



## Health Issue Brief

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# Multi-City Study Shows Beverage Taxes Raise Prices, Reduce and Shift Purchases

In the past decade, taxes on sugar-sweetened beverages (or SSBs, which are drinks such as cola, soda, energy drinks, and fruit-flavored drinks that contain added sugar) have perhaps become the most widely adopted policy designed to improve diets and reduce diet-related chronic disease. Recommended by the World Health Organization, the American Academy of Pediatrics, the American Heart Association, and the American Public Health Association (among others), such taxes have been adopted by dozens of countries, including Mexico, Peru, Chile, the U.K., Ireland, France, Norway, South Africa, India, the Philippines, and Samoa. The U.S. does not have a national tax on SSBs, though Congress has considered such proposals over the past several years. Seven cities in the U.S. currently tax SSBs: Berkeley, California was the first, starting in 2015; it was joined in 2017 by Albany and Oakland, California; Boulder, Colorado; and Philadelphia, Pennsylvania; and in 2018 by Seattle, Washington and San Francisco, California.

To better understand the effects of these city-level beverage taxes, Mathematica undertook a multi-year, multi-city study to provide comprehensive information about their impacts on a wide range of important outcomes, including retail prices, purchases, and consumption. Our study examines both adults and children and focuses on populations with particularly high consumption of SSBs and diet-related chronic diseases (which includes African-American and Hispanic adults and children and families living in poverty). Our study also includes an analysis of strategic responses to the taxes, including cross-border shopping by consumers, and retailers changing the availability of various beverages. Relative to previous analyses of the city-level beverage taxes, our study contributes to the evidence base because it gathers a wide range of primary data, including in-person

store audits of prices and product availability, interviews about beverage purchases with customers exiting stores, longitudinal household surveys regarding beverage consumption, and qualitative interviews with store owners. Notably, this is the first study to examine the impact of city beverage taxes on product availability or on children's beverage consumption. We focus primarily on the racially and ethnically diverse cities of Philadelphia and Oakland, and examine in particular the effects on low-income and minority households.

This brief summarizes the results of our study, which was funded by the Robert Wood Johnson Foundation and led by David Jones at Mathematica in collaboration with Anna Hill of Mathematica, David Frisvold of the University of Iowa, and John Cawley of Cornell University.

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### Findings at a glance:

- Pass-through to retail prices was roughly 100% of the tax in Philadelphia and 61% in Oakland.
- The pass-through translated to prices that were roughly 21% higher in Philadelphia and 8% higher in Oakland due to the taxes.
- Retailers reduced the availability of taxed beverages in both cities, and retailers increased the availability of untaxed beverages in Philadelphia.
- Over 40% of retailers (13 of 31) reported reducing the availability of taxed beverages in their stores, and nearly half of retailers in Philadelphia reported increasing the availability of untaxed beverages.
- Based on exit interviews with consumers at stores, the tax reduced purchases of taxed beverages in Philadelphia (which is supported by consumer receipt data), but no such change was detectable in Oakland.
- Majorities of retailers interviewed in both cities report that the tax reduced their sales of taxed beverages and some retailers (9 of 31) reported an increase in sales of untaxed beverages.
- There was no detectable increase in the probability that residents of Philadelphia and Oakland shopped outside of the cities for beverages.
- However, residents who shopped outside of the cities were more likely to buy beverages that would be taxed at home, to buy more of them, and/or to report that they usually buy beverages outside of the cities.
- There was no detectable change in how often adults or children drank taxed beverages overall.
- However, adults reduced their consumption of regular soda after the tax, and children in Philadelphia who were high consumers of SSBs before the tax reduced their consumption of added sugars from beverages after the tax.

## Study methods

We focused on two cities: Philadelphia (which has a beverage tax of 1.5 cents per ounce) and Oakland (which has a beverage tax of 1 cent per ounce). Both cities taxed caloric SSBs, but Philadelphia also taxed diet (non-caloric) soft drinks. We collected pre-tax data 1-2 months before the tax took effect and post-tax data 10-11 months after the tax took effect. As a result, both waves of data collection took place at the same time of year, which helps control for any seasonal variation in the outcomes.

