In January 2017 Philadelphia, Pennsylvania, implemented an excise tax of 1.5 cents per ounce on beverages sweetened with sugar or artificial sweeteners. Small independent stores are an important yet understudied setting. They are visited frequently in urban and low-income areas, and sugary beverages are among the most commonly purchased items in them. We compared changes in beverage prices and purchases before and twelve months after tax implementation at small independent stores in Philadelphia and an untaxed control city, Baltimore, Maryland. Our sample included 134 stores with price data and 4,584 customer purchases. Compared with Baltimore, Philadelphia experienced significantly greater increases in the price of taxed beverages (1.81 cents per ounce, or 120.4 percent of the tax) and significantly larger declines in the volume of taxed beverages sold (5.76 ounces, or 38.9 percent) after tax implementation. Beverage excise taxes may be an effective policy tool for decreasing the purchase of sweetened drinks in small independent stores, particularly among populations at higher risk for sugar-sweetened beverage consumption.

**ABSTRACT** In January 2017 Philadelphia, Pennsylvania, implemented an excise tax of 1.5 cents per ounce on beverages sweetened with sugar or artificial sweeteners. Small independent stores are an important yet understudied setting. They are visited frequently in urban and low-income areas, and sugary beverages are among the most commonly purchased items in them. We compared changes in beverage prices and purchases before and twelve months after tax implementation at small independent stores in Philadelphia and an untaxed control city, Baltimore, Maryland. Our sample included 134 stores with price data and 4,584 customer purchases. Compared with Baltimore, Philadelphia experienced significantly greater increases in the price of taxed beverages (1.81 cents per ounce, or 120.4 percent of the tax) and significantly larger declines in the volume of taxed beverages sold (5.76 ounces, or 38.9 percent) after tax implementation. Beverage excise taxes may be an effective policy tool for decreasing the purchase of sweetened drinks in small independent stores, particularly among populations at higher risk for sugar-sweetened beverage consumption.
ing the imposition of a beverage tax (ranging from 45 percent to 107 percent) 9,15–17 and declines in the volume of taxed beverage purchases that ranged from 8 percent to 12 percent18,19 or were not detected.1i Some of this variation is partly due to differences by store type (for example, supermarkets versus pharmacies). However, no prior studies have focused on small independent stores.

Although most groceries are purchased at supermarkets,19 small independent stores are visited frequently in urban areas,20 where purchases almost always contain unhealthy foods21 that are heavily marketed.22 SSBs are among the most commonly purchased food or beverage items at independent stores.20,21,23 Studies in New York City have shown that 68 percent of low-income shoppers reported visiting a bodega one or more times per day20 and that some low-income shoppers report using these stores for all or most of their grocery shopping.23 A report from the Philadelphia Department of Public Health found that small stores accounted for 66 percent of all food retailers in the city and that these stores were disproportionately concentrated in low-income areas.24 Despite the ubiquity of such stores, little research has examined the influence that beverage taxes might have in this small retail setting.

This study aimed to evaluate the Philadelphia beverage tax’s influence on beverage prices and purchases among a large sample of small independent stores and their customers. The study’s secondary aims were to examine differences by beverage sweetener status and container size, income levels in stores’ neighborhoods, and customers’ education levels.

**Study Data And Methods**

**STUDY DESIGN** Using a natural experimental design, we examined beverage prices and customer purchases before and after implementation of the tax at small independent food retailers in Philadelphia compared to Baltimore, Maryland. Baltimore was selected as the control city because of its proximity to Philadelphia (without bordering it) and its population having a similar demographic profile.3 Stores were included in our sample if they were independent food retailers that sold at least three of the beverages assessed on our store audit forms. Tax implementation began January 1, 2017. Trained research staff collected data on beverage prices (once per store for each of the time periods described below and customer purchases at baseline (October–December 2016), as well as six months (June–August 2017) and one year (October–December 2017) after implementation of the tax (see online appendices A, B.1–B.3, and C.1–C.4 for additional design details).25 To assess possible economic spillover effects associated with the tax, the research staff also visited small independent stores in untaxed Pennsylvania counties that neighbor Philadelphia to obtain prices in each time period. Because beverage purchases vary by season, our primary analysis compared baseline and twelve-month data, which were collected during the same months in 2016 and 2017, respectively.

