

12 Month Report: Store Audits & Child Cohort

THE EVALUATION OF SEATTLE'S SWEETENED BEVERAGE TAX

MARCH 2020

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EXECUTIVE SUMMARY

CHANGE IN BEVERAGE PRICES AND CONSUMPTION – A YEAR LATER

This report summarizes findings from data collected 12 months after implementation of the Seattle Sweetened Beverage Tax. The tax went into effect on January 1, 2018 in the City of Seattle and is a 1.75 cent per ounce excise tax placed on sugar-sweetened beverages. The tax is paid by distributors of these beverages. Before the tax was implemented, it was unknown whether distributors would increase sugary beverage prices for retailers, and whether retailers, in turn, would increase the shelf prices of sugary beverages paid by consumers. It was also unknown whether the tax would result in consumers decreasing their purchases and consumption of sugary beverages.

We conducted surveys of beverage prices in stores and restaurants and surveys with lower-income children and parents before, six months after, and 12 months after tax implementation to assess whether the tax is passed on to consumers via higher retail prices of taxed beverages. To attempt to isolate the effect of the tax, we compared changes in Seattle to any changes seen in the comparison area of Federal Way, Kent, and Auburn (where no sugar-sweetened beverage tax was in effect). Store audits at 12 months included surveys of 25,756 beverages within 386 stores or restaurants. The family surveys at 12 months included 315 children and parents with lower incomes.

KEY FINDINGS

12 MONTHS AFTER IMPLEMENTATION OF THE SEATTLE SWEETENED BEVERAGE TAX

Did the price of taxed beverages increase?

- **Yes. The overall average price increase was 1.55 cents per ounce, which represents 89% of the tax passed through to consumers.** The average price of all taxed beverages types increased significantly more in Seattle than the comparison area, with the exception of sweetened syrups added to coffee drinks, which did not increase in price. Soda had the lowest price pass-through of all beverage types, and bottled tea had the highest price pass-through. The amount of the tax passed through to the consumer ranged from 82% to 115% by beverage.
- **Prices increased significantly in most store types within Seattle.** Prices of taxed beverages increased more so than in the comparison area, except in coffee shops and warehouses. The percentage of the tax passed through to the consumer on average was: 113% in quick service restaurants, 101% in grocery and drug stores, 86% in superstores and supermarkets, and 82% in small stores.
- **While prices in stores near the northern and southern borders of Seattle also increased, they were lower than elsewhere in the City.** We examined prices of beverages in 35 stores that were within 1 mile of the southern and northern border of the City. We found that, on average, pass-through was lower (64% tax price pass-through) in stores close to the border than the citywide average (89% tax price pass-through).

Did consumption of taxed beverages decrease?

- **Yes, albeit in both Seattle and the comparison area.** Lower-income children living in Seattle reduced their consumption of sugary beverages subject to the tax (-3.3 ounces per day). This reduction did not significantly differ from the reduction seen among children living in the comparison area (-3.9 ounces per day).
- **The percentage of lower-income children who are high consumers of taxed beverages decreased both in Seattle and the comparison area.** Among lower-income Seattle children, the decrease shifted from 33% to 20% consuming ≥ 8 ounces daily and 30% to 17% consuming 1+ time daily. These changes were not significantly different from the decreases among comparison area children (shift from 34% to 20% consuming ≥ 8 ounces daily; and shift from 29% to 14% consuming 1+ time daily).
- **Among lower-income parents, consumption of taxed beverages decreased both in Seattle and the comparison area.** Like their children, this change did not differ from comparison area parents' decrease in average consumption; the percentage of parents who were high consumers of taxed beverages also decreased in Seattle and the comparison area. The decrease did not differ between Seattle and the comparison area.
- **Of the various types of sugary beverages, lower-income Seattle children decreased their consumption of soda/pop the most.**

CONCLUSIONS

One year after implementation, this study finds that the tax on sugary beverages incurred by distributors is being passed through to consumers. This confirms the hypothesized impact of the tax on beverage prices. This study also finds that, as expected, lower-income children and parents living in Seattle who were part of our sample reduced sugary beverage consumption from before to after the Sweetened Beverage Tax implementation. Unexpectedly, the reductions observed among Seattle families were similar to reductions observed among comparison area families over the one-year period. This is unexpected given that over the same period, the prices of taxed sugary beverages in Seattle increased more than they did in the comparison area (section one). These findings could be the result of general norms and trends in sugary beverage consumption, limitations in our measurement of beverage consumption, or other unknown factors affecting beverage consumption among lower-income families in our region. In comparison, a recent study (Powell, 2020) of store product scanner codes also found that one year after implementation, 1) the tax was being passed through to Seattle consumers; and 2) volumes of sugary beverage purchases fell in Seattle (above and beyond decreases seen in Portland, their study's comparison area), indicating the tax resulted in a decrease on purchases of sugary beverages in Seattle. Looking ahead, we will repeat a final round of data collection from stores and families to assess whether changes are sustained 24 months after implementation of the tax.

SECTION 1 | CHANGE IN BEVERAGE PRICES – A YEAR LATER

SUMMARY

The primary objective of the store audits is to see how much of the 1.75 cents per ounce tax on sweetened beverages put on Seattle distributors is passed through to customers (“price pass-through”), focusing primarily on the impact of the tax on prices of taxed beverages approximately 12 months after the tax began. Secondary objectives include assessing whether the tax impacted the price of non-taxed beverages and whether the pass-through was different for stores near the border of Seattle. We additionally qualitatively assess how the price pass-through changed, comparing the short-term results from data collected six months after the tax implementation to the medium-term results from 12-months after the tax was implemented.

Trained staff collected information about beverage prices in stores and restaurants in-person in Seattle and the comparison area (Federal Way, Kent, and Auburn) before the tax was implemented (baseline) and approximately 12 months after the tax had been in effect. They collected prices from a total of 25,756 beverages in 386 stores and restaurants. We included 7 different types of stores or restaurants: supermarkets/superstores, grocery stores/drug stores, small stores, quick service restaurants, coffee shops. We included 7 categories of taxed beverages: soda, sports beverages, energy beverages, juice-flavored beverages, bottled sweetened tea, bottled sweetened coffee, and the sweetened flavor syrup added to coffee beverages in coffee and tea stores. We included 13 categories of non-taxed beverages: diet soda, diet energy beverages, diet sports drinks, 100% juice, milk, water, diet powdered beverage mix, diet or unsweetened bottled tea, diet or unsweetened bottled coffee, chocolate milk, sweetened powdered beverage mix, prepared coffee beverages, sugar free flavored syrup added to coffee beverages.

Key findings and conclusions

The average price of all taxed beverage types increased significantly more in Seattle than the comparison area, with the exception of sweetened syrups added to coffee drinks. The overall average price increase was 1.55 cents per ounce, which represents 89% of the tax passed through to consumers.

When looking separately at specific beverage types, the amount of the tax passed through to the consumer ranged from 82% to 115%. Soda had the lowest price pass-through of all beverage types, and bottled tea had the highest price pass through.

When looking separately at specific store and restaurant types, the price of taxed beverages increased significantly in most store types within Seattle, more so than in the comparison area. The exceptions were in coffee shops, and warehouses, both of which included a smaller sample size which may contribute to our inability to detect a statistically significant effect. The percentage of the tax passed through to the consumer on average was: 113% in quick service restaurants, 101% in grocery and drugstores, 86% in superstores and supermarkets, and 82% in small stores.

To explore whether pass-through was lower in stores near the Seattle city border, we examined prices of beverages in 35 stores that were within 1 mile of the southern and northern border of the City. We found that, indeed, on average, pass-through was lower (64% tax price pass-through) than the citywide average in stores close to the border. The price of a few non-taxed sugar-free beverages increased in Seattle, above and beyond changes seen in the comparison area. The price of diet soda and diet/unsweetened tea increased 0.30 cents per ounce and 1.12 cents per ounce, respectively, which represent 17% and 64% of the price of the tax. By store, grocery store/drug stores and small stores had significant increases of 0.36 cents per ounce and 0.61 cents per ounce for non-taxed sugar-free beverages.

Comparing short-term to medium-term price changes showed that price pass-through was generally moderate to high at both time points (ranging from 64% to 108% at six months, to 82-115% at 12 months).

SECTION 1 | CHANGE IN BEVERAGE PRICES – A YEAR LATER

OBJECTIVE

The main questions answered in this report are:

Question 1: How much of the 1.75 cents per ounce tax on sugary beverages put on distributors in Seattle did stores and quick service restaurants pass through to consumers (“price pass-through”)?

- Did the amount of tax passed through to the consumer vary by beverage type and by store/restaurant type?
- Did the amount of tax passed through to the consumer differ for stores near Seattle’s border compared to the citywide average?
- How do the changes in price observed 12 months after implementation of the tax compare to the changes seen six-months after tax implementation?

Question 2: Did the price of any non-taxed beverages change?

RESULTS AND DISCUSSION

In this section we briefly describe the methods used in this study. An extended description of these methods is in **Appendix A**.

Stores, restaurants, and beverages include in the study sample

Trained data collectors surveyed stores in-person in Seattle and the comparison area (Federal Way, Kent, and Auburn) to measure beverage prices at three time points: before the tax was implemented (baseline), and approximately six (May–July 2018) and 12 months after the tax went into effect (October–November 2018).

Of the 458 stores in our sample at baseline (pre-tax), 413 (90%) were re-surveyed during the 6-month post-tax follow up visit, and 386 at 12-months post-tax (93% of stores visited, and 84% of stores surveyed at baseline; **Table 1**). At 12 months, four (1%) were permanently closed when we returned or no longer meet study criteria, and 23 (6%) refused to participate.

TABLE 1. THE NUMBER OF STORES SURVEYED AT 12-MONTHS IN SEATTLE AND THE COMPARISON AREA, BY STORE TYPE

	SEATTLE	COMPARISON AREA
SUPERSTORE/SUPERMARKET	29	22
GROCERY/DRUG STORES	44	25
SMALL STORE	56	64
QUICK SERVICE	40	57
COFFEE SHOP	18	22
WAREHOUSE	1	1
BUBBLE TEA SHOP*	7	0
SUBTOTAL	195	191
GRAND TOTAL		386

**Bubble tea shops are excluded from the analyses presented below as we were not able to complete follow-up surveys in any comparison area bubble tea shops.
**store definitions are provided in appendix b.*

Trained staff collected prices from a total of 25,756 beverages in 386 stores and restaurants. Prices were collected for multiple types of taxed and non-taxed beverages from different types of stores or restaurants: supermarkets/superstores, grocery stores/drug stores, small stores, quick service restaurants, coffee shops. **Appendix C** displays the beverage types and individual beverages that we examined in each beverage type category. For each beverage measured, we recorded the price and availability of multiple packaging sizes (e.g., 12oz cans, 20oz bottles, 1-liter bottles, 12 packs of 12oz cans).¹ **Table 2** displays the total number of beverages, grouped by beverage type and by store type, for which we recorded a price during the baseline or 12-month post-tax visit.

Trained staff collected prices from a total of 25,756 beverages in 386 stores and restaurants.

TABLE 2. TOTAL NUMBER OF BEVERAGES SURVEYED, GROUPED BY BEVERAGE TYPE AND STORE TYPE	
	NUMBER OF BEVERAGES INCLUDED IN ANALYSIS (N=25,756)
TAXED BEVERAGES	12,005
SODA	6,547
SPORTS BEVERAGES	1,450
ENERGY BEVERAGES	2,205
JUICE BEVERAGES	344
TEA, BOTTLED	905
SUGARY SYRUP ADD ON	76
COFFEE, BOTTLED	554
NON-TAXED SUGAR-FREE BEVERAGES	12,361
DIET SODA	4,453
DIET SPORTS BEVERAGES	759
DIET ENERGY BEVERAGES	1,927
100% JUICE	733
MILK	2,305
WATER	1,123
POWDERED SUGAR-FREE	275
TEA, BOTTLED SUGAR-FREE	577
COFFEE, SF PREPARED	208
SUGAR-FREE SYRUP ADD-ON	69
NON-TAXED SUGAR-SWEETENED BEVERAGES	1,390
CHOCOLATE MILK	596
POWDERED SUGAR ADDED	642
COFFEE, PREPARED (E.G. SWEETENED LATTES)	151
BEVERAGES WITHIN EACH STORE TYPE	
SUPERSTORES/SUPERMARKETS	8,037
GROCERY/DRUG STORES	7,060
SMALL STORES	9,245
WAREHOUSES	118
COFFEE SHOPS	361
QUICK SERVICE RESTAURANTS	935

¹ Please contact the study team for a full copy of the 12-month survey instruments.

QUESTION 1 RESULTS | HOW MUCH OF THE TAX DID STORES AND QUICK SERVICE RESTAURANTS PASS THROUGH TO CONSUMERS?