For this comprehensive study, we examined a wide variety of outcomes by collecting diverse data on the following:

- **Beverage prices.** Field staff manually recorded the prices of a large number of beverages, both taxed and untaxed. Data were collected from all types of stores that sell beverages, including warehouse clubs, large grocery stores, small grocery stores, convenience stores, and pharmacies. Table 1 lists the number of stores from which price data were collected, and the total number of observations of product prices, in each city and its comparison areas, both before and after the tax.
- **Beverage purchases.** We analyzed data on beverage purchases from two sources.
  - First, we conducted interviews with shoppers who were exiting stores about the beverages they just bought. We conducted the interviews before and after the tax with different people randomly selected and interviewed in each period. To be eligible, shoppers had to be an adult (18 or over) with at least one child ages 2-17. Table 2 lists the number of store exit interviews conducted in each city and its comparison areas, both before and after the tax.
  - Second, we acquired consumer receipt data from [InfoScout](#), which reports all beverages purchased by a household (not just those on a single shopping trip by one household member). These data come from consumers, who submit photos of all of their grocery receipts; InfoScout then digitizes the receipts to identify the items

**Table 1. Number of stores visited pre- and post-implementation of taxes**

	Stores in the treated cities		Stores in comparison areas	
	Pre-tax	Post-tax	Pre-tax	Post-tax
<b>Stores</b>				
Oakland	70	61	87	75
Philadelphia	66	64	78	74
<b>Prices collected</b>				
Oakland	1,534	1,270	1,841	1,735
Philadelphia	1,387	1,210	1,765	1,553

Notes: The stores consist of all types that sell beverages, including warehouse clubs, large grocery stores, small grocery stores, convenience stores, and pharmacies.

**Table 2. Number of exit interviews and household surveys completed pre- and post- tax**

	Respondents in treated cities		Respondents in comparison areas	
	Pre-tax	Post-tax	Pre-tax	Post-tax
<b>Exit interviews</b>				
Oakland	785	786	741	766
Philadelphia	600	763	705	738
<b>Household surveys</b>				
Oakland	329	193	361	218
Philadelphia	365	241	321	199

Notes: We conducted exit interviews about beverage purchases as randomly selected shoppers left retail stores. Respondents from the pre-tax exit interviews were invited to participate in the household survey. Respondents from the pre-tax household survey were invited to participate in the post-tax household survey. For the household surveys, we asked one adult and one child in each household about their beverage consumption.

purchased. This is the only part of the study that examined not just Philadelphia and Oakland but also the taxes in two other cities: San Francisco (1 cent per ounce) and Seattle (1.75 cents per ounce). We obtained data from 483 households in the treated cities and 480 households in nearby comparison areas (communities in the same metropolitan statistical area but outside the cities), plus 484 households in a national sample whose observed characteristics match those of the sample in the treated cities. These data are longitudinal; we observed these households' purchases six months before and six months after the tax.

- **Beverage consumption.** We collected information on beverage consumption from longitudinal household surveys; specifically, we asked shoppers who took part in the store exit interviews before the tax to complete an online survey later (with phone follow-up for those unable to complete the survey online). We surveyed the same people about their frequency of consumption in the past month of beverages, both before and after the tax. Notably, we surveyed one adult and one child in each household, providing the first-ever evidence on the effects of any beverage tax on the consumption of children. Table 2 lists the number of household survey respondents in each city and its comparison areas, both before and after the tax.

- **Strategic responses to beverage taxes.** We examined three major types of strategic responses.
  - *Cross-border shopping by consumers:* We studied cross-border shopping by:
    - Observing residents of the treated city shopping outside of the city when we conducted store exit interviews in the comparison areas.
    - Asking people during store exit interviews about where they shop.
    - Asking people during the household interviews about where they shop.
  - *Changes to product availability in stores.* The field staff who recorded the prices of beverages in stores also documented the availability of taxed and untaxed beverages in those stores.
  - *Other strategic responses by retailers.* We conducted a qualitative study based on telephone interviews with 33 retailers in the treated cities (18 in Philadelphia and 15 in Oakland), inquiring whether and how they altered their marketing and other approaches in response to the tax. The managers also described how they changed their prices because of the tax, and their perceptions of the tax's impact on their sales.