**BEVERAGE CATEGORIZATION** Based on Philadelphia’s beverage tax regulations (appendix A.1),25 we categorized beverages by Philadelphia tax status (taxed versus not taxed beverages), sweetener status (sugar sweetened, artificially sweetened, or unsweetened), and container size (individual or family size, where the latter refers to a container with more than thirty-six ounces based on the Food and Drug Administration’s definition of maximum reasonable consumption in one sitting).26 Prevalences of brand-size combinations and beverages by sweetener type are listed in appendices B.3 and C.2.25

**BEVERAGE PRICES**

▸ PROCEDURES: We randomly sampled 100 stores for each location (using a list of stores from ReferenceUSA),27 stratified by income based on the store ZIP code. Many of the stores from the randomly sampled lists were permanently closed, so replacements were selected from nearby independent food retailers with the same income classification. We had to use ZIP codes rather than census tracts when sampling because the research staff had to quickly determine income status in the field based on store address. Low-income ZIP codes were defined as those whose population included at least 30 percent of people with incomes at or below the federal poverty level based on the American Community Survey. All others were considered other-income ZIP codes. For the stores in neighboring untaxed counties, the threshold was lowered to at least 20 percent of residents at or below poverty, because none of those ZIP codes met the 30 percent threshold. For our analysis, we reassigned stores’ income status to low income or other income based on census tracts (rather than ZIP codes), to better represent the stores’ immediate neighboring areas.

We used store price audit forms (appendix D.1)25 adapted from previous studies20 to capture price changes in Philadelphia relative to Baltimore, and in Pennsylvania counties neighboring Philadelphia (Delaware, Bucks, and Montgomery Counties) compared to Baltimore to assess the Philadelphia tax’s influence on stores in Philadelphia and in neighboring untaxed counties. We collected price audits from fifty-three stores in...
Philadelphia, sixty in Baltimore, and forty-eight in neighboring untaxed counties. To conduct a complete case analysis, we excluded stores with missing values (because of ownership changes, store closings, or refusal to participate) to create a final analytic sample of forty-four stores in Philadelphia (twenty-two each in low-income and other-income counties), forty-five stores in Baltimore (sixteen in low-income and twenty-nine in other-income counties), and forty-five stores in neighboring untaxed counties (eighteen in low-income and twenty-seven in other-income counties).

- **MEASURES**: Store observations by research staff documented the availability (yes or no) and price of thirty-one beverages (twenty-four taxed and seven not taxed; for a list of the beverages, see appendix D.1), based on the most frequently purchased beverages at Philadelphia corner stores. Price data were recorded based on shelf prices for specific items by volume and brand (for example, a twelve-ounce bottle of Coke). The exceptions were milk and water, which were recorded by volume (for example, one gallon) but not brand because of regional brand variation. When prices were unlisted, staff members asked store employees or purchased the beverage.

- **CUSTOMER PURCHASES**

- **PROCEDURES**: We conducted objective customer purchase assessments at fifty-seven independent stores in Philadelphia and sixty-six in Baltimore. To meet baseline sample-size targets for our surveys, we collected data at sixty-two of the stores where we also obtained price data, as well as another sixty-one stores where we did not (we identified these stores via convenience sampling). Customer purchase assessment data were not collected in Pennsylvania counties neighboring Philadelphia because of funding constraints and a short data collection window before the tax was implemented. Research staff stood outside stores on weekdays at three times of day (8:00–10:30 a.m., 11:00 a.m.–1:00 p.m., and 2:30–5:30 p.m.) for approximately two months and asked every customer leaving a store who appeared at least thirteen years old if they had purchased any food or beverage item and would allow a bag check (for additional details about customer purchase assessments, see appendix C.1). The final cross-sectional sample sizes, which included customers who purchased any food or beverage item and excluded customers who purchased only nondible items, were 2,001 purchases at baseline (880 purchases at low-income stores and 1,121 at other-income stores) and 2,583 purchases at twelve months (1,218 and 1,365, respectively).

- **MEASURES**: The research staff recorded detailed descriptions, volumes, quantities, and prices for each individual food or beverage item purchased and asked customers to report the total amount they had spent, the frequency with which they visited the store and consumed SSBs, and their demographic characteristics (for data collection forms, see appendixes D.2 and D.3).

- **OUTCOME VARIABLES**: For our price analyses, the primary outcomes were the change in mean beverage price (in cents per ounce) of taxed and not taxed beverages. For our customer purchase analyses, there were multiple primary outcomes (purchased ounces of taxed beverages, purchased ounces of not taxed beverages, and the sum of those two). The secondary outcomes were changes in beverage price and total purchased ounces by sweetener type (for taxed beverages only), beverage container size, store income level, and customer’s education level. We also examined total amounts spent (including food/ beverages and other items) and—to assess tax avoidance—the self-reported frequency of buying sweetened beverages in neighboring jurisdictions.