Our primary goal was to assess the impact of the tax on prices of beverages. To do so, we tested whether the tax increased prices of taxed beverages more in Seattle than in the comparison area. Conceptually, we used the price changes in the comparison area as an estimate of what we think would have happened to prices in Seattle had Seattle not passed a tax (i.e. changes due to market trends, inflation, seasonality). We attribute any change in price in Seattle above and beyond changes in the comparison area to the tax, thus calculated the price change in Seattle after subtracting out the change in the comparison area. Statistically speaking, we used a difference-in-difference model to estimate how much the price of beverages in Seattle changed above and beyond price changes for the same beverages in the comparison area. The difference-in-difference model assumes that the trend in the comparison area is a reasonable substitute for the price trend we would have expected in Seattle, had Seattle not passed the Sweetened Beverage Tax. It is equivalent to subtracting the change in prices over this time period in the comparison area from the change in prices over this time period in Seattle. All beverage price results are presented as mean price per ounce, to more easily compare price changes to the price of the tax (1.75 cents per ounce).

Our primary goal was to assess the impact of the tax on prices of beverages. To do so, we tested whether the tax increased prices of taxed beverages more in Seattle than in the comparison area.

...we calculated the pass-through rate, the percentage of the tax (1.75 cents per ounce) that is passed through to consumers.

In addition, we calculated the **pass-through rate**, the percentage of the tax (1.75 cents per ounce) that is passed through to consumers (e.g., if a price goes up by 1.50 cents per ounce, this is 86% pass-through or $1.50/1.75*100$).

AVERAGE PRICE CHANGES IN SEATTLE AND THE COMPARISON AREA

First we compared the average changes in beverage prices between baseline and 12-months-post-tax in Seattle and the comparison area (**Table 3**). We discuss the impact of the tax on prices and difference-in-difference results in the following section.

By beverage type.

In Seattle, the **average price of all taxed beverage types increased significantly**, except for sweetened syrup added to coffee beverages, which has an ambiguous tax status (**Table 3**, Seattle Difference Column). Price increases in Seattle ranged from 1.49 cents per ounce to 2.06 cents per ounce.

We included sweetened syrups added to coffee beverages in coffee shops in our taxed category. Their tax status is ambiguous, however, since retailers can provide a signed written statement to the distributor stating that the syrups will be added to drinks that have milk as their primary ingredient, and the distributor will not be taxed for these syrups (Ord. 125324, § 2, 2017. Section 5.53.020). The average price of adding these syrups increased by 12.42 cents per flavor shot in Seattle, but price changes had a large range and were not statistically significant.

In the comparison area, only the prices of soda and bottled tea increased significantly, 0.32 cents per ounce for both beverages. This increase in the price of soda in the comparison area likely contributes to decreases in the overall pass-through rate for soda (discussed further below). All other beverages in the comparison area had small, non-statistically significant changes in price (**Table 3**).

By store type.

In Seattle, the price of taxed beverages increased significantly in all store types with the exception of coffee shops, which were only statistically significant at the 0.10 level, and warehouses, which saw a large but non-statistically significant increase (2.73 cents per ounce; **Table 3**, Seattle Difference Column). In all other store types within Seattle, the increase was more than 1.75 cents per ounce on average.

In the comparison area, we observed a statistically significant increase in prices of taxed beverages in small stores and a marginally significant increase in price among quick service restaurants. Superstores/supermarkets and grocery stores/drug stores had smaller, non-statistically significant increases in prices. Non-statistically significant decreases in prices occurred in warehouses and coffee shops.

Though Seattle warehouses had the largest price increase for taxed beverages at 2.73 cents per oz., there was substantial variation in the estimate of the change in price, and the change is not statistically significant. Furthermore, there is a sizable decrease in the price of taxed beverages of 0.37 cents for ounce in comparison area warehouses. Because our sample contains only two warehouse stores, the number of observations in these models is relatively small. In Seattle there is only one store that met our warehouse definition.

TABLE 3. THE AVERAGE PRICE AND PRICE CHANGES IN CENTS PER OUNCE OF ALL TAXED BEVERAGES IN SEATTLE AND THE COMPARISON AREA AT BASELINE AND 12-MONTHS POST-TAX

	SEATTLE BASELINE, CENTS/OZ. (95% CI)	SEATTLE 12-MONTHS, CENTS/OZ. (95% CI)	SEATTLE DIFFERENCE, CENTS/OZ. (95% CI)	COMPARISON BASELINE, CENTS/OZ. (95% CI)	COMPARISON 12-MONTHS, CENTS/OZ. (95% CI)	COMPARISON DIFFERENCE, CENTS/OZ. (95% CI)
TAXED BEVERAGES	9.31 (8.92, 9.70)	11.25 (10.81, 11.69)	1.94* (1.73, 2.16)	8.88 (8.60, 9.17)	9.15 (8.84, 9.46)	0.26* (0.12, 0.41)
SODA	6.00 (5.72, 6.28)	7.78 (7.45, 8.11)	1.78* (1.61, 1.95)	5.69 (5.48, 5.91)	6.01 (5.78, 6.24)	0.32* (0.18, 0.46)
SPORTS BEVERAGES	5.88 (5.50, 6.26)	7.65 (7.21, 8.10)	1.78* (1.54, 2.01)	5.96 (5.53, 6.38)	6.11 (5.70, 6.52)	0.15 (-0.06, 0.36)
ENERGY BEVERAGES	21.01 (20.40, 21.62)	22.74 (22.03, 23.46)	1.73* (1.25, 2.22)	19.71 (19.33, 20.10)	19.72 (19.32, 20.11)	0.01 (-0.29, 0.30)
JUICE BEVERAGES	5.42 (4.79, 6.05)	7.19 (6.13, 8.25)	1.77* (0.85, 2.69)	6.05 (4.64, 7.46)	6.17 (5.10, 7.24)	0.12 (-1.13, 1.37)
TEA, BOTTLED	5.92 (5.56, 6.27)	7.98 (7.53, 8.43)	2.06* (1.76, 2.36)	5.83 (5.48, 6.18)	6.15 (5.79, 6.51)	0.32* (0.10, 0.53)
SWEETENED SYRUP ADD-ON	54.12 (43.52, 64.71)	66.53 (55.05, 78.02)	12.42+ (-2.37, 27.20)	50.00 (42.75, 57.25)	48.18 (43.21, 53.15)	-1.82 (-7.39, 3.75)
COFFEE, BOTTLED	20.23 (19.44, 21.01)	21.71 (20.87, 22.56)	1.49* (0.85, 2.13)	18.60 (17.83, 19.37)	18.70 (17.87, 19.53)	0.10 (-0.65, 0.85)
STORE TYPE						
SUPERSTORES / SUPERMARKETS	7.68 (7.32, 8.05)	9.48 (8.97, 9.98)	1.79* (1.48, 2.11)	7.17 (6.95, 7.40)	7.28 (6.97, 7.60)	0.11 (-0.12, 0.34)
GROCERY / DRUG STORES	9.42 (8.80, 10.05)	11.39 (10.61, 12.17)	1.97* (1.61, 2.33)	8.78 (8.26, 9.30)	8.82 (8.24, 9.40)	0.04 (-0.28, 0.36)
SMALL STORES	10.70 (10.20, 11.19)	12.63 (12.10, 13.16)	1.94* (1.51, 2.36)	9.65 (9.37, 9.92)	10.04 (9.79, 10.30)	0.39* (0.17, 0.62)
WAREHOUSES	5.71	8.44	2.73	5.78	5.41	-0.37

	(2.83, 8.59)	(4.31, 12.57)	(-2.30, 7.77)	(2.78, 8.78)	(2.30, 8.53)	(-4.69, 3.96)
COFFEE SHOPS	54.12 (43.52, 64.71)	66.53 (55.05, 78.02)	12.42* (-2.37, 27.20)	50.00 (42.75, 57.25)	48.18 (43.21, 53.15)	-1.82 (-7.39, 3.75)
QUICK SERVICE RESTAURANTS	10.90 (9.59, 12.22)	13.17 (11.74, 14.61)	2.27* (0.92, 3.62)	10.48 (9.70, 11.26)	10.88 (10.09, 11.66)	0.40* (-0.12, 0.92)

*P≤0.05

*P≤0.10

Note: the overall ‘taxed beverages’ category does not include the sweetened syrup add-on flavor shot. In coffee shops, the only taxed beverage measured was the sweetened syrup add-on described above. For this reason, the coffee shop taxed beverage results are the same as the sweetened syrup add-on results.

OVERALL IMPACT OF THE TAX ON TAXED BEVERAGE PRICES IN SEATTLE, ABOVE AND BEYOND COMPARISON AREA CHANGES: DIFFERENCE-IN-DIFFERENCE RESULTS

Our findings suggest that the tax resulted in an increase in the average price of all measured taxed beverage types in Seattle, above and beyond price changes in the comparison area, except for sweetened syrups added to coffee drinks. After accounting for changes in the comparison area (the difference-in-differences) and controlling for price variations by store characteristics (store “fixed effects”), beverage type, and/or beverage size, the overall average price increase was 1.55 cents per ounce, which represents 89% of the tax (**Table 4**).

Our findings suggest that the tax resulted in an increase in the average price of all measured taxed beverage types in Seattle, above and beyond price changes in the comparison area, except for sweetened syrups added to coffee drinks.

The tax amount passed through to the consumer ranged from 82% to 115% by beverage type.

The tax amount passed through to the consumer ranged from 82% to 115% by beverage type. By store type, the price increases on taxed beverages were statistically significant among superstores and supermarkets, grocery and drug stores, small stores, and quick service restaurants. Prices increased but did not reach statistical significance in warehouses and coffee shops.

TABLE 4. THE ESTIMATED IMPACT OF THE TAX ON PRICES OF TAXED BEVERAGES IN SEATTLE (THE DIFFERENCE-IN-DIFFERENCES) AFTER CONTROLLING FOR STORE CHARACTERISTICS (STORE “FIXED EFFECTS”), BEVERAGE TYPE, AND/OR BEVERAGE SIZE AND ACCOUNTING FOR PRICE CHANGES IN THE COMPARISON AREA

	12 MONTH DIFFERENCE-IN-DIFFERENCE, INCLUDING ALL BEVERAGES MEASURED CENTS PER OZ., (95% CI)	PASS-THROUGH RATE, THE PERCENT OF THE 1.75 CENTS/OZ. PASSED TO CONSUMERS
TAXED BEVERAGES	1.55 (1.34, 1.76)*	89%
SODA	1.44 (1.25, 1.63)*	82%
SPORTS BEVERAGES	1.56 (1.26, 1.86)*	89%
ENERGY BEVERAGES	1.78 (1.22, 2.33)*	102%
JUICE BEVERAGES	1.65 (0.71, 2.59)*	94%
TEA, BOTTLED	2.02 (1.64, 2.39)*	115%

SUGARY SYRUP ADD-ON	13.68 (-2.85, 30.22)+	--
COFFEE, BOTTLED	1.70 (0.74, 2.66)*	97%
STORE TYPE		
SUPERSTORES / SUPERMARKETS	1.50 (1.15, 1.85)*	86%
GROCERY / DRUG STORES	1.76 (1.42, 2.10)*	101%
SMALL STORES	1.43 (1.03, 1.84)*	82%
WAREHOUSES	2.08 (-0.84, 4.99)	119%
COFFEE SHOPS	13.68 (-2.85, 30.22)+	--
QUICK SERVICE RESTAURANTS	1.97 (0.73, 3.21)*	113%

*P≤0.05

+P≤0.10

Note: 'taxed beverages' overall excludes the sugary syrup add-on.

We also investigated price pass-through by beverage size. Pass-through was 94% on individual size beverages, 86% on 2 Liters and 93% on 12-packs (**Appendix D**).

LIMITED TO SAME BEVERAGES IN SAME STORE OVER TIME

Our primary tax impact results presented above include all measured beverages, regardless of whether the beverage was present at both time points (approximately 12,000 taxed beverages total). These findings reflect the average change in prices faced in stores and restaurants by consumers in our sampled beverages at baseline and the 12-month follow-up. To see how prices changed for a given beverage over time, we limited analyses to the same beverages in the same stores during both the baseline and 12-month store audits (approximately 10,000 taxed beverages total). Findings obtained when limited to the same beverages over time were similar to the average findings from all beverages (**Appendix E**).

STORES NEAR SEATTLE BORDER

The tax may be affecting beverage prices in stores near the Seattle border differently than in other stores. Some other cities with beverage taxes (Berkeley and Philadelphia) report that pass-through tends to be lower in stores closer to the city border, presumably due to nearby competition. To explore whether this was the case in Seattle, we examined prices of beverages in 35 stores that were within 1 mile of the southern and northern border of the city, and compared the price changes in these stores to the price changes in the comparison area stores (**Table 5**). We found that, indeed, on average, pass-through was lower in stores close to the border (64% tax price pass-through) than the citywide average.