See the text box on page 12 for further details on the analytic approach taken to estimate impacts of the taxes.

## Results of the study

### Effects of beverage taxes on prices

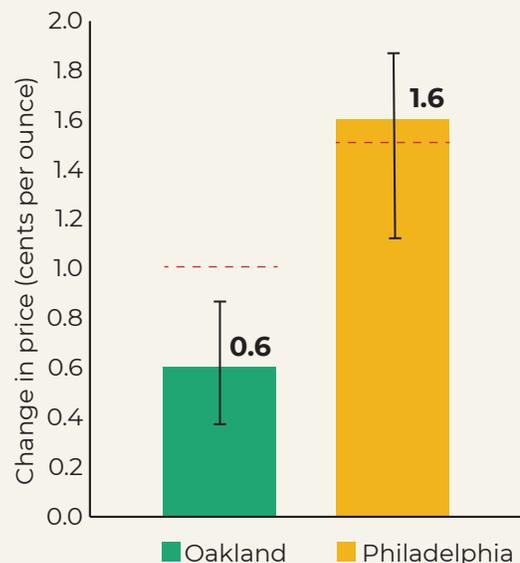
#### Key takeaways:

- Beverage taxes were passed through to retail prices, but at differing rates across cities. Pass through of the tax was 105% in Philadelphia but only 61% in Oakland.
- The average price of taxed beverages increased in both cities, but more so in Philadelphia (21% increase) than in Oakland (8% increase).

All of the beverage taxes in U.S. cities are levied on distributors—the firms that sell and deliver beverages to the retail stores. The extent to which a tax is passed from the distributors to consumers in the form of higher retail prices is known as “pass-through.”

We found that the pass-through of the beverage taxes varied by city. In Philadelphia, the tax of 1.5 cents per ounce raised prices by an average of 1.6 cents per ounce, a pass-through rate of 105% (Figure 1). The entire tax was passed on to consumers for all taxed beverages combined, and for specific categories such as regular and diet soda (which, in Philadelphia, is taxed). The resulting increase in prices was substantial, averaging 21% for all taxed beverages. For example, the average price of regular Coke rose by 22% (36 cents) for a 20-ounce bottle; 43% (84 cents) for a 2-liter bottle; and 31% (\$1.66) for a 12-pack of 12-ounce cans.

**Figure 1. Impact of SSB Taxes on the Price of Taxed Beverages**



Notes: The beverage tax in Oakland (1 cent per ounce) increased the prices of SSBs by 0.6 cents per ounce from an average pre-tax price of 8.0 cents per ounce. The beverage tax in Philadelphia (1.5 cents per ounce) increased the prices of SSBs and diet soft drinks (all of which were taxed) by 1.6 cents per ounce from an average pre-tax price of 7.5 cents per ounce. The height of the bars represent the estimate of the tax's impact on prices, with the 95% confidence interval shown by the black vertical bracket. The dashed red line shows the amount of the tax in each city.

In Oakland, the tax of 1 cent per ounce raised prices by 0.6 cents per ounce, a pass-through rate of 61%, for all taxed beverages. The estimate for regular soda was similar: 63%. The tax increased the average price of all taxed beverages by 8%. For example, the average price of regular Coke rose by 6% (11 cents) for a 20-ounce bottle; 18% (41 cents) for a 2-liter bottle; and 16% (99 cents) for a 12-pack of 12-ounce cans.

The impact on prices was less in Oakland than in Philadelphia for two reasons: 1) the tax in Oakland is two-thirds the size of that in Philadelphia (1 cent versus 1.5 cents per ounce); and 2) the percentage of the tax passed through to retail prices is lower in Oakland than in Philadelphia (61% versus roughly 100%).

In our qualitative interviews with retailers in Philadelphia and Oakland, 24 of 33 reported raising the price of taxed beverages by the exact amount of the tax, 5 of 33 raised the prices of some or all taxed beverages by more than the amount of the tax, and 1 raised prices of all taxed beverages by less than the amount of the tax.

