Participants recruited via landline and cellular random-digit phone dialing for initial survey	Baseline 2014 measurements for N=649 Berkeley participants; Follow-up 2015 measurements for N=654 participants. Low-income census blocks were disproportionately favored during random-digit dialing recruitment.	Phone survey	1 year
Lee et al., 2019	Separate groups of participants recruited via intercept surveying at high-traffic intersections at baseline and follow-up timepoints.	Baseline 2014 data for N=1513 Berkeley participants, N=3712 comparison participants from Oakland and San Francisco, CA; Unspecified sample sizes for follow-up data collected in 2015, 2016, and 2017. Participants recruited from low-income neighborhoods with large minority populations.	In-person interview	3 years, plus annual follow-up

## 6 FRUIT & VEGETABLE SUBSIDIES: AN ALTERNATIVE OBESITY-MINDED INVESTMENT FOR PHILADELPHIA'S SWEETENED-BEVERAGE EXCISE TAX REVENUE

Though additional research is needed to know the full extent to which SSB taxes reduce soda consumption, existing evidence from U.S.-based studies in relevant cities like Berkeley and Philadelphia suggests that such taxes are effective to at least some extent (Bleich & Long, 2020). And while the Philadelphia SB excise tax in particular was, again, not proposed with obesity as a primary motive (Kane & Malik, 2019), positive externalities are never unwelcomed. Yet, one has to question why the \$150.9 million in tax revenue in the General Fund has not yet been devoted to fulfilling the mayor's mission of funding universal pre-K or supporting the mission of Rebuild (Kane & Malik, 2019; City of Philadelphia, 2022). The Philadelphian public ought to demand that this revenue be reinvested within a set period of time, yet given the present lack of action and the burden of obesity in America, perhaps at least a portion of this revenue might be better spent directly funneled into programs that further fight obesity. I suggest a program that funds fruit and vegetable subsidies, whereby government funding would artificially lower the cost of such foods.

It is generally well accepted that increasing consumption of whole fruits and vegetables is inversely associated with weight gain and obesity (Guyenet, 2019; Nour et al., 2018; Dreher, 2018; He et al., 2004). Possible causes for this correlational trend are the relatively low energy and high fiber content of fruits and vegetables, as well as their constituent plant phytochemicals (Dreher, 2018). Moreover, increasing fruit and vegetable consumption may reduce the risk of cardiovascular disease, hypertension, stroke, and certain cancers (Boeing et al., 2012; Hung et al., 2004). Despite the fact that most data on the health effects of fruits and vegetables is correlational, there is no significant evidence to suggest that fruits and vegetables are harmful, and the science-backed 2020-2025 Dietary Guidelines for America recommend filling half your plate

with whole fruits and vegetable (USDA, 2022). Yet according to nationwide 2013 Behavioral Risk Factor Surveillance System (BRFSS) data, only 12.3% of Americans meet the fruit intake recommendations laid out by the 2015-2020 Dietary Guidelines for Americans, and only 9.3% of Americans meet the vegetable intake recommendations (Lee-Kwan et al., 2015). For many Americans, however, complex socioeconomic factors, such as the relatively high cost of fruits and vegetables and limited access, make their low intake of such foods more than a matter of personal preference (Lee-Kwan et al., 2015).

Regarding cost barriers to accessing fruits and vegetables, relatively few interventional studies have explored the effectiveness of subsidies in promoting the purchase of healthy food (An, 2013; Herman et al., 2008; Pearson-Stuttard et al., 2017). Significantly, however, in one Los Angeles-based study amongst 602 postpartum women enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), researcher Dena Herman and colleagues issued participants in the experimental group \$10 worth of vouchers per week on a bimonthly basis to spend at either a farmers market site or a supermarket site over a 6-month intervention period (2008). Survey data revealed that compared to control participants, who were given a monthly \$13 dollar voucher to spend on disposable diapers, farmer's market participants in the experimental group consumed 1.4 additional servings of fruits and vegetables per 1000 kcal in contrast to baseline, and supermarket participants consumed 0.8 additional servings per 1000 kcal (Herman et al., 2008). Remarkably, the reported increases in consumption were maintained 6 months after participants stopped receiving the vouchers (Herman et al., 2008). Such a finding suggests that even short periods of fruit and vegetable subsidization might have sufficiently positive effects on individuals to establish resilient changes in long-term purchasing behavior.

If drawn out for a year, Herman et al.'s fruit and vegetable subsidy intervention would cost \$480 per WIC participant (2018). According to U. S. Department of Agriculture (USDA) data, there were

233,500 enrolled WIC participants in Pennsylvania as of 2016 (USDA, 2019). No further data is available on the breakdown of this state-wide data, however (USDA, 2019). Employing Herman et al.'s intervention amongst all Pennsylvania WIC participants for one year would theoretically cost approximately \$112 million, almost double the \$65.1 million average annual revenue generated by the Philadelphia SB excise tax (Rhynhart, 2019). Further information about the number of WIC participants in Philadelphia is needed before conclusions can be drawn about the feasibility of establishing such an intervention. However, even if the vast majority of the 233,500 enrolled WIC participants in Pennsylvania were enrolled in Philadelphia, funding might still be feasible with SB tax revenue if weekly subsidies were cut by a small percentage or if funding was received more intermittently throughout the year.