- **STATISTICAL ANALYSES**: Taking a difference-in-differences approach, we used generalized linear mixed-effects models with random intercepts for stores to estimate changes in mean prices and purchase volumes. Each model included an indicator for the period (after versus before implementation of the tax), store location, and their interaction (which produced the difference-in-differences estimate of the tax effect). For price analyses, separate models compared Philadelphia to Baltimore and Philadelphia’s neighboring counties to Baltimore (to examine whether the tax influenced prices at stores bordering Philadelphia). The percentage of the tax passed on to customers is the estimated change in cents per ounce divided by 1.5 cents per ounce (the Philadelphia tax). The results of sensitivity, subgroup, and price elasticity analyses appear in

**Our results suggest that the taxes may help people with lower income or education levels more than those with higher levels.**
Tests were two-sided, and the significance threshold was 0.05. A Bonferroni correction was used to adjust analyses (two corrections each for tax status and sweetener type and four corrections each for container size, income, and education). Analyses were conducted using SAS, version 9.4, and were replicated by a second author.

LIMITATIONS This study had several limitations. First, we partially relied on a convenience sampling of stores and did not gather data on evening and weekend purchases, which limited the generalizability of our findings.

Second, although sociodemographic characteristics of Philadelphia and Baltimore were similar over time, we could not rule out the possibility that unobserved factors might have changed, causing time-dependent residual confounding.

Third, because trends in beverage volumes sales before implementation of the tax were parallel for large chain retailers in Philadelphia and Baltimore in the year before implementation, we assumed that this was also true for small retailers. However, we could not test this assumption directly.

Fourth, many independent stores did not post prices, which led us to rely on storeowner and clerk reports. However, the rate at which stores didn’t post prices and the reliability of reports were not expected to differ between cities. Nonetheless, we observed large declines in the prices of not taxed beverages in Philadelphia, which might have been because the average amount spent was small ($6.00 at baseline), so price increases were salient. In addition, our study and previous studies20,23,29 show that some customers visit small stores often (40 percent of customers visit at least weekly, and 15 percent visit daily), which may contribute to price change saliency.

Fifth, our customer purchase data represent repeated cross-sections rather than longitudinal data.

Sixth, we did not collect customer purchase assessments at stores in neighboring untaxed counties to assess possible tax avoidance. This also means that our elasticity calculation did not include an offset for purchases outside Philadelphia.

Seventh, our response rate in Baltimore at twelve months (55 percent) was comparable to the rates in other studies,26 but the Philadelphia rate was lower (17 percent). We did not expect either rate to change over time.

Eighth, we could not rule out the possibility that customers who purchased taxed beverages at independent stores before implementation of the tax switched after implementation to buying taxed beverages at larger stores, where less of the tax has been passed on to customers via price changes.5

Ninth, we were unable to adjust for the volume of customers who visited each store.

Finally, our sample sizes for artificially sweetened beverages were small: At baseline, in low-income neighborhoods there were two purchases in Philadelphia and fourteen in Baltimore, and in other-income areas there were nine and fifteen purchases, respectively.

Study Results

CHANGE IN BEVERAGE PRICES The characteristics of price-audited stores were similar across Philadelphia, Baltimore, and the neighboring counties (appendix B.2).25 In Philadelphia compared to Baltimore, there was a price increase between baseline and twelve months later of 1.81 cents per ounce (95% confidence interval: 1.52, 2.09; appendix B.4),25 or 28.5 percent (exhibit 1)—a 120.4 percent tax pass-through. There were no significant changes in the prices of not taxed beverages in any analyses (exhibit 1 and appendix B.4).25 The price increases were 1.78 cents per ounce (95% CI: 1.46, 2.09), or 27.9 percent, for SSBs and 1.96 cents per ounce (95% CI: 1.20, 2.72), or 31.7 percent, for artificially sweetened beverages. For taxed beverages in individual-size containers, the price increase was 1.77 cents per ounce (95% CI: 1.50, 2.05), or 24.9 percent. For taxed beverages in family-size containers, the increase was 1.17 cents per ounce (95% CI: 1.01, 1.33), or 37.0 percent. Changes in mean beverage prices are shown in appendix B.5.25