Based on our store exit interviews, the tax reduced the amount of taxed beverages purchased at Philadelphia stores relative to stores in the comparison areas by 9 ounces per shopping trip (Figure 2). This relative reduction includes a decrease of taxed beverages purchased in Philadelphia store but also an increase at stores in comparison areas. The literature suggests that households make roughly 16 shopping trips per month, which combined with our estimate, translates to roughly two fewer two-liter bottles purchased per month. However, we caution that this finding at least in part reflects increased cross-border shopping, which we discuss later in this issue brief. The reduction was greater at large grocery stores and chain stores than at independent retailers, particularly small grocery stores or convenience stores. We did not find changes in purchases specifically among African American or Hispanic shoppers, or those living in low-income households.

*“We only added enough [to beverage prices] to recoup the amount of the tax we pay to distributors, and not a cent more.”*

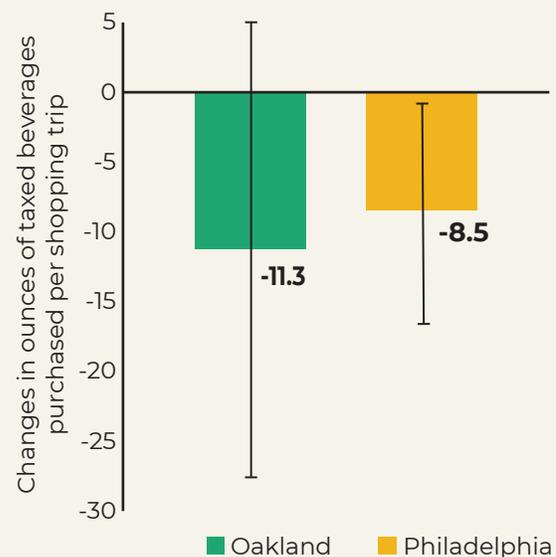
—Large grocery retailer

### Effects of beverage taxes on purchases

#### Key takeaways:

- Based on the store exit interviews, the Philadelphia tax reduced purchases of taxed beverages relative to stores in comparison areas, but there was no detectable impact of the Oakland tax.
- The vast majority of retailers interviewed in both cities reported that the beverage tax lowered their sales of taxed beverages.
- The customer receipt data shows that the taxes in the four cities (Philadelphia, Oakland, San Francisco, Seattle) reduced consumer purchases of taxed beverages, but the decline was concentrated in Philadelphia.

**Figure 2. Impact of SSB Taxes on Purchases of Taxed Beverages**



Notes: The SSB tax in Oakland (1 cent per ounce) did not have a statistically significant impact on the volume of SSBs purchased. The beverage tax on SSBs and diet soft drinks in Philadelphia (1.5 cents per ounce) decreased the purchases of taxed beverages by 8.5 ounces per shopping trip. The height of the bars represent the estimate of the tax’s impact on purchases, with the 95% confidence interval shown by the black vertical bracket.

In Oakland, the tax had no detectable impact on the ounces of taxed beverages purchased for the entire sample of shoppers (we estimated that purchases fell by 11 ounces per trip, but the change was not statistically significant). Among African Americans, the Oakland tax reduced purchases of taxed beverages by 28 ounces per shopping trip, while increasing purchases of untaxed beverages by 30 ounces per shopping trip.

Our qualitative interviews with retailers also shed light on the impact of the taxes on sales. Most retailers in Philadelphia (15 of 17) and Oakland (10 of 14) said that their sales of taxed beverages dropped as a result of the tax. A much smaller percentage of retailers in Philadelphia (7 of 17) and Oakland (2 of 14) said that sales of untaxed beverages rose as a result of the tax.

Yet another perspective on purchases comes from our analysis of the InfoScout consumer receipt data. A one-cent beverage tax reduced purchases of taxed beverages by an average of 53 ounces per month or 12%. The size of the impact varies depending on the comparison group used; when we use the nationwide comparison group, a one-cent beverage tax reduced purchases of taxed beverages by an average of 62 ounces per month or 14% compared to 49 ounces per month or 11% when we used the comparison group just outside the treated cities. The difference suggests that there was some spillover effect of the tax in the areas outside of the cities; that is, purchases of taxed beverages declined somewhat among households living in these areas. Finally, the decline in purchases was concentrated in Philadelphia; its 1.5 cents per ounce tax reduced purchases of taxed beverages by an average of 126 ounces per month (99 ounces for SSBs, 27 ounces for non-caloric sweetened beverages) or 28%. Assuming that the decline is spread evenly among household members, and the decline is all in consumption of regular soda, it is equivalent to roughly 10 fewer calories consumed per household member per day.