Importantly, the findings of a recent longitudinal cohort study of SNAP beneficiaries throughout North Carolina further support the efficacy of fruit and vegetable subsidies in encouraging more healthful dietary consumption (Berkowitz et al., 2021). Compared to those registered for standard SNAP benefits alone (N=33246), those receiving an additional \$40 per month through enrollment in SuperSNAP, established to fund only the purchase of fresh, frozen, or canned fruits and vegetables free of added sugar and salt, purchased an average of \$31.84 more of fruits, vegetables, nuts, and legumes per month. While it follows that enrollment in SuperSNAP did not increase out-of-pocket spending on fruits, vegetables, and other whole foods, it nonetheless produced a significant shift in purchasing behavior. This shift also included a significant decrease in spending on both processed foods and sugar-sweetened beverages, though because SuperSNAP beneficiaries were enrolled in the program by clinical staff due to pre-existing health conditions (e.g., diabetes or obesity), there is the possibility that such beneficiaries may have been relatively biased towards healthy eating. Nonetheless, this study further supports the theory that lowering the cost barrier to accessing fruits and vegetables

can potentially induce a measurable change in dietary consumption, which one can presume aligns reasonably well with food purchasing behavior.

Ultimately, WIC participants pose a more economically feasible target population for a subsidy program in Philadelphia than SNAP participants, as significantly more individuals are enrolled in the latter: as of 2021, 464,008 individuals were receiving SNAP benefits in Philadelphia alone (U.S. Census Bureau, 2022). Additionally, given that research suggests that parental modeling and exposure to foods during childhood plays a significant role in shaping long-term feeding behavior (Birch et al., 2007; Vollmer & Baietto, 2017; Ventura & Worobey, 2013; Wadhera et al., 2015), subsidizing fruits and vegetables for WIC participants might generate self-perpetuating positive effects on diets across generations.

Beyond subsidizing fruit and vegetables for WIC participants, tax revenue from the Philadelphia SB excise tax might alternatively be used to lower the cost of fruit and vegetable subsidies on a somewhat broader scale. Amongst other findings, a meta-analysis of 23 interventional studies and 7 prospective cohort studies selected from 3,163 reviewed abstracts related to the impact on price changes on diet identified that just a 10% decrease in fruit and vegetable prices resulted in a 14% increase in fruit and vegetable purchases (Pearson-Stuttard et al., 2017). Such findings suggest that using a portion of the SB tax revenue to subsidize select fruits and vegetables in Philadelphia might produce a measurable rise in purchases of these health-promoting foods. Perhaps such subsidies might be better selectively applied to grocery stores or farmer's markets serving lower-income neighborhoods, where the existing costs of fruits and vegetables pose more of a significant access barrier.

While additional expertise in economics, data science, and public health beyond the scope of this synthesis paper is needed to propose a specific and practicable plan for using tax revenue from the Philadelphia SB excise tax to subsidize fruits and vegetables, the aforementioned studies suggest that subsidizing fruits and vegetables could pro-

duce measurable results. Indeed, the available evidence indicates that targeting smaller populations or select fruits and vegetables could make the costs of the subsidies realistic, given existing revenue from the taxes. Moreover, such subsidies might help support Philadelphia grocery stores, which appear to have suffered losses after implementation of the tax in 2017. A few months after the tax had been put into practice, the owner of 6 ShopRite stores in Philadelphia, Jeff Brown, told National Public Radio that his sales were down 15%, leaving him with no choice but to cut hours for his Union employees (Aubrey, 2017). Sales presumably underwent such a remarkable drop due to some individuals choosing to shop outside of Philadelphia to avoid the tax (Aubrey, 2017), and whether or not this drop lessened over time is unclear. Nonetheless, the number is striking. Subsidizing fruits and vegetables while simultaneously taxing SBs might help to bring back some of this lost business in Philadelphia.

## 7 CONCLUSION

Obesity has been on the rise since the late 1970s, and its massive health and economic consequences cannot be ignored. While SSB excise taxes are by no means capable of resolving this public health threat altogether, existing evidence reasonably supports the use of such taxes, as SSBs have been shown to promote weight gain and chronic disease, and this scientific consensus might be even more clear if methodological issues and probable industry-biases in some studies and reviews were eliminated. SSB excise taxes, though still few and far between, seem to hold some efficacy in reducing the purchase and consumption of SSBs. Yet, while these taxes generate valuable revenue, their obesity-fighting potential might be optimized if such revenue were devoted to addressing other factors that contribute to the obesity equation. Fruit and vegetable subsidies pose one such promising possibility and might help to combat lost business generated by SB/SSB excise taxes in cities like Philadelphia, where the majority of SB tax revenue generated since its 2017 inception remains unspent.

Despite inevitable industry opposition, bringing back a federal proposal for a SSB excise

ought to be the ultimate goal, as this more unified approach would maximize public health benefits and likely rid retail stores in cities with existing SB/SSB taxes of the issue of lost revenue that may emerge when some individuals resultingly choose to shop for groceries in areas with no such taxes. Until then, however, cities like Philadelphia ought to continue to act as role models and work to improve their SB/SBB tax programs to optimize their obesity-fighting potential, setting examples that will hopefully ignite a larger movement ■

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