In low-income neighborhoods, taxed beverage prices increased by 2.01 cents per ounce (95% CI: 1.52, 2.49), or 32.9 percent, while in other-income neighborhoods, they increased 1.64 cents per ounce (95% CI: 1.21, 2.08), or 25.1 percent. There were no significant changes in prices among taxed and not taxed beverages in neighboring counties, compared to Baltimore. Similar price results were found in our sensitivity analyses (appendix B.6),25 six-month audits (appendix B.7),25 and the small sample of chain convenience stores combined with the independent stores (appendix B.8).25 Energy drink price results are shown in appendix B.9.25

CUSTOMER CHARACTERISTICS AND PURCHASE VOLUME CHANGES Customers in the baseline sample were mostly male (55.6 percent in Philadelphia and 57.7 percent in Baltimore), black (69.0 percent and 72.2 percent, respectively), and ages eighteen and older (89.2 percent and 92.9 percent, respectively) and had at least some college (43.5 percent and 41.8 percent, respec-
Changes in beverage prices per ounce at small independent stores in Philadelphia or Baltimore from baseline to 12 months after implementation of the excise tax in Philadelphia, by selected characteristics, 2016–17

| Mean cents per ounce | Philadelphia Baseline | Philadelphia After tax | Baltimore Baseline | Baltimore After tax | Change in cents per ounce | Amount of tax passed through to customer | Difference-in-differences estimate |
|----------------------|-----------------------|------------------------|--------------------|---------------------|--------------------------|------------------------------------------|----------------------------------|
| ALL                  |                       |                        |                    |                     |                          |                                          |                                  |
| Taxed                | 6.11                  | 7.87                   | 6.25               | 6.31                | 28.5%                    | 120.4%                                   | 1.81****                         |
| Not taxed            | 6.35                  | 6.56                   | 6.57               | 6.82                | −0.7                     | −a                                       | −0.04                            |
| BY SWEETENER TYPE    |                       |                        |                    |                     |                          |                                          |                                  |
| Sugar (taxed)        | 6.10                  | 7.85                   | 6.23               | 6.31                | 27.9%                    | 118.4%                                   | 1.78****                         |
| Artificial (taxed)   | 6.16                  | 7.98                   | 6.35               | 6.33                | 31.7                     | 130.7                                    | 1.96****                         |
| IN INDIVIDUAL-SIZE CONTAINER |            |                        |                    |                     |                          |                                          |                                  |
| Taxed                | 6.94                  | 8.68                   | 6.96               | 6.98                | 24.9%                    | 118.3%                                   | 1.77****                         |
| Not taxed            | 7.85                  | 8.25                   | 8.00               | 8.08                | 4.1                      | −a                                       | 0.35                             |
| IN FAMILY-SIZE CONTAINER |                    |                        |                    |                     |                          |                                          |                                  |
| Taxed                | 3.22                  | 4.55                   | 3.30               | 3.50                | 37.0%                    | 78.0%                                    | 1.17****                         |
| Not taxed            | 5.23                  | 5.27                   | 4.62               | 4.69                | −1.0                     | −a                                       | −0.05                            |
| STORE IN LOW-INCOME CENSUS TRACT |                  |                        |                    |                     |                          |                                          |                                  |
| Taxed                | 5.71                  | 7.66                   | 6.32               | 6.28                | 32.9%                    | 133.7%                                   | 2.01****                         |
| Not taxed            | 6.10                  | 6.05                   | 6.43               | 6.54                | −2.6                     | −a                                       | −0.16                            |
| STORE IN OTHER-INCOME CENSUS TRACT |              |                        |                    |                     |                          |                                          |                                  |
| Taxed                | 6.44                  | 8.08                   | 6.20               | 6.33                | 25.1%                    | 109.6%                                   | 1.64****                         |
| Not taxed            | 6.54                  | 6.93                   | 6.66               | 7.05                | 0.1                      | −a                                       | 0.01                             |

**Source:** Authors’ analysis of price data from forty-four small independent stores in Philadelphia, Pennsylvania, and forty-five in Baltimore, Maryland. **Notes:** The tax was implemented January 1, 2017. Baseline was October–December 2016. “After tax” was October–December 2017. The difference-in-differences estimates compare changes in price over time between Philadelphia and Baltimore. “Taxed” refers to beverages covered under Philadelphia’s tax of 1.5 cents per ounce on sugar-sweetened (any taxed beverages that contain sugar as an ingredient) and artificially sweetened beverages. “Not taxed” refers to beverages not covered. Baltimore had no comparable tax. Individual-size containers hold no more than thirty-six ounces; family-size containers hold more than that amount. Census tracts with 30 percent or more of the population living in poverty (based on five-year American Community Survey estimates from 2014) are considered “low income,” and the rest are “other income.” The analysis includes thirty-eight stores in low-income census tracts and fifty-one stores in other-income census tracts. The change in cents per ounce, the amount of tax passed through to customers, and the difference-in-differences estimates compare changes in price over time between Philadelphia and Baltimore. *Not applicable. a0.01. b0.05. c0.01. d0.001.