## Effects of beverage taxes on consumption

### Key takeaways:

- The beverage taxes had no detectable impact on the frequency of drinking taxed beverages in Philadelphia or Oakland for children.
- However, there is some suggestive evidence of a decline in frequency among adults in Philadelphia.
- There is also evidence that the tax reduced adults' consumption of regular soda in both cities.
- Children with high baseline consumption of SSBs in Philadelphia also saw reduced consumption of added sugars from beverages.

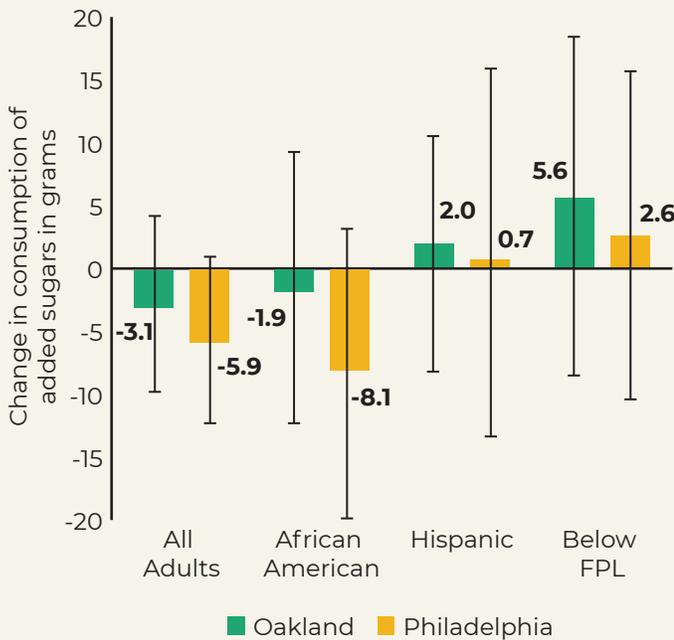
In Philadelphia and Oakland, we did not detect an impact of the tax on a summary measure of consumption—the amount of added sugars consumed through beverages—for either adults (Figure 3) or children (Figure 4). Although, the decline for adults in Philadelphia, 6 grams (15%) per day (the equivalent of 24 calories), is close to being statistically significant at the 10% level. We also did not detect an impact on added sugars consumed by African American adults, Hispanic adults, and adults in low-income households in Philadelphia or Oakland (Figure 3). The tax did reduce added sugars consumed by African American children in Philadelphia by 8 grams per day (34%), the equivalent of 32 calories (Figure 4). However, there was no detectable impact on other groups of children, including Hispanic children or children in low-income households in Philadelphia or African American children, Hispanic children, or children in low-income households in Oakland. Furthermore, the taxes did not appear to change how often adults or children drink taxed beverages overall.

There were, however, changes in consumption for certain groups or certain products. For example, the Philadelphia tax reduced the consumption of added sugars from beverages by 15 grams (22%) among

children who were high consumers of SSBs before the before the tax (defined as consuming roughly one 20-ounce regular soda per day). Among adults, the Philadelphia tax decreased how often adults consumed regular soda by about 10 times per month (30%), which implies a price elasticity of demand for regular soda of -1.0. The tax also reduced the chance