TABLE 5. THE ESTIMATED IMPACT OF THE TAX (DIFFERENCE-IN-DIFFERENCE) AMONG STORES WITHIN 1 MILE OF SEATTLE'S NORTHERN OR SOUTHERN BORDER COMPARED TO ALL STORES IN THE COMPARISON AREA

	DIFFERENCE OF DIFFERENCES, CENTS/OZ. (95% CI)	PASS-THROUGH RATE, THE PERCENT OF THE 1.75 CENTS/OZ. PASSED TO CONSUMERS	NUMBER OF BEVERAGES IN ANALYSIS
TAXED BEVERAGES	1.14 (0.76, 1.51)*	64%	7434
NON-TAXED BEVERAGES	0.03 (-0.23, 0.30)	--	8057

*P≤0.05

COMPARISON TO SIX-MONTH RESULTS

We qualitatively assessed how the price pass-through changed over time by comparing the short-term results from data collected six months to the medium-term results collected 12-months after tax implementation. The 12-month follow-up is a useful comparison because the baseline and the follow-up are at the same time of year. It was also of interest to compare price differences between the shorter-term six-month follow-up and the 12-month follow-up to see if retailers are changing the way they respond to the tax over time. To assess changes at six-months versus twelve-months, we compared the price pass-through rates from models including all measured beverages, controlling for store characteristics, beverage type and beverage size (**Figure 1**).

At both time points (six-months and 12-months), with the exception of sweetened syrups added to coffee drinks, all taxed beverages had increased significantly more in price in Seattle than in the comparison area, and pass-through was generally moderate to high (ranging from 64% to 108% at six months, to 82-115% at 12 months). Of note, the pass-through rate decreased for two beverage types (soda and energy beverages) and increased for four beverages (sports beverages, juice beverages, bottled tea, and bottled coffee) over the six months. Bottled coffee and juice beverages had the lowest pass-through rate at six-months (64% and 66%, respectively) and saw higher pass-through at 12 months (97% and 94%, respectively).

When comparing pass-through rates by store type at six and 12 months, results were similar (**Figure 2**). All store types had increased prices significantly from baseline to each time point, except warehouses and coffee shops which had noticeably larger increases at 12-months than at six-months. We observed notable qualitative differences in pass-through rates among small stores (decreased from 102% to 82%) and quick service restaurants (increased from 92% to 113%).

FIGURE 1. PRICE PASS-THROUGH BY BEVERAGE TYPE IN SEATTLE

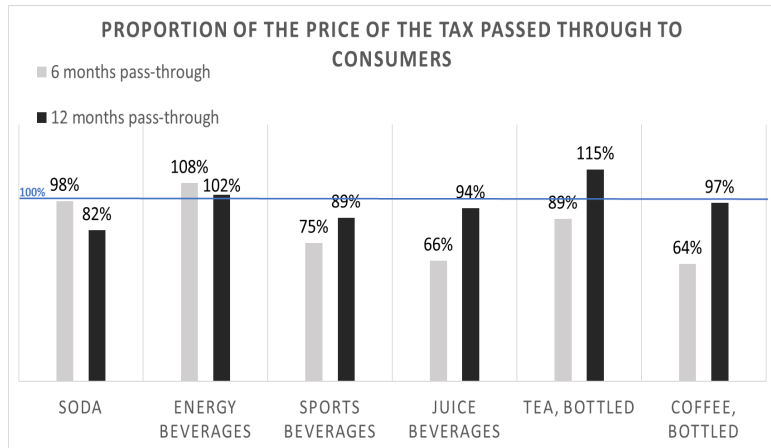


FIGURE 2. PRICE PASS-THROUGH BY STORE CATEGORY IN SEATTLE

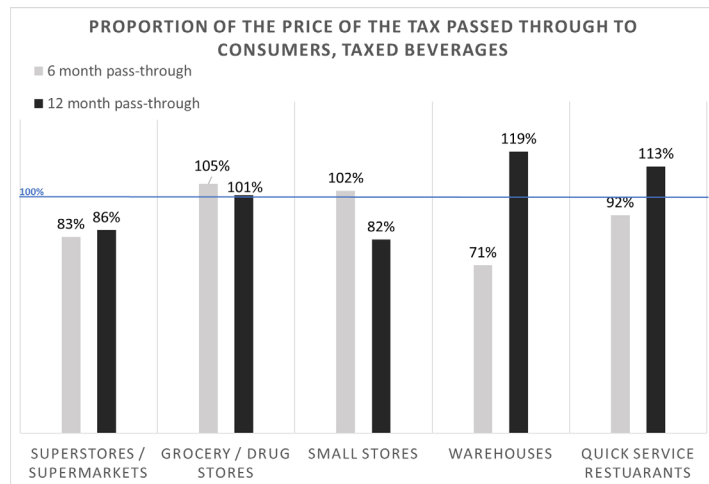


Figure note: We have excluded the sweetened syrup add-on and coffee shops from the figure. Because the sweetened syrup add-on is measured as a 'flavor shot' rather than per ounce, the mean cents result is not directly comparable to the mean cents per ounce results of other beverages and store types.

QUESTION 2 RESULTS | DID WE SEE CHANGES IN PRICE FOR NON-TAXED BEVERAGES?

In addition to investigating whether the tax affected prices of beverages subject to the tax, we examined whether the tax was associated with changes in the price of beverages not subject to the tax (**Table 6**).

The prices of two non-taxed sugar-free beverages increased in Seattle, above and beyond changes seen in the comparison area. Specifically, the price of diet soda and diet/unsweetened tea increased significantly at 0.30 cents per ounce and 1.12 cents per ounce, respectively, which represent 17% and 64% of the price of the tax, respectively. The price of milk decreased by 0.15 cents per ounce. Among the sugary beverages measured that are not subject to the tax (chocolate milk, powdered drink mixes with sugar, sweetened prepared coffee), there were no significant price increases in Seattle above and beyond changes seen in the comparison area.

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Results from the statistical model limited to only non-taxed beverages observed at both baseline and 12-months are in **Appendix F**. The findings are similar to those of the model including all beverages at both time points, with the exception of some diet/unsweetened tea beverages, which only increased by 0.45 cents per ounce (compared to 1.12 cents per ounce increase among all diet/unsweetened tea beverages). This suggests that stores were more like to carry higher priced teas on average by 12 months.

TABLE 6. THE ESTIMATED IMPACT OF THE TAX ON PRICES OF NON-TAXED BEVERAGES IN SEATTLE, ABOVE AND BEYOND CHANGES IN THE COMPARISON AREA (THE DIFFERENCE-IN-DIFFERENCES), AFTER ADJUSTING FOR STORE CHARACTERISTICS, BEVERAGE TYPE, AND BEVERAGE SIZE (N=12,361)

	12 MONTH DIFFERENCE-IN-DIFFERENCE, INCLUDING ALL BEVERAGES MEASURED CENTS PER OZ., (95% CI)	NUMBER OF BEVERAGES IN ANALYSIS
NON-TAXED SUGAR-FREE BEVERAGES		
DIET SODA	0.30 (0.09, 0.51)*	4453
DIET SPORTS BEVERAGES	0.20 (-0.11, 0.50)	759
DIET ENERGY BEVERAGES	0.37 (-0.25, 0.99)	1927
100% JUICE	0.14 (-0.40, 0.67)	733
MILK	-0.15 (-0.33, 0.02)+	2305
WATER	0.04 (-0.33, 0.41)	1123
POWDERED SUGAR FREE	0.03 (-0.07, 0.12)	275
TEA, BOTTLED SUGAR FREE	1.12 (0.66, 1.58)*	577
COFFEE, SF PREPARED	0.65 (-1.75, 3.04)	208
SUGAR-FREE SYRUP ADD-ON	6.03 (-31.40, 43.46)	69

NON-TAXED SUGAR-SWEETENED BEVERAGES		
CHOCOLATE MILK	-0.04 (-0.47, 0.39)	596
POWDERED SUGAR ADDED COFFEE, PREPARED (E.G. SWEETENED LATTES)	0.07 (-0.00, 0.14)+	642
	0.39 (-1.29, 2.07)	151
STORE CATEGORIES, NON-TAXED BEVERAGES		
SUPERSTORES/SUPERMARKETS	0.10 (-0.10, 0.31)	4651
GROCERY/DRUG STORES	0.36 (0.10, 0.61)*	3948
SMALL STORES	0.61 (0.32, 0.91)*	4350
WAREHOUSES	-0.13 (-1.02, 0.76)	77
COFFEE SHOPS	0.36 (-9.32, 10.04)	283
QUICK SERVICE RESTAURANTS	0.39 (-1.18, 1.97)	364

* $P \leq 0.05$

+ $P \leq 0.10$

Note: 'taxed beverages' overall excludes the sugary syrup add-on.

CONCLUSIONS

Twelve months after the implementation of Seattle's Sweetened Beverage Tax, we continue to observe generally high and consistent pass-through of the price of the tax to consumers in the city of Seattle. We found statistically significant price increases in all beverage categories, except sweetened syrup added to coffee (which has an ambiguous tax status), and nearly all store types. When looking at specific beverage types, we found that pass-through ranged from 82% (soda) to 115% (bottled tea). When looking specifically by store type, which included all beverages, pass-through ranged from 82% in small stores to 113% in quick service restaurants. Average pass-through in supermarkets was 86%. We found that pass-through was lower on average among stores within one-mile of the northern or southern border of Seattle.

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Analyses limited to specific beverages observed in a given store both at baseline and the 12-month follow-up showed similar results as analyses that included all beverages at each time point.

A recently published study by Powell and Leider (2020) used data from Seattle stores from store purchasing transactions at the Unique Product Code (UPC)-level (in other words, a record of all beverages purchased from a sample of stores according to the product UPC, which uniquely identifies each product) and estimated the price pass-through of the tax. That study reports a substantially lower pass-through compared to our results. As we describe below, the study designs of these two studies differ and would be expected to produce different estimates of pass through based on the way price is collected and the way the stores are sampled. Together, we believe the Powell study may be an underestimate of the price pass through that Seattle customers are experiencing.

One difference to note is that the sample of stores surveyed for the retail audit by the Seattle team (presented in this report) is balanced geographically across the city, with stores and restaurants of each type in sampled in each council district. To our knowledge, the stores included in the Powell study are stores that automatically share check-out data with Nielsen. While we do not know the exact stores that are in the Powell and Leider study, the UW study likely includes more small and independently-owned stores as compared to Powell and Leider, and better reflects the local experience. Additionally, the UW study includes the warehouse store, Costco. We are uncertain whether Costco is included in the Powell and Leider study.

Of importance, in our study, data was collected using shelf price (regular price and discounted prices) while Powell and Leider used information from check-out transactions at the product UPC-code level. This means the Powell study would not have detected any beverage tax added as a separate line item on the receipt. The on-the-ground work of the Seattle study team found that three large supermarket chains (Fred Meyer, QFC, and Metropolitan Market) are adding the tax at the register as a separate line item on the receipt (**Figure 3**). The Powell methodology does not capture this amount since it is not linked to a UPC code. Therefore, their estimate of the price pass through of the tax will exclude the actual price of the tax for all transactions in these three retailers (and possibly others), which would explain a lower pass-through estimate compared to what we found in the UW study.

We tested to see whether our results would be more similar to Powell and Leider had we excluded the amount of the beverage tax that is added at the register. We found that the estimates when ignoring this portion of the tax, which should not be ignored when estimating the pass-through, are substantially lower and closer to Powell's estimates (see Appendix G). We note that similar differences in the pass-through estimates were seen in Philadelphia when comparing the estimates from their scanner data (43% pass-through at supermarkets) to estimates from their store audits (approximately 100% pass-through) (Roberto, 2019) (Cawley, 2018).

There are a few additional considerations to note. Although we do not know which stores are included in the Powell study, if any of these three supermarket chains are included, the check-out transactions from these chains are likely to contribute a large fraction of the volume of taxed beverages in the Powell study (since they are chain supermarkets and since households likely purchase their large volume taxed beverages in supermarkets and since the Powell study weights prices by volume sold). Specifically, while 17 percent of the beverages we surveyed had the tax added at the register, we suspect that, because of the selection of stores and the weighting by what is actually purchased, the Powell study would include a larger fraction of beverages priced in this way.

FIGURE 3. EXAMPLE OF RECEIPT THAT INCLUDES BEVERAGE TAX SEPARATELY ADDED AT THE REGISTER TO THE LISTED SHELF PRICE.



Figure note: Unlike the Powell and Leider study, the Seattle study team collected information about taxes added on at the register (as shown in this receipt) and was able to include it in their estimation of price pass through, which leads to a higher estimate of pass-through.

Another difference derives from the sampling of stores and beverages. Powell and Lieder use beverages purchased at a sample of stores, whereas we use a sample of beverages for sale on store shelves at a sample of stores-- this difference in design affects the pass-through estimates in two ways. As above, because the Powell and Lieder study relies on scanner data, or store check-out transactions, whereas the Seattle study uses the price on the shelf, if people are more likely to buy taxed beverages only when they are on sale (for a lower total price), the average price paid will be lower on average for the scanner data than for the price observed on the shelf at one point in time (i.e., products may sit on the shelf longer when not on sale). This difference in the source of the price data would also lead to a lower estimate of pass-through in the Powell study compared to the Seattle study.