Although the percentage of black participants was higher in Baltimore than in Philadelphia (consistent with these cities’ demographics), descriptive statistics were similar across the two cities and both at baseline and twelve months after implementation of the tax. Philadelphia had more purchases in low-income neighborhoods (45.3 percent), compared to Baltimore (43.1 percent; appendix C.3). In Philadelphia compared to Baltimore, there was a decline of 5.76 ounces (95% CI: −9.64, −1.89), or 38.9 percent, in the volume of taxed beverages purchased, and no significant change in the ounces of not taxed beverages purchased (exhibits 3 and 4, appendix C.5). All analyses are unadjusted. Including covariates in the primary analysis did not appreciably change the parameter estimates, standard errors, or our conclusions (appendix C.6). The reduction in taxed beverage purchases was driven by a reduction of 4.94 ounces (95% CI: −8.45, −1.44), or 37.2 percent, in the purchase of SSBs. There were no significant changes in the purchases of artificially sweetened beverages, though few were purchased overall. For taxed drinks in individual-size containers, the volume purchased declined by 2.63 ounces (95% CI: −5.24, −0.02), or 25.4 percent. For those in family-size containers (sold less frequently than individual-size containers at corner stores), the decline was 3.07 ounces (95% CI: −6.65, 0.51), or 70.9 percent. In low-income neighborhoods, the volume of taxed beverages declined by 6.78 ounces (95% CI: −12.84, −0.73), or 41.5 percent. There was no significant change in other-income neighborhoods. Although education did not significantly moderate the volume of sales of taxed beverages, exploratory stratified analyses showed that people with lower education purchased 6.41 fewer ounces (95% CI: −12.14, −0.68), a decline of 38.5 percent, of taxed beverages in Philadelphia compared to Baltimore, twelve months after implementation of the tax, while there was no significant difference among those with higher education. Education level moderated the volume of sales of not taxed beverage purchases (inter-
Descriptive statistics for customers and their purchases at small independent stores in Philadelphia or Baltimore, at baseline and 12 months after implementation of the excise tax in Philadelphia, 2016–17