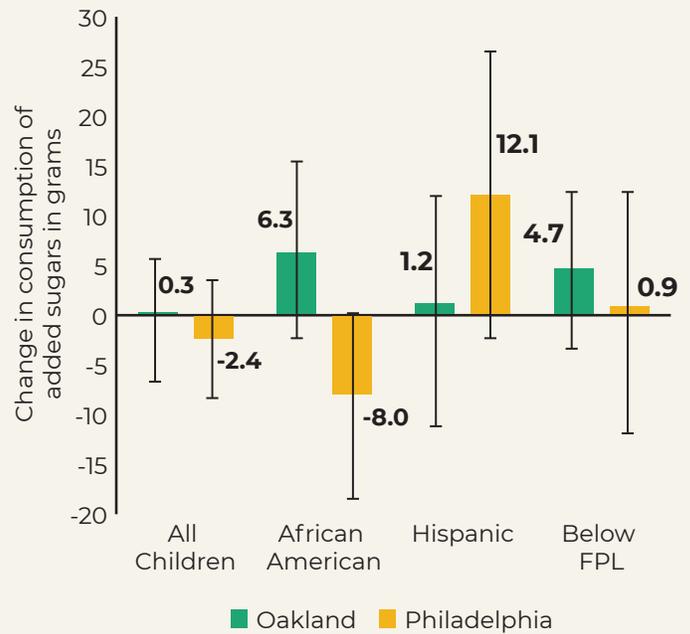
that an adult in Philadelphia consumed regular soda daily by 11 percentage points or 31%. In Oakland, the tax reduced the chance that an adult consumed any regular soda by 7 percentage points (9%), while increasing the probability that an adult consumed tap water daily by 12 percentage points (20%).

**Figure 3. Impact of SSB Taxes on Consumption of Taxed Beverages (Adults)**



Notes: The SSB tax in Oakland (1 cent per ounce) and the beverage tax on SSBs and diet soft drinks in Philadelphia (1.5 cents per ounce) did not have statistically significant impacts (at the 5% level) on the amount of added sugars from beverages consumed daily by adults. In Philadelphia, the tax was associated with a decline of 5.9 grams of added sugars per day (which is roughly 24 calories), although the estimate was not quite statistically significant at the 10 percent level. The height of the bars represent the estimate of the tax's impact on consumption of added sugars, with the 95% confidence interval shown by the black vertical bracket.

**Figure 4. Impact of SSB Taxes on Consumption of Taxed Beverages (Children)**



Notes: The SSB tax in Oakland (1 cent per ounce) and the beverage tax on SSBs and diet soft drinks in Philadelphia (1.5 cents per ounce) did not have statistically significant impacts on the amount of added sugars from beverages consumed daily by all children and by most groups of children. However, the tax in Philadelphia reduced the amount of added sugars consumed by African American children by 8.0 grams per day (which is roughly 32 calories), from a pre-tax average of 23.7 grams per day. The height of the bars represent the estimate of the tax's impact on consumption of added sugars, with the 95% confidence interval shown by the black vertical bracket.

### Strategic responses by stores and consumers

#### Key takeaways:

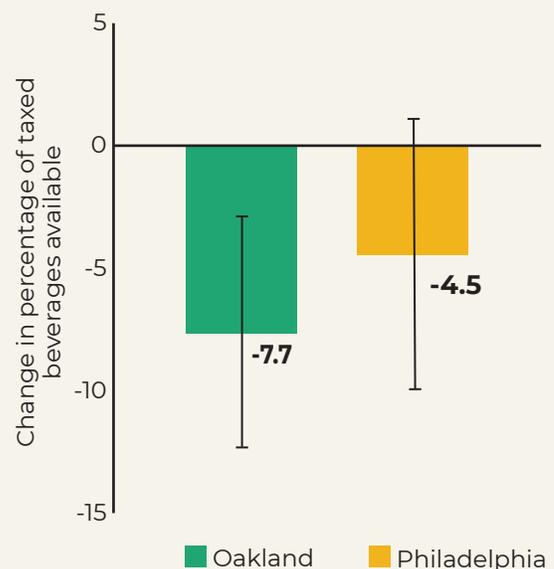
- Residents of Philadelphia and Oakland were not more likely to cross-border shop after the tax, but those who were already doing so became more likely to buy beverages in neighboring areas or to buy more of them.
- Retailers in both cities reported reducing the availability of taxed beverages in their stores.
- Nearly half of Philadelphia retailers interviewed for the study (8 of 17) reported stocking more untaxed beverages as a result of the tax.
- Subsets of retailers also responded to the tax in other ways, such as notifying consumers of the tax or increasing their promotion of untaxed beverages.