A final difference between the transaction data analyzed by Powell and Lieder and the Seattle retail audit study data, is that each product in the Powell and Lieder study is statistically weighted in proportion to the volume sold for each beverage. This means that the Powell and Lieder study allows for an estimate of pass-through based on what people buy (the Powell and Lieder study talks about this as ‘weighting’ the data to reflect the proportions in which people purchase different types and sizes of beverages). The Seattle study team beverage sample, again, is what people see on the shelves and reflect the shelf price for each beverage, but it is not weighted to be in proportion to the amount of each beverage that consumers purchase.

In conclusion, comparing the short-term (6 month) to the medium-term (12 month) results suggests some “learning” occurred, in that the range of pass-through rates generally narrowed, with 12-month pass-through rates increasing on beverages that had relatively lower pass-through rates at 6 months (bottled coffee and juice-flavored beverages).

LIMITATIONS

This study has limitations that should be noted. Although we surveyed a large sample of beverages and beverages of various sizes, we did not measure all beverages. Average price changes presented are not weighted according to the average frequency at which the population purchases each beverage type in each store type. We stratified analyses by beverage type and by store type, however, to account for the fact that our survey and sample design introduce differential probabilities of products and stores being included in the sample. We also adjusted our overall impacts for store characteristics, beverage type and beverage size. Although we include a large sample of stores in Seattle and our comparison area, we have only *a sample* of stores rather than a census of all stores. We did not include some popular grocery stores such as Whole Foods, Trader Joe’s, and PCC because these stores devote relatively little shelf space to sugary beverages. We were not able to survey a prepared coffee beverage that would be always subject to the tax, since coffee shop beverages that contain sugary syrup also tend to have milk as the primary ingredient and are therefore eligible for exemption from the tax. We were unable to include bubble tea stores in the comparison area at follow-up and instead were limited to examining only the change in price of these beverages in Seattle.

FUTURE WORK & CONSIDERATION FOR ONGOING EVALUATION

We have now collected and reported short-term (6 month) and medium-term (12 month) data on the impact of the tax on prices of beverages subject to the tax. We revisited these stores again between October and November 2019 to obtain a 24-month assessment and match the timing of our pre-tax and 12-month data collection. This will allow us to determine whether findings related to increased prices of taxed and non-taxed beverages are sustained in the long-term. These 24-month results will be available in 2020.

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SECTION 2 | CHANGE IN CONSUMPTION OF SUGARY BEVERAGES – A YEAR LATER

SUMMARY

We conducted surveys with lower-income children and parents living in Seattle and the South King County area (comparison area including Renton, Federal Way, Kent, Auburn, and other South King County cities) to measure their change in beverage consumption. Lower-income children and parents completed surveys at three time periods: before Seattle’s Sweetened Beverage Tax began in January 2018, six months (Spring 2018) and 12 months later. The primary objective was to explore whether consumption of sugary beverages that would be subject to the tax in Seattle changed from before to 12 months after the tax among children living in Seattle, compared to children and parents living in the comparison area where the same beverages were not subject to the Sweetened Beverage Tax. Secondary objectives included examining changes in percentage of high consumers (≥ 8 ounces per day or 1+ times per day) of taxed beverages, child beverage consumption changes at 6-months, parental changes in taxed beverage consumption, and child and parental change in consumption of non-taxed beverages. We also explored whether children changed their consumption of common foods with added sugar to compensate if they had reduced sugary beverage consumption.

Key findings and conclusions

Child consumption of taxed beverages:

- Lower-income children living in Seattle reduced their consumption of sugary beverages subject to the tax from before the tax went into effect to 12 months later (-3.3 ounces per day), but this reduction did not significantly differ from the reduction seen among children living in the comparison area (-3.9 ounces per day). Thus, we are not able to attribute the observed decrease in Seattle residents’ consumption of sugary beverages to the tax.
- The percentage of high consumers of taxed beverages decreased among Seattle children from before the tax to 12 months later (shift from 33% to 20% consuming ≥ 8 ounces daily, shift from 30% to 17% consuming 1+ time daily), but these changes were not significantly different from the decreases among comparison area children (shift from 34% to 20% consuming ≥ 8 ounces daily; and shift from 29% to 14% consuming 1+ time daily).

Additional findings:

- Lower-income parents living in Seattle decreased taxed beverage consumption, but like their children, this change did not differ from comparison area parents’ decrease in average consumption; although decreased, the change in the percentage of parents who were high consumers of taxed beverages did not differ between Seattle and the comparison area.
- Of the various types of sugary beverages, lower-income Seattle children decreased their consumption of soda/pop with sugar the most.
- Lower-income Seattle child and parent consumption of non-taxed beverages decreased from before the tax to 12 months later, but comparison area children and parents similarly reduced their non-taxed beverage consumption.
- Children did not increase their consumption of foods with added sugar from before the tax to 12 months later in either Seattle or the comparison area.
- The reductions seen in lower-income child and parent beverage consumption from before the tax to six- and 12-month follow-ups were similar, with no significant differences between Seattle and the comparison area.

As expected, lower-income children and parents living in Seattle reduced sugary beverage consumption from before to after the Sweetened Beverage Tax implementation. Unexpectedly, the reductions observed among Seattle families were similar to reductions observed among comparison area families over the one-year period. This is unexpected given that over the same period, the prices of taxed sugary beverages in Seattle increased

more than they did in the comparison area (section one) and evidence exists (Powell, 2020) that the volume of sugary beverages purchased in Seattle stores decreased from before to after the tax, but did not change much from another non-taxed comparison area (Portland, OR). Self-reported beverage consumption findings could be the result of general norms and trends in sugary beverage consumption, limitations in our measurement of beverage consumption, or other unknown factors affecting beverage consumption among lower-income families in our region.

SECTION 2 | CHANGE IN CONSUMPTION OF SUGARY BEVERAGES – A YEAR LATER

OBJECTIVE

Our primary objective was to examine whether children from lower-income families (<312% Federal Poverty Level) living in Seattle reduced their consumption of sugary beverages from before Seattle’s Sweetened Beverage Tax went into effect to the same time of year 12 months later when the tax was in effect. To test whether these changes were due to the tax itself or other things, we also examined changes in beverage consumption among children from lower-income families living in a nearby comparison area with no sugary beverage tax. We surveyed the same families before the tax, then six and 12 months later, instead of surveying different families at these time-points, so that other individual characteristics that may affect beverage consumption would remain constant across time-points. We also explored whether the children changed their consumption of common foods with added sugar to compensate for reduced sugary beverage consumption if it occurred.

RESULTS

We recruited and collected survey data from lower-income children and parents before the tax was implemented, six months later, and 12 months later, with 315 (n=127 in Seattle; n=188 in comparison area) children and parents available for final 12-month analysis. More details about recruitment of families are provided in the baseline (before the tax) report

(<https://www.seattle.gov/Documents/Departments/CityAuditor/auditreports/SBTBaselineReport.pdf>).

At both time points, parents reported on their own beverage consumption and on younger children’s (<11 years old) beverage consumption. Children 12 years old and older reported on their own beverage consumption. Parent and child surveys included a common measure of the frequency and typical volume consumed in the past 30 days of various beverages, including beverages taxed and not taxed in Seattle. Additional questions collected children’s consumption of foods that are frequent contributors to added sugar in their diets. More details about methods are available in the baseline report. Difference-in-difference analyses examined change over time between Seattle versus comparison area residents in taxed and non-taxed beverage consumption among children and adults, as well as change in children’s consumption of added sugar from food. Our retention rate at 12-month follow-up was 75% among eligible families, although removing outliers and those with incomplete data reduced the sample in the final 12-month analysis to 315. More details about the sample and data analyses are available in **Appendix H** to this report.

Lower-income children living in Seattle decreased their consumption of taxed beverages on average by 3.3 oz/day, and lower-income children in the comparison area decreased their consumption of the same types of beverages by 3.9 oz/day over the year since the tax began.

Changes in children’s consumption of taxed beverages

Lower-income children living in Seattle decreased their consumption of taxed beverages on average by 3.3 oz/day, and lower-income children in the comparison area decreased their consumption of the same types of beverages by 3.9 oz/day on average from before to one year since the tax began (**Table 1**). The difference in average reduction of taxed beverage consumption between Seattle and comparison area children is not statistically significant.

The biggest average absolute change from baseline to 12-month follow-up in lower-income children’s consumption of taxed beverages was for regular soda/pop with sugar among Seattle children (-1.8 oz/day), and fruit-flavored beverages with sugar among comparison area children (-1.2 oz/day). Seattle children’s consumption of sports beverages with sugar, fruit-flavored beverages with sugar, and prepared/bottled tea or coffee with sugar also decreased, with similar consumption decreases in these beverages among comparison area children (Table 1).

The biggest average absolute change from baseline to 12-month follow-up in lower-income children’s consumption of taxed beverages was for regular soda/pop with sugar among Seattle children (-1.8 oz/day), and fruit-flavored beverages with sugar among comparison area children (-1.2 oz/day).

TABLE 1. LOWER-INCOME CHILD CONSUMPTION OF TAXED BEVERAGES BEFORE THE TAX AND AT 12-MONTH FOLLOW-UP

	SEATTLE RESIDENCE			COMPARISON AREA RESIDENCE			DIFFERENCE -IN- DIFFERENCE*
	BEFORE THE TAX	12-MONTH	CHANGE	BEFORE THE TAX	12-MONTH	CHANGE	
BEVERAGES SUBJECT TO THE SWEETENED BEVERAGE TAX (TOTAL)– PREPARED/BOTTLED	9.1 (5.7, 12.5)	5.8 (4.3,7.4)	-3.3	8.9 (7.2,10.6)	5.0 (4.0,6.0)	-3.9	0.6 (-3.0,4.1)
• FRUIT-FLAVORED BEVERAGES WITH SUGAR	2.5 (1.5,3.4)	1.9 (1.2,2.6)	-0.5	2.8 (2.0,3.7)	1.7 (1.2,2.1)	-1.2	0.6 (-0.8,2.0)
• SODA/POP WITH SUGAR	3.6 (2.1,5.1)	1.8 (1.2,2.3)	-1.8	2.5 (2.0,3.1)	1.9 (1.5,2.3)	-0.7	-1.2 (-2.8,0.5)
• PREPARED/BOTTLED TEA OR COFFEE WITH SUGAR	0.6 (0.3,1.0)	0.5 (0.2,0.7)	-0.2	1.2 (0.7,1.6)	0.4 (0.1,0.6)	-0.8	0.6 (0.1,1.2)
• ENERGY BEVERAGES WITH SUGAR	0.1 (0,0.3)	0.1 (0,0.3)	0	0.1 (0,0.2)	0.2 (0,0.3)	0	0 (-0.3,0.2)
• SPORTS BEVERAGES WITH SUGAR	2.5 (0.5,4.5)	1.5 (0.9,2.2)	-0.9	1.9 (1.3,2.5)	0.9 (0.6,1.3)	-1.0	0 (-1.9,2.0)

Note. Values are means (95% Confidence intervals) in ounces per day, rounded to the nearest tenth and based on propensity-score weighted linear model.

*Difference-in-difference values are change in Seattle minus change in comparison area; difference-in-difference values closer to zero suggest no difference in changes from before the tax to after the tax in Seattle versus comparison area; positive values are in the direction of less change in Seattle than the comparison area and negative values in the direction of more change in Seattle than the comparison area.

We also examined whether the percentage of high consumers of taxed beverages changed. ‘High consumers’ were defined as 1) those consuming taxed beverages 1 or more times per day on average (high consumer based on frequency) or 2) those consuming 8 or more ounces of taxed beverages per day on average (high consumer based on volume). The percentage of Seattle children who consume more than 8 oz per day of taxed beverages went from 33% before the tax to 20% after the tax.

The percentage of Seattle children who consume more than 8 oz per day of taxed beverages went from 33% before the tax to 20% after the tax.

Similarly, the percentage of Seattle children who consume taxed beverages 1+ times per day dropped from 30% before the tax to 17% after the tax. Lower-income children in the comparison area showed similar decreases in high consumer percentages based on volume (34% to 20%) and on frequency (29% to 14%). These differences between the reductions in Seattle and the reductions in the comparison area (the difference-in-difference analyses) were not statistically significant (**Table 2**).

TABLE 2. PERCENTAGE OF LOWER-INCOME CHILDREN WHO ARE HIGH CONSUMERS OF TAXED BEVERAGES AT BASELINE AND 12-MONTH FOLLOW-UP

	SEATTLE RESIDENCE			COMPARISON AREA RESIDENCE			DIFFERENCE -IN- DIFFERENCE**
	BEFORE THE TAX	12-MONTH	RELATIVE CHANGE*	BEFORE THE TAX	12-MONTH	RELATIVE CHANGE*	
HIGH CONSUMER BASED ON FREQUENCY (1+ TIMES PER DAY)	30%	17%	.57	29%	14%	.48	1.19
HIGH CONSUMER BASED ON VOLUME (8+ OZ PER DAY)	33%	20%	.61	34%	20%	.59	1.03

Note. Before the tax and 12-month values are percentages of children.