|                                | Philadelphia Baseline | After tax | Baltimore Baseline | After tax |
|--------------------------------|-----------------------|----------|--------------------|----------|
| **No. of customers**           | 768                   | 816      | 1,233              | 1,767    |
| **Sex**                        |                       |          |                    |          |
| Male                           | 55.6%                 | 62.7%    | 57.7%              | 57.2%    |
| Female                         | 44.3%                 | 37.2%    | 42.3%              | 42.7%    |
| Other                          | 0.1%                  | 0.1%     | 0.0%               | 0.1%     |
| **Race**                       |                       |          |                    |          |
| White                          | 27.4%                 | 16.3%    | 16.6%              | 18.0%    |
| Black                          | 69.0%                 | 76.6%    | 72.2%              | 74.5%    |
| Other                          | 3.7%                  | 7.1%     | 11.1%              | 7.5%     |
| Hispanic                       | 6.8%                  | 6.6%     | 3.9%               | 4.3%     |
| **Highest level of education** |                       |          |                    |          |
| Less than high school          | 10.0%                 | 12.3%    | 15.2%              | 13.0%    |
| High school or GED             | 46.4%                 | 48.1%    | 43.0%              | 41.3%    |
| Some college or associate’s degree | 16.6%             | 19.1%    | 19.9%              | 18.6%    |
| Bachelor’s degree or higher    | 26.9%                 | 20.5%    | 21.9%              | 27.1%    |
| **Age, years**                 |                       |          |                    |          |
| 13–17                          | 10.8%                 | 5.3%     | 7.1%               | 5.4%     |
| 18 or older                    | 89.2%                 | 94.7%    | 92.9%              | 94.6%    |
| **Store in low-income neighborhood** | 45.3%       | 55.0% | 43.1%              | 43.5%    |
| **City resident**              | 97.4%                 | 94.5%    | 92.1%              | 87.2%    |
| **Frequency of visiting store**|                       |          |                    |          |
| 1-3 times per month            | 27.8%                 | 17.7%    | 30.4%              | 34.2%    |
| 1-6 times per week             | 45.2%                 | 35.0%    | 36.5%              | 35.0%    |
| 1-3 times per day              | 23.2%                 | 34.6%    | 26.8%              | 22.5%    |
| 4 or more times per day        | 3.8%                  | 12.7%    | 6.4%               | 8.3%     |
| **Frequency of cross-border shopping** |                   |          |                    |          |
| Never                          | 30.8%                 | 28.5%    | —                  | —        |
| 1 time per month or less       | 9.0%                  | 9.9%     | —                  | —        |
| 2-3 times per month            | 5.4%                  | 4.4%     | —                  | —        |
| 1-2 times per week             | 1.8%                  | 5.2%     | —                  | —        |
| 3-6 times per week             | 0.4%                  | 2.2%     | —                  | —        |
| 1 time per day                 | 0.3%                  | 1.0%     | —                  | —        |
| 2-3 times per day              | 0.1%                  | 0.8%     | —                  | —        |
| 4 or more times per day        | 0.0%                  | 0.3%     | —                  | —        |
| **Who was this purchase for?** |                       |          |                    |          |
| Only the customer              | 74.0%                 | 69.6%    | 63.6%              | 70.8%    |
| To share                       | 25.3%                 | 26.2%    | 31.0%              | 24.0%    |
| Someone else                   | 0.7%                  | 4.2%     | 5.4%               | 5.2%     |
| Purchased a beverage           | 65.1%                 | 56.1%    | 46.0%              | 51.5%    |
| Purchased a taxed beverage     | 45.8%                 | 34.7%    | 33.8%              | 40.5%    |
| Purchased a not taxed beverage | 23.2%                 | 24.1%    | 14.8%              | 12.7%    |
| **Frequency of consuming sugar-sweetened beverages** |                 |          |                    |          |
| Never                          | 19.9%                 | 19.1%    | 17.0%              | 9.8%     |
| 1-6 times per week             | 58.5%                 | 44.6%    | 37.7%              | 35.4%    |
| Daily                          | 21.5%                 | 36.3%    | 45.3%              | 54.8%    |
| **Frequency of consuming artificially sweetened beverages** |                 |          |                    |          |
| Never                          | 62.0%                 | 77.8%    | 82.1%              | 80.9%    |
| 1-6 times per week             | 27.9%                 | 15.8%    | 11.8%              | 12.2%    |
| Daily                          | 10.1%                 | 6.3%     | 6.1%               | 6.8%     |
| **Mean amount spent on purchase** | 86.0%       | 5.7%    | 57.7%              | 57.4%    |

**Source:** Authors’ analysis of 4,584 customer purchases at 123 small independent stores in Philadelphia or Baltimore. **Notes:** The tax was implemented January 1, 2017. Baseline was October–December 2016. “After tax” was October–December 2017. Customers were people who purchased any food or beverage item. Subcategories do not always sum to totals as we excluded “don’t know” and “refused to answer” responses. The p values for the differences between groups are in appendix C.3 (see note 25 in text). We adjusted for covariates that were imbalanced across cities (sex, race, ethnicity, education, age, who the purchase was for, frequency of visiting the store, city residency, body mass index, and total amount spent). Because this did not change the standard errors, we present the unadjusted models. Appendix C.6 provides more information on model selection. Significance refers to the standardized mean difference between cities for a given variable. *Not applicable. *p < 0.10 **p < 0.05 ***p < 0.01 ****p < 0.001
Discussion

This study found that 120.4 percent of the Philadelphia beverage tax was passed on to purchasers of taxed beverages via price increases at small independent stores one year after the tax was implemented (exhibit 1). We did not find evidence that small stores in counties that border Philadelphia increased their prices. The volume of taxed beverages purchased declined significantly—by 38.9 percent, or approximately 6 ounces, per customer (exhibits 3 and 4). For context, intensive randomized controlled behavioral trials designed to reduce SSB intake have found reductions in total energy intake\(^31\) or body mass index\(^32\) due to SSB reductions of approximately 11–14 ounces per day.

Although other Philadelphia tax studies have demonstrated substantial declines in the volume of taxed beverages sold in chain supermarkets or by mass merchandisers,\(^6\) prior studies have not evaluated small-store settings\(^5\) or have reported null results of similar magnitude to ours in small stores,\(^7\) which may be due to smaller sample sizes.