One important type of strategic response by consumers was tax avoidance; specifically, cross-border shopping. We collected data about this practice during the in-person exit interviews and the subsequent household interviews. In both Philadelphia and Oakland, there was no detectable change in the likelihood that residents of the treated cities shopped outside of their cities. However, among Philadelphia residents who did shop outside the city, the tax increased by 35 percentage points the probability that they bought beverages taxed by Philadelphia (compared to a baseline of 17 percent), and they purchased a larger volume (31 ounces more) of SSBs after the tax (compared to a baseline of 17 ounces). Using the longitudinal household surveys, we estimated that the tax increased the probability that Philadelphia residents said that they usually purchased beverages outside of the city by 17 percentage points (more than doubling the baseline mean of 16 percent) and by 10 percentage points (42%) in Oakland.

We also examined how retailers changed the beverage selection in their stores. The probability that a store in Philadelphia carried a given taxed beverage fell by 5 percentage points (9%) after the tax, which is not quite statistically significant at the 10% level (Figure 5).

Stores in Philadelphia became 5 percentage points (17%) more likely to carry untaxed beverages after the tax; in particular, they were 11 percentage points more likely to carry bottled water. In Oakland, the probability that a store carried a given taxed beverage fell by 8 percentage points (14%), with the largest decline for regular soda (13 percentage points). Surprisingly, the probability that stores in Oakland stocked *untaxed* beverages also fell, by 5 percentage points (12%), in contrast to our findings in Philadelphia.

**Figure 5. Impact of SSB Taxes on the Availability of Taxed Beverages**



Notes: The SSB tax in Oakland (1 cent per ounce) reduced the availability of SSBs in stores by 7.7 percentage points or 14%. The beverage tax on SSBs and diet soft drinks in Philadelphia (1.5 cents per ounce) reduced the availability of taxed beverages in retailers by 4.5 percentage points or 17% (not quite statistically significant at the 10% level). The height of the bars represent the estimate of the tax's impact on availability, with the 95% confidence interval shown by the black vertical bracket.

These strategic responses by stores were confirmed by our interviews with retailers; 13 of 31 reported stocking fewer taxed beverages as a result of the tax. Nearly half of the Philadelphia retailers (8 of 17) said they also stocked more untaxed beverages as a result of the tax—something not reported by the vast majority of retailers in Oakland (only 1 of 14).

In general, substantial percentages of retailers reported strategic responses to the tax in Philadelphia (15 of 17) and Oakland (10 of 14). Their responses included posting signs notifying shoppers about the tax (12 of 31), increasing the prominence of untaxed beverages in the store (7 of 31), and adjusting the advertising outside their store (such as circulars) to promote taxed beverages less and untaxed beverages more (5 of 31).

*“We started stocking more untaxed beverages in small coolers near the register, and we put a sign on them saying ‘non-Philly beverage tax,’ so people would know nothing in there was taxed.”*

—Large grocery retailer

*“My customers trust that I’m charging them fair prices, so I wanted to be 100 percent transparent about why the [beverage] prices were suddenly a lot higher. So I listed the old price and the amount of the soda tax on the shelf tag. They could double-check our calculations and feel like we weren’t ripping them off.”*

—Large grocery retailer

## Discussion and policy implications

The results of our study suggest that there is no uniform, universal effect of a city-level SSB tax. The impacts on price, purchases, and consumption differ considerably between Philadelphia and Oakland, and they also differ from the effects documented earlier for cities like Berkeley and Boulder. The effects of SSB taxes may vary across cities for a number of reasons, including the amount of the tax, its scope (for example, whether it applies to diet or non-caloric drinks), and how sensitive consumers are to the prices of taxed drinks (which in turn could be based on weather, historic advertising, and the ease of cross-border shopping).