**Relative change = ratio of 12-month to before the tax (12-month value divided by before the tax value); a relative change closer to 1 suggest little or no change, a time ratio significantly greater than 1 suggests an increase the percentage of high consumers and a relative change significantly less than 1 suggests a decrease in the percentage of high consumers.*

***Difference-in-difference = ratio of the Seattle relative change compared to the Comparison area relative change (Seattle relative change divided by the Comparison area relative change); a difference-in-difference value close to or equal to 1 suggests no differential change over time between Seattle and the Comparison area in percentage of high consumers, whereas a location by time ratio significantly less than 1 suggests more of a change in percentage of high consumers among Seattle than the Comparison area and a value significantly more than 1 suggests more of a change in percentage of high consumers among the Comparison area than Seattle.*

Changes in children’s consumption of non-taxed beverages

Lower-income children’s consumption of non-taxed beverages decreased in both Seattle (-11.1 oz/day) and the comparison area (-6.8 oz/day) from before the tax to 12-month follow-up (**Table 1**). The difference between the decreases in Seattle and in the comparison area for children’s consumption of non-taxed beverages is not statistically significant. Children’s consumption of water (tap, bottled, sparkling) also decreased in Seattle and the comparison area, with these not being significantly different changes (-6.9 oz/day and -2.1 oz/day, respectively; **Table 3**).

TABLE 3. LOWER-INCOME CHILD CONSUMPTION OF NON-TAXED BEVERAGES BEFORE THE TAX AND AT 12-MONTH FOLLOW-UP

	SEATTLE RESIDENCE			COMPARISON AREA RESIDENCE			DIFFERENCE -IN- DIFFERENCE**
	BEFORE THE TAX	12-MONTH	CHANGE	BEFORE THE TAX	12-MONTH	CHANGE	
NON-TAXED BEVERAGES INCLUDING WATER (TOTAL)	54.6 (47.4,61.7)	43.4 (37.7,49.2)	-11.1	52.9 (47.8,58.0)	46.2 (41.5,50.9)	-6.8	-4.4 (-14.5,5.8)

• WATER BEVERAGES (TAP, BOTTLED, SPARKLING) WITHOUT SUGAR	31.8 (27.4,36.2)	24.9 (21.6,28.3)	-6.9	32.0 (28.2,35.8)	29.9 (26.2,33.6)	-2.1	-4.8 (-11.8,2.1)
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Note. Values are means (95% Confidence intervals) in ounces per day, rounded to the nearest tenth and based on propensity-score weighted linear model.

*Difference-in-difference values are change in Seattle minus change in comparison area; difference-in-difference values closer to zero suggest no difference in changes from before the tax to after the tax in Seattle versus comparison area; positive values are in the direction of less change in Seattle than the comparison area and negative values in the direction of more change in Seattle than the comparison area.

Changes in parent’s consumption of taxed and non-taxed beverages

Lower-income parents had higher baseline and 12-month follow-up consumption of taxed beverages than their children. Like their children, Seattle parents decreased their consumption of taxed beverages (-4.9 oz/day). Parents in the comparison area decreased their consumption of sugary beverages to a similar degree (-6.6 oz/day), and the difference between these reductions is not statistically significant. The biggest absolute average change in individual taxed beverages for parents was for prepared/bottled tea or coffee with sugar in both Seattle (-2.0 oz/day) and soda/pop with sugar in the comparison area (-2.5 oz/day; **Table 4**).

Parents also decreased their consumption of non-taxed beverages by similar amounts; -13.0 oz/day among parents in Seattle and -12.8 oz/day among comparison area parents. Both also decreased water consumption by a lot and in amounts that did not differ significantly (**Table 4**).

Lower-income parents had higher baseline and 12-month follow-up consumption of taxed beverages than their children. Like their children, Seattle parents decreased their consumption of taxed beverages (-4.9 oz/day).

TABLE 4. LOWER-INCOME PARENT BEVERAGE CONSUMPTION BEFORE THE TAX AND AT TO 12-MONTH FOLLOW-UP

	SEATTLE RESIDENCE			COMPARISON AREA RESIDENCE			DIFFERENCE -IN- DIFFERENCE *
	BEFORE THE TAX	12-MONTH	CHANGE	BEFORE THE TAX	12-MONTH	CHANGE	
BEVERAGES SUBJECT TO THE SWEETENED BEVERAGE TAX (TOTAL) – PREPARED/BOTTLED	14.7 (10.6,18.8)	9.8 (7.3,12.3)	-4.9	14.2 (11.1,17.3)	7.6 (5.7,9.6)	-6.6	1.7 (-3.5,6.9)
• FRUIT-FLAVORED BEVERAGES WITH SUGAR	2.6 (1.4,3.8)	1.4 (0.8,2.0)	-1.2	2.6 (1.8,3.4)	1.2 (0.7,1.8)	-1.4	0.3 (-1.2,1.7)
• SODA/POP WITH SUGAR	5.3 (2.3,8.4)	3.6 (1.6,5.6)	-1.7	5.0 (3.4,6.5)	2.5 (1.7,3.2)	-2.5	0.8 (-1.7,3.2)
• PREPARED/BOTTLED TEA OR COFFEE WITH SUGAR	4.9 (3.2,6.6)	2.9 (1.7,4.0)	-2.0	4.2 (3.1,5.3)	2.9 (1.9,3.9)	-1.3	-0.7 (-3.1,1.7)

• ENERGY BEVERAGES WITH SUGAR	1.1 (0.3,1.9)	1.0 (0,1.9)	-0.1	0.6 (0.3,0.9)	0.7 (0,1.4)	0.1	-0.2 (-1.6,1.1)
• SPORTS BEVERAGES WITH SUGAR	0.8 (0.5,1.2)	0.9 (0.4,1.4)	0.1	1.7 (1.0,2.4)	0.6 (0.3,0.9)	-1.1	1.2 (0.3,2.1)
NON-TAXED BEVERAGES INCLUDING WATER (TOTAL)	71.5 (63.1,80.0)	58.5 (52.0,65.1)	-13.0	71.5 (66.0,76.9)	58.6 (53.9,63.4)	-12.8	-0.2 (-10.8,10.4)
• WATER BEVERAGES (TAP, BOTTLED, SPARKLING) WITHOUT SUGAR	43.5 (38.1,48.9)	33.0 (28.5,37.5)	-10.5	42.0 (38.3,45.7)	37.3 (33.7,40.9)	-4.7	-5.9 (-13.9,2.2)

Note. Values are means (95% Confidence intervals) in ounces per day, rounded to the nearest tenth and based on propensity-score weighted linear model.

*Difference-in-difference values are change in Seattle minus change in comparison area; difference-in-difference values closer to zero suggest no difference in changes from before the tax to after the tax in Seattle versus comparison area; positive values are in the direction of less change in Seattle than the comparison area and negative values in the direction of more change in Seattle than the comparison area.

As with their children, the percentage of lower-income parents in Seattle and the comparison area who are high consumers decreased, by similar amounts, from before the tax to 12-month follow-up (Table 5).

TABLE 5. PERCENTAGE OF LOWER-INCOME PARENTS WHO WERE HIGH CONSUMERS OF TAXED BEVERAGES AT BASELINE TO 12-MONTH FOLLOW-UP

	SEATTLE RESIDENCE			COMPARISON AREA RESIDENCE			DIFFERENCE -IN- DIFFERENCE**
	BEFORE THE TAX	12- MONTH	RELATIVE CHANGE*	BEFORE THE TAX	12- MONTH	RELATIVE CHANGE*	
HIGH CONSUMER BASED ON FREQUENCY (1+ TIMES PER DAY)	54%	41%	.76	40%	28%	.70	1.09
HIGH CONSUMER BASED ON VOLUME (8+ OZ PER DAY)	57%	43%	.75	42%	31%	.74	1.01

Note. Before the tax and 12-month values are percentages of children.

*Relative change = ratio of 12-month to before the tax (12-month value divided by before the tax value); a relative change closer to 1 suggest little or no change, a time ratio significantly greater than 1 suggests an increase the percentage of high consumers and a relative change significantly less than 1 suggests a decrease in the percentage of high consumers.

**Difference-in-difference = ratio of the Seattle relative change compared to the Comparison area relative change (Seattle relative change divided by the Comparison area relative change); a difference-in-difference value close to or equal to 1 suggests no differential change over time between Seattle and the Comparison area in percentage of high consumers, whereas a location by time ratio significantly less than 1 suggests more of a change in percentage of high consumers among Seattle than the Comparison area and a value significantly more than 1 suggests more of a change in percentage of high consumers among the Comparison area than Seattle.

Changes in children's consumption of food with added sugar

A concern about attempts to reduce children's consumption of sugar from certain sources, such as from sugary beverages, is that children will shift consumption to other sugar sources, such as foods with

added sugar. Lower-income children completed the Dietary Screener Questionnaire before the tax and at 12-month to examine whether consumption of added sugars from foods changed over this period. Screener questions ask about the frequency of eating various food types and specifically five food types high in added sugar and common in children’s diets: cereal, chocolate or other candy, doughnuts or other pastries, cookies or cake or other baked goods, and ice cream or other frozen desserts. We converted children’s consumption frequency using scoring procedures created by the National Cancer Institute to obtain an estimate of the total daily teaspoon equivalents of added sugar children are consuming from these types of foods.

Children’s consumption of added sugar from these foods did not increase, particularly in the comparison area, from before the tax to 12 months later (**Table 6**). The difference in the change in reported added sugar from foods between children living in Seattle versus the comparison area was not statistically significant.

Children’s consumption of added sugar from these foods did not increase, particularly in the comparison area, from before the tax to 12 months later.

TABLE 6. LOWER-INCOME CHILD CONSUMPTION OF ADDED SUGAR FROM FOOD BEFORE THE TAX AND AT TO 12-MONTH FOLLOW-UP

	SEATTLE RESIDENCE			COMPARISON AREA RESIDENCE			DIFFERENCE -IN- DIFFERENCE*
	BEFORE THE TAX	12-MONTH	CHANGE	BEFORE THE TAX	12-MONTH	CHANGE	
ADDED SUGAR FROM FOODS (TSP EQUIVALENTS PER DAY)	3.6 (2.9,4.3)	3.5 (2.7,4.3)	-0.1	3.5 (2.9,4.1)	2.9 (2.5,3.3)	-0.6	0.5

Note: Values of means (95% confidence intervals).

**Difference-in-difference values are change in Seattle minus change in Comparison area; difference-in-difference values closer to zero suggest no difference in changes from before the tax to after the tax in Seattle versus Comparison area; positive values are in the direction of less change in Seattle than the comparison area and negative values are in the direction of more change in Seattle than the comparison area.*

Relative changes in children’s consumption of taxed sugary beverages at 6-month and 12-month follow-up

Comparing lower-income children’s beverage consumption before the tax to 12 months later helps control for seasonality and other influences of time of year on consumption. We also, however, administered surveys approximately 6 months after the tax began to examine possible short-term effects of the tax. Although we did not conduct statistical tests comparing changes at 6-month to changes at 12-month follow-up (each was compared separately to before the tax), the changes from before the tax to the 12-month follow-up in children’s taxed sugary beverage consumption are similar to changes observed at the 6-month follow-up (**Table 7**). We observed no significant differences in child or parent taxed or non-taxed beverage consumption changes between those living in Seattle versus those living in the comparison area from before the tax to the 6-month follow-up (see **Appendix H** for more details about the 6-month follow-up).

TABLE 7. RELATIVE CHANGES IN LOWER-INCOME CHILD CONSUMPTION OF TAXED BEVERAGES BEFORE THE TAX TO 6- MONTH AND 12-MONTH FOLLOW-UP

SEATTLE RESIDENCE	COMPARISON AREA RESIDENCE
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	RELATIVE CHANGE BEFORE TAX TO 6-MONTH FOLLOW-UP	RELATIVE CHANGE BEFORE TAX TO 12-MONTH FOLLOW-UP	RELATIVE CHANGE BEFORE TAX TO 6-MONTH FOLLOW-UP	RELATIVE CHANGE BEFORE TAX TO 12-MONTH FOLLOW-UP
SUGARY BEVERAGES SUBJECT TO THE TAX (TOTAL) – PREPARED/BOTTLED	0.74	0.63	0.68	0.59
• FRUIT-FLAVORED BEVERAGES WITH SUGAR	0.76	0.78	0.70	0.59
• SODA/POP WITH SUGAR	0.79	0.49	0.63	0.74
• PREPARED/BOTTLED TEA OR COFFEE WITH SUGAR	0.36	0.73	0.48	0.31
• ENERGY BEVERAGES WITH SUGAR	0.75	1.0	0.31	1.15
• SPORTS BEVERAGES WITH SUGAR	0.83	0.62	0.92	0.49

Note. Values are ratios or percentages of pre-tax values at each follow-up (for example, 6-month average divided by the before tax average) within Seattle and the Comparison area. Values less than one suggest a decrease compared to pre-tax values, values close to or at one suggest no change from pre-tax values, and values greater than one suggest an increase compared to pre-tax values. The sample sizes are different for the 6-month (n=353) and 12-month follow-up (n=315).