The observed 120 percent pass-through of the tax in small independent stores is in line with the results of another study of the Philadelphia tax that included an estimated sixty chain and independent small stores.\(^8\) That study found 140 percent pass-through at independent stores, 87 percent pass-through at convenience stores, and 130 percent pass-through at small grocery stores.\(^8\) In contrast, a one-year evaluation of the Berkeley beverage tax reported price decreases in thirteen independent corner stores and one independent gas station following implementation of the tax.\(^14\)

The current study adds to the literature that shows considerable pass-through variation based on retailer type: drugstores or pharmacies ranged from 18 percent\(^33\) to 104 percent,\(^7\) convenience stores from 37 percent to 93 percent,\(^9\) supermarkets from 43 percent\(^2\) to 107 percent,\(^14\) small grocery stores or small chain supermarkets from 0 percent\(^13\) to 131 percent,\(^14\) and liquor stores at 135 percent.\(^33\) We do not know if the more than 100 percent pass-through for small stores observed in this study was due to the decisions of distributors or store owners. Store owners may have been trying to maximize profits following implementation of the tax, compensating for other operational costs, or responding to pass-through rates from distributors that differed from the rates for larger stores.

Our volume results showed that the absolute declines in taxed beverage purchases among customers shopping in low-income neighborhoods and people with lower education levels were slightly larger (–6.78 ounces and –6.41 ounces, respectively).
respectively) compared to the overall decline (−5.76 ounces) and that consumers with low education were purchasing significantly more not taxed beverages (for example, water). Studies of the Philadelphia beverage tax, including this one, have not found evidence of overall substitution of not taxed beverages for taxed ones,5,7,8 but these results suggest some limited substitution at small stores among consumers with lower education levels.

One criticism of beverage taxes is that they are regressive, because the tax is a larger percentage of income for low-income people than for high-income ones. However, our results suggest that the taxes may help people with lower income or education levels more than those with higher levels. We found large price increases in independent stores that led to reductions in SSB sales. These stores are frequented by low-income customers20,21,23,29,34,35 and disproportionately concentrated in low-income areas,24,36 and SSBs are a top-selling item for them.20,21,23 Low-income people consume more SSBs than high-income people do9 and are disproportionately affected by health problems linked to excessive SSB consumption.37 Therefore, if beverage taxes produce greater SSB reductions among this group without unhealthy foods being used as substitutes for SSBs, low-income people may have greater long-term health benefits and fewer health care costs. Dedicating revenue to programs that provide greater benefit to low-income populations, as was done in Philadelphia, could further address regressivity concerns.

Our study results also showed a marginal trend toward greater total spending at small stores.

EXHIBIT 4

Changes in beverage volume sales per purchase at small independent stores in Philadelphia or Baltimore from baseline to 12 months after implementation of the excise tax in Philadelphia, by selected characteristics, 2016–17

| Raw mean volume (ounces) | Philadelphia | Baltimore | % change | Difference-in-differences estimate |
|--------------------------|--------------|-----------|----------|-----------------------------------|
| **ALL**                  |              |           |          |                                   |
| Taxed                    | 14.35        | 9.88      | 9.96     | 12.37                             | −38.9 | −5.76*** |
| Not taxed                | 8.59         | 7.17      | 3.79     | 3.49                              | −2.1  | −0.18  |
| **BY SWEETENER TYPE**    |              |           |          |                                   |
| Sugar (taxed)            | 13.15        | 9.1       | 7.71     | 9.91                              | −37.2 | −4.94***|
| Artificial (taxed)       | 0.46         | 0.43      | 0.53     | 0.50                             | 0.3   | 0.00   |
| **IN INDIVIDUAL-SIZE CONTAINERS** |          |           |          |                                   |
| Taxed                    | 10.35        | 7.75      | 7.26     | 8.59                              | −25.4 | −2.63** |
| Not taxed                | 4.83         | 4.37      | 2.43     | 2.04                             | 10.6  | 0.49   |
| **IN FAMILY-SIZE CONTAINERS** |          |           |          |                                   |
| Taxed                    | 4.00         | 2.13      | 2.70     | 3.78                              | −70.9 | −3.07  |
| Not taxed                | 3.76         | 2.80      | 1.36     | 1.45                             | −20.8 | −0.79  |
| **STORE IN LOW-INCOME CENSUS TRACT** |          |           |          |                                   |
| Taxed                    | 16.21        | 10.59     | 7.84     | 10.83                             | −41.5 | −6.78** |
| Not taxed                | 4.66         | 5.23      | 4.52     | 4.13                             | 40.8  | 2.15   |
| **STORE IN OTHER-INCOME CENSUS TRACT** |          |           |          |                                   |
| Taxed                    | 12.81        | 9.01      | 11.57    | 13.57                             | −37.7 | −4.92  |
| Not taxed                | 11.85        | 9.55      | 3.24     | 3.00                             | −14.6 | −1.73  |
| **CUSTOMER WITH LOW EDUCATION** |          |           |          |                                   |
| Taxed                    | 16.21        | 10.92     | 11.01    | 12.63                             | −38.5 | −6.41**|
| Not taxed                | 5.28         | 6.23      | 3.74     | 2.19                             | 56.5  | 2.89   |
| **CUSTOMER WITH HIGH EDUCATION** |          |           |          |                                   |
| Taxed                    | 12.06        | 8.43      | 8.66     | 12.10                             | −38.7 | −5.33  |
| Not taxed                | 13.07        | 8.73      | 3.94     | 5.17                              | −33.0 | −4.05  |