Because the efficacy of SSB taxes can vary greatly depending on a variety of factors, policymakers should carefully consider the details of the policy and the setting in which it will be implemented. For example, our study shows that prices rose by much more in Philadelphia than in Oakland, which is due to a higher tax rate (a policy decision) and because retailers passed on more of the tax to consumers (a decision by distributors and retailers). In addition, we found evidence in both cities of an increase in city residents shopping for taxed beverages outside of the city, particularly for Philadelphia, where it is relatively common and easy for many residents to shop outside of the city. By contrast, in Oakland, several of the nearby cities also have SSB taxes, and there are not many stores close to the city border because of the geography of the area, which limits the untaxed options for Oakland residents. Thus, the coverage of the tax matters; a tax covering a larger area (for example, a county, state, or federal tax) would reduce the ability of residents to avoid the tax by shopping outside of the taxed area. Finally, the level of consumption of SSBs prior to the tax could influence the efficacy of the tax. Philadelphia residents consumed substantially more SSBs on average before the tax than Oakland residents, which gives them more room to reduce consumption, and we found that those consuming high levels of SSBs prior to the tax in Philadelphia

were those that reduced consumption the most. All of these factors influence the finding that there is greater evidence of a decline in purchases and consumption in Philadelphia, although we do not find substantial declines in SSB consumption overall in either city.

Given that these taxes are recommended by a number of medical and public health organizations for their potential to improve health, and have been widely adopted worldwide, it is important to build and improve the limited evidence base on their effects. We contribute to the evidence base by evaluating the effect of the tax in two U.S. cities, and by making three novel contributions. We: 1) provide the first-ever evidence of the impact of any beverage taxes on children's beverage consumption; 2) examine qualitative data from interviews with store owners about their strategic responses to the taxes; and 3) comprehensively evaluate numerous outcomes using standardized methods in two cities.

We encourage researchers to continue evaluating the effects, particularly the longer-term effects, of these taxes in additional cities and countries to better understand the factors that influence the efficacy of the taxes. We also encourage researchers to evaluate the effects of the tax on other outcomes, such as the effect on retailers and labor market outcomes, and to continue to examine how the taxes affect low-income communities (including how the revenues collected from the taxes help these communities). Such efforts will ensure that, as additional countries and cities consider designing and implementing such taxes, they have the most accurate information available.

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## Analytic approach

We used a “difference-in-differences” or DiD approach to estimate the impacts of beverage taxes. The approach estimates the relative change in outcomes (such as consumption) in the city that implemented the tax (the treated city) relative to comparison areas without a tax.

This approach has two data requirements: (1) data from both before and after the tax was implemented and (2) data for the treated city and a comparison area that is a reasonable counterfactual for the treated city. What constitutes a reasonable comparison area is dictated by the assumptions of the DiD approach, which requires the trend in the outcome to be the same in both areas. In other words, there can be no unobserved changes in trends for outcomes in the treated city around the time of the tax that did not also occur in the comparison area. This requirement for the DiD approach is sometimes called the parallel trends assumption.

Our approach was to use geographic areas adjacent to the treated cities as comparisons. These areas are likely to have parallel trends in outcomes because they are part of the same media market (and thus have similar exposure to advertising and information); have similar weather; and likely experience the same changes to the beverage market, such as the availability of new products. We verified using an independent data source (retail scanner data from Nielsen) that the volume of sales and prices of taxed beverages in the treated cities and comparison areas have nearly identical trends in the year before the taxes.

**Limitations of the study.** Our study has several limitations to consider when interpreting the findings. For example, the original data collection includes few treatment cities and time periods (one before and one after the tax), which can limit the ability to detect impacts and examine changes in the impacts over time. Also, there are tradeoffs associated with our decision to choose comparison areas close to the treated cities. One advantage is that the treated cities and comparison areas were likely to experience any unobserved events that may have affected demand around the same time as the tax, but the disadvantage is that the taxes may have affected outcomes in the comparison areas, which would lead us to underestimate the impact of the taxes. The sample of retailers with whom we conducted qualitative interviews is relatively modest in size (N=33). The sample for the household survey included children between the ages of 2 and 17 years; however, most children we interviewed were under the age of 10. These younger children consumed fewer SSBs before the tax than the older children, which could limit our ability to detect reductions in consumption for children overall. Finally, the data on consumption is self-reported, which may contain some degree of reporting error. To the extent that any reporting error affected the treatment cities similarly to the comparison areas, using the DiD approach, the error will not bias our estimates of the impact of the tax on consumption.

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