CONCLUSIONS

We observed decreases in the consumption of beverages subject to Seattle’s Sweetened Beverage Tax among lower-income children and parents living in Seattle from before the tax went into effect to 12 months later. These reductions among Seattle families were similar, however, to reductions seen among lower-income comparison area families over this one-year period. The percentage of children and parents who consume large amounts of sweetened beverages decreased in both Seattle and the comparison area, and in similar amounts. Lower-income children and parents also decreased non-taxed beverage consumption whether residing in Seattle or the comparison area. Thus, the observed reductions in this sample of lower income Seattle resident’s reported sugary beverage consumption from the pre-tax period to 12 months post-tax may not be attributable to Seattle’s sugary beverage tax.

We observed decreases in the consumption of beverages subject to Seattle’s Sweetened Beverage Tax among lower-income children and parents living in Seattle from before the tax went into effect to 12 months later. These reductions among Seattle families were similar, however, to reductions seen among lower-income comparison area families over this one-year period.

It does not appear that reductions in reported sugary beverage consumption changed children’s consumption of foods with high amounts of added sugar. This lack of substitution (i.e., not adding foods with more sugar when reducing sugary beverage consumption) is important if strategies like a sugary beverage tax are hoping to improve child health through reductions in overall added sugar.

It is also possible that information about the tax and associated media and other messages that highlighted health concerns about sugary beverages resulted in parents changing their own and their children's beverage consumption patterns regardless of where they lived.

The changes in beverage consumption seen at the 12-month follow-up were similar to the changes seen at the 6-month follow-up, suggesting that the observed reductions soon after the tax was implemented were not the result of seasonal differences between the pre-tax (late fall/winter) and 6-month follow-up (early spring/summer). The lack of difference between Seattle and the

comparison area in the change in children's or parent's taxed beverage consumption is unexpected given that over the same period, the prices of taxed sugary beverages increased in Seattle significantly more than prices for the same sugary beverages in non-taxed comparison areas (section one; Powell et al., 2020). It could be that information, news, and other media about the Seattle Sweetened Beverage tax was available throughout the Seattle area, including in the comparison area, which led to decreased consumption of taxed beverages in both areas. It could be that children and perhaps especially parents became aware of this tax and believed it applied throughout the greater Seattle metropolitan area and not only within the City of Seattle. It is also possible that information about the tax and associated media and other messages that highlighted health concerns about sugary beverages resulted in parents changing their own and their children's beverage consumption patterns regardless of where they lived, given Seattle and the comparison area share the same media market. Neither potential explanation, however, explains the decrease seen in consumption of non-taxed beverages among both parents and children in both Seattle and the comparison area. A systematic review by von Philipsborn and colleagues (2019) about information campaigns and other environmental interventions to change sugary beverage consumption found that community campaign interventions generally have small effects, so this seems like a less likely explanation. Alternatively, something else other than the tax or communication about it may have led to decreased sugary beverage consumption within the comparison area, resulting in similar observed reductions in Seattle and the comparison area. Observed decreases in sugary beverage consumption in this evaluation, particularly in regular soda/pop consumption, may be part of an overall general trend of lower consumption of sugary beverages in the U.S. Miller and colleagues (2017) found that daily regular soda/pop consumption in the U.S. dropped from roughly one out of every three high school students in 2007 to approximately one out of every five high school students in 2015. We are exploring more local sources of recent changes in sugary beverage consumption among children and youth.

It could also be that surveying people about beverage consumption multiple times results in them reporting less beverage consumption over time, regardless of other things that might be impacting consumption such as taxes. This highlights the importance of including a comparison area within a longitudinal cohort design when examining sugary beverage taxes or other strategies seeking to change beverage consumption, although evaluating beverage consumption changes requires more resources and is more complicated. Having such a comparison group in a cohort study helps to capture the simple effects of doing multiple measurements over time, with the group exposed to an intervention (like a sugary beverage tax) having to demonstrate an effect above and beyond any effects of multiple measurements to conclude that an intervention had an effect.

It is critical to consider the present findings in combination with other data examining whether consumption might be changing as a result of sugary beverage taxes. The evidence is mixed about whether and how much beverage consumption changes in response to sugary beverage taxes in other parts of the U.S. Zhong and colleagues (2018) examined self-report adult beverage consumption among Philadelphia residents and nearby non-taxed comparison area residents one month before and 1-2

months after the Philadelphia tax was implemented in January 2017 (a multiple cross-section study). They found that the odds of daily consumption of regular soda and energy beverages were significantly lower among Philadelphia adult residents after the tax compared to before the tax, and this reduction significantly differed from the change among non-Philadelphia residents. Philadelphia and non-Philadelphia residents did not significantly differ, however, in the change in percentage of daily consumers of total sugary beverages, or the monthly average frequency or overall consumption of sugary beverages or any specific type of sugary beverage. Lee and colleagues (2019) also used a multiple cross-sectional study and found that the frequency of consumption of sugary drinks decreased among Berkeley adults from before to the 3 years after the Berkeley tax was implemented in early 2015 and this change differed significantly from comparison areas without a tax. This contrasts with findings from Silver and colleagues (2017) who found no significant changes in reported sugary beverage consumption among Berkeley adult residents from before to 1 year after the tax, although they did find reductions of sugary beverage sales within two large grocery chains in Berkeley.

The sugary beverage tax studies most like the present evaluation that assessed beverage consumption based on parent and child report in longitudinal cohorts were conducted by Cawley and colleagues in Philadelphia (2018/2019a) and in Oakland (2019b). Similar to the present findings, they found that the frequency of consumption of taxed beverages did not significantly change differently among children or parents in the taxed areas relative to the comparison areas from before to 1 year after the respective sugary beverage taxes were implemented in Philadelphia and Oakland. In the Philadelphia study, similar to the present evaluation, children's frequency of taxed beverage consumption decreased in both taxed and untaxed areas, particularly for regular soda. Parents' frequency of consumption of regular soda decreased in Philadelphia but increased in the comparison area, resulting in a significant difference-in-difference between Philadelphia versus the comparison area for adult consumption of regular soda. In the Oakland study, they found little to no change in taxed beverage consumption in Oakland or the nearby non-taxed comparison area for either children or adults from before to 1 year after the Oakland sugary beverage tax was implemented.

Present findings about consumption should be considered also in the context of other studies examining the impact of sugary beverage taxes on purchases and sales of beverages. Powell and Leider (2020) recently published findings about the impact of Seattle's sugary beverage tax on beverage prices (see section one for more details) and volumes sold in stores. Based on Nielsen retail scanner data, they found that the volume of taxed sugary beverages sold decreased by 22% from before to after the tax in Seattle relative to the non-taxed Portland, Oregon area. The magnitude of the pre-to-post tax change in Seattle store sugary beverage volumes sold (-30%) observed is similar to the magnitude of change in consumption of taxed sugary beverages observed in the present evaluation for children (-36%) and parents (-33%) in Seattle. However, this does not explain why similar decreases were observed in taxed beverage consumption in our comparison area (King County outside of Seattle). Indeed, Powell and Leider (2020) did not find any change in sugary beverage volumes sold among stores within a 2-mile radius from the Seattle border, which is part of (although not the whole) the comparison area for the present evaluation.

LIMITATIONS

The evaluation has limitations, including:

- The short timeframe for baseline data collection and the common challenges of retention within longitudinal cohorts and having participants needing to maintain eligibility over time which reduces sample size, limiting the power to detect potentially meaningful differences in changes in beverage consumption.

- This cohort sample is ethnically/racially diverse and mostly on the lower end of low-income (especially among Seattle residents with >70% reporting household incomes that put them <130% Federal Poverty Level), which is a strength because it is examining consumption among groups more likely to consume taxed beverages and/or be more sensitive to price changes. However, it is not representative of all City of Seattle residents or comparison area residents.
- Self-report consumption surveys have potential bias and response may be influenced by social desirability bias (e.g., reporting what the respondent thinks is healthy or desirable, rather than what behavior they are actually doing). Indeed, information and media about the sweetened beverage tax may have heightened awareness about sugary beverages that resulted in respondents reporting lower consumption of these beverages even if they were not actually changing their consumption patterns or exposed to a sugary beverage tax. However, it is not clear why this would have also resulted in a reduction in non-taxed beverage consumption. As noted above, it could be that people generally report lower consumption of beverages over time when completing the same beverage consumption survey querying about frequency and typical volume, particularly from their first survey to any later completion of the survey.
- This evaluation did not collect information about where respondents purchased beverages.

FUTURE WORK & CONSIDERATION FOR ONGOING EVALUATION

We have now collected short-term (6 month) and medium-term (12 month) data on children's and parent's consumption of beverages. We are re-contacting families to complete surveys again as close as possible to their 2-year anniversary of completing pre-tax (baseline) surveys. This will help us to determine whether the decreases in taxed beverage consumption we have observed are sustained at this more distal follow-up among children and parents in Seattle and the comparison area. These data will be considered along with the store audit evaluation examining beverage prices at the same time. In addition to continuing to collect beverage consumption from this cohort, we will continue to collect dietary screener information about children in the cohort, with a focus on added sugars from commonly consumed foods by children. Examining the change over time in non-taxed beverages as well as estimated added sugars from foods will allow us to contextualize the changes in children's sugary beverage consumption and look for the potential for substitution.

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APPENDIX A | METHODS

Sample.

To obtain our sample of stores at baseline (pre-tax implementation), first we identified all food stores in Seattle and our comparison area based on a list of all permitted, permanent food establishments in 2016, maintained by Public Health Seattle King County (PHSKC). The Urban Form Lab at the University of Washington previously created algorithms to classify each of these businesses into meaningful food store or restaurant categories (supermarkets, grocery stores, corner stores, counter-service restaurants, etc.). Store definitions are provided in Appendix B. We used this classification to initially categorize stores and restaurants and then updated the category as necessary when we visited each store or restaurant.

We aimed for a geographically balanced sample of food stores (supermarkets, grocery stores, corner stores, gas stations), coffee shops, and counter-service restaurants in Seattle and in the comparison area (Federal Way, Kent, and Auburn). At baseline, when selecting our store sample, we obtained geographic balance by dividing our study areas into 16 equal-sized areas, geocoding all the food establishments, then selecting a quota of stores from each store type within each of the 16 areas.

In addition to the sample derived from the above process, we also worked with community liaisons and used “minority-owned business” lists to sample small stores and counter-service restaurants owned by people of color; we included this additional community-based sampling approach due both to the anticipation that these stores may be more affected by the tax and the expressed interest of the City of Seattle and the Community Advisory Board in ensuring these stores were represented in the sample.

During the 12-month follow up survey, we revisited every store included in the 6-month sample and attempted to re-survey the prices of items in each store.

Data collectors attended one six-hour training, then practiced data collection in the field until achieving 90% raw agreement on responses. We conducted all in-store audits between October 23 and November 22, 2017 for the pre-tax, baseline assessment. The six-month, post-tax follow-up audits were conducted between May 21 and July 20 2018. The 12-month, one-year post-tax follow-up audits were conducted between October 15 and November 16, 2018. Consistent with our baseline data collection methodology we completed data collection prior to the Thanksgiving holiday to minimize capturing holiday-specific sales.

Data collection.

Within each store we measured the availability and prices of: soda, sports and energy drinks, teas and coffees, juices, powdered drink mixes, water, milks, fountain drinks, and a handful of snack and sugary foods. **Appendix C** shows all surveyed beverages by beverage type and beverage tax category. For each beverage listed, we recorded the pricing and availability of multiple packaging sizes (e.g., 12oz cans, 20oz bottles, 1-liter bottles, 12 packs of 12oz cans).

Variables.

Exposure Variable

Our exposure of interest is the Seattle Sweetened Beverage Tax, which was implemented beginning on January 1 2018 and was imposed on distributors selling targeted beverages inside the City of Seattle. We consider beverages as subject to the tax if they are measured inside Seattle after January 1 2018. Our primary analyses focuses on beverage prices collected approximately 12 months after tax implementation (October -November 2018). In secondary analyses, we test whether the impact of the tax was different in the short term (6 months post tax), compared to the longer-term 12 months post-tax.

Outcome Variables

The primary outcome of interest was the price of beverages subject to the tax, which we express as cents per ounce. We collected regular and discounted prices for all surveyed beverages. For these analyses, we use the lowest price at which each beverage could have been purchased on the day the store was surveyed. In secondary analyses, we examine prices of beverages that are not subject to the tax.

Stratified Models and Covariates

We present 3 sets of models. First, an overall average model. This model controls for store “fixed effects” (i.e. an indicator variable for each store to control for time-fixed store characteristics), beverage type, and beverage size. Second, we present models stratified by beverage type, which control for store fixed effects and beverage size. Third, we present models stratified by store type, which control for store fixed effects and beverage size.