SOURCE Authors’ analysis of 4,584 customer purchases at 123 small independent stores in Philadelphia or Baltimore. NOTES The tax was implemented January 1, 2017. Baseline was October–December 2016. “After tax” was October–December 2017. “Taxed” and “not taxed,” sugar-sweetened and artificially sweetened beverages, individual- and family-size containers, and low-income census tracts are explained in the notes to exhibit 1. Of the 4,584 customer purchases in the study, 2,098 were at stores located in low-income census tracts, and 2,486 were at stores in other-income census tracts. Customer education is based on self-report of highest level of education. “Low education” means having a high school diploma, GED, or less. “High education” means having at least some college. Of the purchases, 2,559 were made by customers who reported low education, and 1,945 were made by customers who reported high education (80 purchases were missing data on education level). The percent change and the difference-in-differences estimates compare changes in volume sales over time between Philadelphia and Baltimore. The 95% confidence intervals for the difference-in-differences estimates and the p values are in appendix C.5 (see note 25 in text). ***p < 0.001 **p < 0.01
after tax implementation that was driven by increases in spending in low-income neighborhoods. This suggests that customers, especially those with low education who increased their purchases of not taxed beverages, may be spending more at these stores, though we do not know what they are purchasing (for example, unhealthy foods versus healthy foods or household products). Because healthy food availability is limited in these stores, it is important to understand whether unhealthy foods are being used as substitutes for SSBs. Taken together, beverage price increases of more than the amount of the tax and a lack of decline or possible increase in the total amount spent on purchases suggest that the Philadelphia beverage tax did not necessarily have a negative business impact on independent stores, although data on total sales or revenue were not available.

Unlike any other existing US beverage tax, artificially sweetened beverages were also taxed in Philadelphia to broaden the tax base, address regressivity concerns, and help achieve revenue targets for education and infrastructure programs. Previous Philadelphia tax studies showed similar relative declines in sugar-sweetened and artificially sweetened beverages in chain supermarkets or nonsignificant consumption declines, or did not distinguish among purchases. Although we found no change in the volume of artificially sweetened beverages purchased, these drinks are so infrequently purchased in these settings that it is hard to draw conclusions.

We found a small but significant increase in customer-reported frequency of buying sweetened beverages in neighboring counties irrespective of store type, which suggests some tax avoidance—amounting to an extra trip outside the city every two months. Some tax avoidance is consistent with a study of chain retailers that estimated that 25 percent of the decline in the volume of taxed beverages purchased in Philadelphia was made up for by new purchases outside the city, and another study that showed customers already making trips outside the city were more likely to purchase taxed beverages in nearby jurisdictions. Estimates of tax avoidance in Berkeley appear to be higher than those in Philadelphia but lower than those in Oakland.

Because of the convenience-oriented nature of small-store purchases compared to large-store purchases, we would expect to find limited tax avoidance for small-store purchases.

Conclusion
This study had a number of strengths, including a natural experiment design with a non-neighboring city as a control; a large panel of small independent stores in urban settings, followed over one year; several objective measures of customer purchases; and a diverse sample population. Understanding the influence of a sweetened beverage tax on these stores is of great interest to policy makers, who understandably want local small businesses—not only their customers—to thrive. Taken together, our results suggest that beverage excise taxes may be an effective policy tool to decrease sweetened drink purchases from small independent retailers in urban areas, particularly among populations at high risk for SSB consumption.

NOTES

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