Store type. We included 6 different categories of stores or restaurants: Superstores/supermarkets, grocery stores and drug stores, small stores, counter-service restaurants, warehouses, and beverage shops (coffee or tea). We present models that control for store type as well as models that stratify by store type to examine heterogeneity in the degree of pass-through by store type.

Statistical analysis.

Tax impact analyses.

Our primary analyses aim to estimate the impact of the tax on the price of beverages subject to the tax. To do this, we use a regression-based difference-in-difference model to estimate the degree to which the price of beverages in Seattle changed above and beyond price changes for the same beverages in the comparison area. We do this for taxed beverages and non-taxed beverages. Specifically, we ran ordinary least squares models with standard errors adjusting for clustering at the store level of the general form:

$$Y_{it} = \beta_0 + \beta_1(\text{city})_i + \beta_2(\text{time})_t + \beta_3(\text{city} \times \text{time})_{it} + \epsilon_{it},$$

where, Y_{it} is the price per ounce of beverage i at time t . *City* is an indicator variable that takes the value of 1 for observations in Seattle and 0 for observations in the comparison area; this controls for baseline differences in prices between Seattle and the comparison area. *Time* is an indicator variable that takes the value of 1 for prices measured in the post-tax period and 0 for prices measured in the pre-tax period; this controls for the time trend we could have expected to see had Seattle not implemented the tax. The coefficient on the interaction between *city* and *time* (*city* × *time*), β_3 , is the difference-in-difference estimator. It estimates the average change in prices in Seattle above and beyond the change in prices in the comparison area and is our estimate of the impact of the tax on the prices of taxed beverages. This is also our estimate of the tax pass-through. A pass-through of the tax of 100% would mean $\beta_3 = 1.75$, meaning that the price of beverages subject to the tax rose an additional 1.75 cents per ounce above and beyond the change seen in the comparison area.

Using these same difference-in-difference models, we then run models stratified by beverage type, since previous studies have noted different pass-through of the tax by beverage type. We do this for both taxed and non-taxed beverages, separately.

In all models, we include only stores that we surveyed at both time points in the model. Our primary models examine all beverages that were surveyed in these stores at either time point. In sensitivity models, we limit our models to include only beverages that were measured at both time points in a store.

In sensitivity analyses, we 1) limited the difference-in-difference analyses to include only beverages that we observed in each store at both time points, and 2) used difference-in-difference models by beverage size to identify how prices changed in association with the tax by beverage size, and 3) limited the Seattle sample to stores within 1 mile of the North or South border to understand the impact of the tax on border stores.

APPENDIX B | STORE DEFINITIONS

SBT Retail Audit Store Type Definitions

Grocery & Food Stores

1) Warehouse – Warehouses carry a wide array of products usually including clothing, household items, and often children’s items such as toys. Warehouses specialize in bulk size products. The only warehouse in our sample is Costco.

2) Supermarket or Superstore – To qualify as a supermarket, the store must 1) sell fresh meat (uncooked, unprocessed, not frozen meat, not fish/seafood, not packaged deli meat), 2) have four or more cash registers (including self-checkout), and 3) have at least two of the following services: butcher, bakery and/or deli. The butcher, bakery and deli must be staffed service counters (i.e., availability of fresh bread and/or fresh meat does not count if there is not a separate, staffed service counter). Examples of supermarkets include Safeway, QFC, and Metropolitan Market. Superstores carry a wide array of products usually including clothing, household items, and often children’s items such as toys. Some general merchandize stores may also have a grocery or supermarket within the store. Examples include Target and Walmart.

3) Grocery Store – To qualify as a grocery store, the store must 1) sell fresh meat (uncooked, unprocessed, not frozen meat, not fish/seafood, not packaged deli meat) and 2) not meet all of the criteria for being a supermarket. Examples of grocery stores include Red Apple, Pioneer Square Market, Viet-Wah, and some ethnic and “mom-and-pop” food stores.

4) Small Stores – Store types a-d qualify as “small stores.” These stores do not sell fresh meat. They may, but typically do not, have deli and/or bakery service counters. Please note there should not be butcher or fresh meat service counters and this is why they are identified as small stores.

a. Chain Convenience – This includes small chain stores that sell an edited selection of staple groceries and other convenience items, i.e., ready-to-heat and ready-to-eat foods. They often sell fresh milk and may have a deli or sell some processed meats (hot dogs, cold cuts, etc.) and other hot foods. Convenience stores are typically open long hours. Examples of convenience stores are 7-Eleven and Plaid Pantry. In this study, based on pre-screening, we will indicate chain versus non-chain status for field workers.

b. Non-Chain Convenience – This includes small, independently-owned stores that sell an edited selection of staple groceries and other convenience items, i.e., ready-to-heat and ready-to-eat foods. They often sell fresh milk and may have a deli or sell some processed meats (hot dogs, cold cuts, etc.) and other hot foods. Convenience stores are typically open long hours. Please note that corner stores will also be classified as non-chain convenience stores. Examples include Union Market, and many ethnic and “mom and pop” stores.

c. Discount Store – This includes small stores that sell a variety of goods like household, personal, and party supplies and household cleaning products, as well as some food and beverages, typically at discounted prices. We will include stores that have the word “dollar” or “discount” in the title. Examples include Dollar General and Dollar Tree.

d. Gas Station – This includes the quick-stop shops at gas stations. Gas station shops sell a selection of snacks, beverages, convenience items, and ready-to-heat and ready-to-eat foods. They may sell a selection of staple groceries. To be a gas station store, these stores must have gas pumps connected to the store. A few stores, such as 7-11s, can be both “gas stations” and “chain convenience stores.” The distinction is the presence of gas pumps. Examples include AMPM, 76, or Shell.

5) Drug Store/Pharmacy – This includes stores that sell prescription and over the counter medication, as well as additional merchandise including food and beverages. Examples include Walgreens, CVS, and Rite Aid.

Beverage Stores

1) Coffee Shop – A small café that serves primarily coffee as well as other drinks. Usually but does not have to serve simple foods. Can be a separate building, or inside of a larger store or restaurant. Can be a drive-thru or a walk-in café. If it is a drive-thru only coffee stand, only survey if the coffee stand has a menu that is visible to the exterior. If there is no exterior menu, do not survey the shop.

2) Bubble Tea Shop – A small café that serves primarily bubble tea as well as other drinks, including coffee. Can serve simple food. Can be a separate building, or inside of a larger store or restaurant.

Fast Food / Quick Service

1) Quick Service Chain – A restaurant that serves fast food cuisine and has minimal table service. Food is usually offered from a limited menu, cooked or prepped in bulk in advance and kept hot, finished and packaged to order, and usually available for take away, though seating may be provided. “Fast casual” are also included in this category, and tend to have more seating, and food items that are made-to-order. “Chain” quick-service refer to national fast-food brands (e.g., McDonalds, Dairy Queen, Taco Bell).

2) Quick Service Non-Chain – A restaurant that serves fast food cuisine and has minimal table service. Food is usually offered from a limited menu, cooked in bulk in advance and kept hot, finished and packaged to order, and usually available for take away, though seating may be provided. “Fast casual” are also included in this category and tend to have more seating as well as food items that are made-to-order. “Non-chain” quick-service refers to chains that are not national chains / brands. Local chains (e.g., Dicks, Pagliacci Pizza) are included in this category.

APPENDIX C | SURVEYED BEVERAGE TYPES AND BEVERAGE TAX STATUS

ALL SURVEYED BEVERAGES BY BEVERAGE TYPE AND BEVERAGE TAX STATUS¹

TAXED BEVERAGES (N=25)	NON-TAXED SUGAR-FREE BEVERAGES (N=32)	NON-TAXED SUGAR-SWEETENED BEVERAGES (N=9)
SODA	DIET SODA	CHOCOLATE MILK
COCA COLA DR. PEPPER FANTA JARRITOS MOUNTAIN DEW PEPSI SODA, LOWEST COST AVAILABLE	COCA COLA ZERO COCA COLA DIET DR. PEPPER DIET MOUNTAIN DEW DIET PEPSI DIET JARRITOS LIGHT	CHOCOLATE MILK, ALL FAT CONTENTS
JUICE DRINK	JUICE 100%	POWDERED DRINKS
CAPRISUN TROPICANA FRUIT TWIST DRINK KIRKLAND CRANBERRY JUICE COCKTAIL KOOL-AID MINUTE MAID CRANBERRY JUICE COCKTAIL MINUTE MAID FRUIT PUNCH TROPICANA CRANBERRY JUICE COCKTAIL JUICE DRINK, LOWEST COST AVAILABLE	CAPRISUN 100% JUICE KIRKLAND APPLE 100% JUICE KIRKLAND ORANGE 100% JUICE MINUTE MAID ORANGE 100% JUICE TROPICANA ORANGE 100% JUICE TREETOP APPLE 100% JUICE	GATORADE G2 GATORADE CHOCOLATE MILK COUNTRY TIME LEMONADE KOOL-AID
SPORTS DRINK	DIET SPORTS DRINK	BUBBLE TEA PREPARED
GATORADE POWERADE VITAMIN WATER	POWERADE ZERO VITAMIN WATER ZERO GATORADE G2	BUBBLE TEA SWEETENED, MILK-BASED
ENERGY DRINK	DIET ENERGY DRINK	COFFEE PREPARED
MONSTER ENERGY DRINK RED BULL ENERGY DRINK	MONSTER ENERGY DRINK ZERO RED BULL ENERGY DRINK SUGAR-FREE	COFFEE LATTE SWEETENED COFFEE MOCHA
TEA BOTTLED	WATER	
ARIZONA TEA PURE LEAF TEA	LA CROIX WATER	
TEA PREPARED	MILK	
BUBBLE TEA, NON-MILK BASED	WHITE MILK, ALL FAT CONTENTS	
COFFEE BOTTLED	POWDERED DRINKS, SUGAR-FREE	
STARBUCKS FRAPPUCCINO	CRYSTAL LITE LEMONADE KOOL-AID CHOCOLATE MILK	
SUGARY FLAVOR SHOT*	TEA BOTTLED	
	ARIZONA TEA, UNSWEETENED PURE LEAF TEA, UNSWEETENED	
	BUBBLE TEA PREPARED	
	BUBBLE TEA, SUGAR-FREE BUBBLE TEA, UNSWEETENED TEA FRUIT SMOOTHIE	
	COFFEE PREPARED	
	COFFEE, DRIP COFFEE, LATTE PLAIN COFFEE, LATTE SUGAR-FREE FLAVORED	
	SUGAR-FREE FLAVOR SHOT*	

¹ For each beverage listed, we measured the pricing and availability of multiple packaging sizes (e.g., 12oz cans, 20oz bottles, 1 liter bottles, 12 packs of 12oz cans)

* Sugary syrup add-on has ambiguous tax status.

APPENDIX D | PRICE PASS-THROUGH BY BEVERAGE SIZE, ALL BEVERAGES MEASURED

BEVERAGE PRICE IN MEAN CENTS PER OUNCE IN SEATTLE AND COMPARISON AREA FOR TAXED AND NON-TAXED BEVERAGES, BY BEVERAGE SIZE		
	DIFFERENCE OF DIFFERENCES CENTS/OZ, (95% CI)	NUMBER OF BEVERAGES IN MODEL
20 OUNCE BEVERAGES		
TAXED	1.65 (1.43, 1.88)*	4485
UNTAXED	0.41 (0.20, 0.61)*	
2-LITER BEVERAGES		
TAXED	1.50 (1.24, 1.75)*	2524
UNTAXED	0.24 (-0.01, 0.49)+	
12-PACK OF 12 OUNCE BEVERAGES		
TAXED	1.63 (1.35, 1.92)*	1906
UNTAXED	0.16 (-0.13, 0.46)	

* $P \leq 0.05$
+ $P \leq 0.10$

APPENDIX E | IMPACT OF THE TAX ON PRICES OF TAXED BEVERAGES IN SEATTLE (THE DIFFERENCE-IN-DIFFERENCES), BY BEVERAGE TYPE AND BY STORE TYPE, LIMITING TO SAME BEVERAGES OVER TIME

	DIFFERENCE OF DIFFERENCES CENTS/OZ, (95% CI)	P VALUE OF DIFFERENCES	N OBSERVATIONS IN MODEL
TAXED BEVERAGES	1.59 (1.43, 1.75)	0.00	11096
SODA	1.66 (1.51, 1.80)	0.00	5930
SPORTS BEVERAGES	1.34 (1.07, 1.60)	0.00	1348
ENERGY BEVERAGES	1.84 (1.41, 2.27)	0.00	2142
JUICE BEVERAGES	1.21 (0.68, 1.75)	0.00	290
TEA, BOTTLED	1.46 (1.12, 1.80)	0.00	858
SUGARY SYRUP ADD ON	0.79 (-0.56, 2.14)	0.25	80
COFFEE, BOTTLED	1.02 (0.06, 1.98)	0.04	528
NON-TAXED SUGAR-FREE BEVERAGES	0.33 (0.19, 0.47)	0.00	11128
DIET SODA	0.48 (0.31, 0.65)	0.00	3976
DIET SPORTS BEVERAGES	0.12 (-0.19, 0.44)	0.43	608
DIET ENERGY BEVERAGES	0.90 (0.44, 1.36)	0.00	1772
100% JUICE	-0.28 (-0.87, 0.31)	0.35	678
MILK	0.10 (-0.04, 0.24)	0.18	2130
WATER	0.03 (-0.25, 0.31)	0.85	996
POWDERED SUGAR FREE	0.02 (-0.05, 0.08)	0.61	264
TEA, BOTTLED SUGAR FREE	0.23 (-0.15, 0.61)	0.24	498
COFFEE, SF PREPARED	0.10 (-0.95, 1.15)	0.85	206
SUGAR-FREE SYRUP ADD ON	0.90 (-0.65, 2.46)	0.25	72
NON-TAXED SUGARY BEVERAGES	0.29 (0.07, 0.52)	0.01	1266
CHOCOLATE MILK	0.50 (0.07, 0.93)	0.02	538
POWDERED SUGAR ADDED	0.04 (-0.03, 0.11)	0.24	574
COFFEE, PREPARED (EG SWEETNED LATTES)	0.73 (-0.17, 1.63)	0.11	154
SUPERSTORES/SUPERMARKETS	1.45 (1.22, 1.68)	0.00	3436
GROCERY/DRUG STORES	1.84 (1.45, 2.24)	0.00	3229
SMALL STORES	1.79 (1.43, 2.14)	0.00	5300
WAREHOUSES	1.24 (-1.60, 4.07)	0.382	44
COFFEE SHOPS	9.38 (-4.91, 23.67)	0.192	81
QUICK SERVICE RESTAURANTS	1.61 (0.73, 2.50)	0.00	623

APPENDIX F | IMPACT OF THE TAX ON PRICES OF NON-TAXED BEVERAGES IN SEATTLE (THE DIFFERENCE-IN-DIFFERENCES), LIMITING TO SAME BEVERAGES OVER TIME

THE ESTIMATED IMPACT OF THE TAX ON PRICES OF NON-TAXED BEVERAGES 12-MONTHS POST-TAX IN SEATTLE (THE DIFFERENCE-IN-DIFFERENCES) AFTER ADJUSTING FOR STORE CHARACTERISTICS, BEVERAGE TYPE, AND/OR BEVERAGE SIZE, RESTRICTING TO THE SAME BEVERAGES OVER TIME		
	DIFFERENCE-OF-DIFFERENCES, SAME BEVERAGES OVER TIME CENTS/OZ, (95% CI)	NUMBER OF BEVERAGES IN MODEL
NON-TAXED SUGAR-FREE BEVERAGES:	0.19 (0.04, 0.33)*	10480
DIET SODA	0.28 (0.09, 0.46)*	3760
DIET SPORTS BEVERAGES	0.29 (0.02, 0.55)*	598
DIET ENERGY BEVERAGES	0.59 (0.02, 1.16)*	1734
100% JUICE	0.17 (-0.45, 0.79)	518
MILK	-0.13 (-0.29, 0.04)	2072
WATER	0.05 (-0.24, 0.33)	894
POWDERED SUGAR FREE	-0.01 (-0.09, 0.06)	236
TEA, BOTTLED SUGAR FREE	0.45 (0.10, 0.79)+	474
COFFEE, SF PREPARED	-0.65 (-2.62, 1.31)	194
SUGAR-FREE SYRUP ADD ON	6.03 (-31.74, 43.79)	64
NON-TAXED SUGARY BEVERAGES:	0.08 (-0.20, 0.35)	1208
CHOCOLATE MILK	0.06 (-0.37, 0.49)	516
POWDERED SUGAR ADDED	0.06 (0.01, 0.10)+	544
COFFEE, PREPARED (E.G. SWEETENED LATTES)	0.40 (-1.30, 2.10)	148
STORE CATEGORIES, NON-TAXED BEVERAGES		
SUPERSTORES/SUPERMARKETS	0.10 (-0.10, 0.31)	4651
GROCERY/DRUG STORES	0.36 (0.10, 0.61)*	3948
SMALL STORES	0.61 (0.32, 0.91)*	4350
WAREHOUSES	-0.13 (-1.02, 0.76)	77
COFFEE SHOPS	0.36 (-9.32, 10.04)	283
QUICK SERVICE RESTAURANTS	0.39 (-1.18, 1.97)	364
	* $P \leq 0.05$	
	+ $P \leq 0.10$	

APPENDIX G | COMPARING PRICE PASS-THROUGH IF UW STUDY EXCLUDES BEVERAGE TAX AT REGISTER, AN APPROACH SIMILAR TO POWELL’S STUDY

	POWELL AND LEIDER STUDY	UW STUDY WHEN WE IGNORE BEVERAGE TAX AT REGISTER	UW ORIGINAL ESTIMATES INCLUDING BEVERAGE TAX ADDED AT REGISTER
SODA	1.09 (62%)	1.21 (69%)	1.44 (82%)
SPORTS	1.12 (64%)	1.31 (75%)	1.56 (89%)
ENERGY	1.34 (77%)	1.47 (84%)	1.78 (102%)
JUICE	0.75 (43%)	1.38 (79%)	1.65 (94%)
OVERALL AVERAGE	1.03 (59%)	1.29 (74%)	1.55 (89%)

This table presents findings of price-pass through for taxed beverages in Seattle using three approaches:

1. Powell study (analysis of UPC barcodes, or scanner data, which has no information on any beverage taxes added at the register)
2. UW study without beverage tax at register (analysis of shelf-price data and excludes any beverage taxes added at the register)
3. UW study original with beverage tax at register (analysis of shelf-price data and known beverage taxes added at the register)

The data source used in the Powell study reflects prices associated with UPC barcodes and therefore does not include beverage taxes that were separately added at the register, which would result in an underestimate of a price-pass through to consumers. Indeed, when the UW excluded beverage taxes added at the register, we found lower price-pass through of taxed beverages. The Seattle research team believes it is important to reflect the on-the-ground experience of price pass-through onto consumers based on shelf prices and final price paid and concludes that the Seattle consumers experienced an 89% price pass-through due to the Sweetened Beverage Tax.

APPENDIX H | CHILD COHORT METHODS AND SAMPLE

Design

The design of the child cohort component to evaluate consumption is a longitudinal cohort design. The particular strength of the longitudinal design is the measurement of the same people over time. This design reduces the potential influence of unmeasured and stable individual-level factors that might be influencing beverage consumption. Many evaluations of sweetened beverage tax consumption used serial cross-sectional designs which measure consumption among different people at different time points, such as before and after a tax.

We named the child cohort evaluation component SeaSAW (Seattle Shopping and Wellness), so families had an easy way to refer to it. SeaSAW children/families include those children/families residing in the City of Seattle or, for comparison purposes, residing in nearby cities in South King County. Families initially recruited into SeaSAW had a lower-income (<312% Federal Poverty Level or FPL) and a 7-10 or 12-17 year old child. Families had to indicate that this child does consume sugary drinks, that is they are not among those who never consume such beverages. Full details about recruitment and data collection methods and child/family participation for the baseline component of SeaSAW are available in the baseline methods report, submitted to the City of Seattle in February 2018. Full details about the baseline results are available in the baseline results report submitted to the City of Seattle in August 2018.

Surveys

To ensure comparability over time, we did not change the survey used to measure children's and parent's beverage consumption from baseline to the 6-month or 12-month follow-ups (**Appendix Table 1**). Other data collection at follow ups was also identical to baseline with two exceptions. We added a Household Contact Information Questionnaire, which requested more in-depth contact information from families, including back-up contacts, to enhance our ability to contact families for continued planned follow-ups. We also added questions to the Household Information Survey about 1) parent work location, to assess the potential for cross-border shopping, based on the idea that parents working outside of Seattle but living in Seattle may purchase beverages outside of Seattle, near their work location, to avoid the Sweetened Beverage Tax; 2) participation in food assistance programs (e.g., Fresh Bucks) to better understand food access needs and participation in these programs of this sample; and 3) child oral health to obtain a general assessment of children's oral health over time, which may be impacted by changes in sugary drink consumption and compliment the eventual findings from the SeaSAW Oral Health study.²

Surveys were available in English, Somali, and Spanish, in multiple modes-- online, by phone, or on paper. Vietnamese language materials were available at baseline, but we did not enroll any Vietnamese speaking families then who preferred completing the surveys in Vietnamese. We purposefully limited participant burden by keeping survey items to a minimum. To try not to influence responses or

² The SeaSAW Oral Health study seeks to examine whether the Seattle sweetened beverage tax has an impact over time on dental health and particularly dental caries among children living in Seattle versus the comparison area. Baseline data, which included dental exams and surveys, was collected in Spring 2018. The study is being conducted by Dr. Christy McKinney from Seattle Children's Research Institute and the University of Washington.

create bias, we purposefully did not ask questions about the City of Seattle Sweetened Beverage Tax or its perceived impact on beverage consumption.

APPENDIX TABLE 1. DATA OBTAINED AT BASELINE AND THE 6-MONTH & 12-MONTH FOLLOW-UPS		
SURVEY	MEASURE	CHANGE FROM BASELINE
ADAPTED BEV-Q (CHILD)	CHILD CONSUMPTION OF 19 DIFFERENT BEVERAGES IN THE PAST MONTH (FREQUENCY AND HABITUAL VOLUME)	SURVEY/MEASURE NOT CHANGED
ADAPTED BEV-Q (PARENT)	PARENT CONSUMPTION OF 22 DIFFERENT BEVERAGES, INCLUDING ALCOHOL IN THE PAST MONTH (FREQUENCY AND HABITUAL VOLUME)	SURVEY/MEASURE NOT CHANGED
DIETARY SCREENER QUESTIONNAIRE	CHILD DIETARY QUALITY SCREENER BASED ON CONSUMPTION OF 25 DIFFERENT FOODS AND BEVERAGES IN THE PAST MONTH (FREQUENCY)	SURVEY/MEASURE NOT CHANGED
HOUSEHOLD INFORMATION SURVEY	DEMOGRAPHIC AND OTHER HOUSEHOLD INFORMATION	ADDED QUESTIONS ABOUT ORAL HEALTH, PARTICIPATION IN VARIOUS LOCAL FOOD ASSISTANCE PROGRAMS, AND PARENTAL WORK LOCATION (IF APPLICABLE)

Calculating beverage consumption

The beverage survey queries about individual beverage consumption in the past month. Child and parent beverage consumption was calculated for each of the individual beverages on the questionnaire, with 19 beverages queried for children and 22 for parents (includes 3 questions about different types of alcohol). Consumption is based on the response to frequency (options being “*never or less than 1 time per week*”, “*1 time per week*”, “*2-3 times per week*”, “*4-6 times per week*”, “*1 time per day*”, “*2+ times per day*”, or “*3+ times per day*”) and the typical volume each time (options being “*less than 6 fl oz (3/4 cup) size of most juice boxes*”, “*8 fl oz (1 cup)*”, “*12 fl oz (1½ cup) size of a regular can of soda/pop*”, “*16 fl oz (2 cups) size of most sports drinks or bottled drinks*”, or “*More than 20 fl oz (2½ cups)*”) for each beverage. A snapshot of a portion of the beverage questionnaire (assessing 5 of the beverage types queried) is provided below (**Appendix Figure 1**).

APPENDIX FIGURE 1. SNAPSHOT OF BEVERAGE QUESTIONNAIRE

Type of Beverage	A) How Often Do You Drink It? (Choose One)								B) How Much Each Time? (Choose One)				
	Never or less than 1 time per week- go to next beverage	1 time per week	2-3 times per week	4-6 times per week	1 time per day	2+ times per day	3+ times per day		Less than 6 fl oz (3/4 cup) Size of most juice boxes	8 fl oz (1 cup)	12 fl oz (1 ½ cups) Size of a regular can of soda/pop	16 fl oz (2 cups) Size of most sports drinks or bottled drinks	More than 20 fl oz cups (2 ½ cups)
1. Tap water								→					
2. Plain bottled water (e.g., Aquafina, Dasini, Smart Water)								→					
3. Flavored water without added sugar or other caloric sweeteners (e.g., coconut water; club soda or bubbly water; aqua frescas without sugar or other caloric sweeteners such as honey) or other flavored waters with low or no calories (e.g., La Croix, Mio, Vitamin Water Zero, Sobe Life Water)								→					
4. 100% Fruit juice (e.g., orange, apple, Honest Kids)								→					
5. Fruit-flavored drinks with added sugar that are ready to drink – in bottle/can or from a drink fountain/dispenser (e.g., lemonade, Sunny Delight, Hawaiian Punch)								→					

Based on the survey response to how often the type of beverage was consumed, the frequency was converted to times per day (e.g., “1 time per week” = 0.14 times per day), with the “never or less than 1 time per week” set to 0 times per day. Daily consumption in ounces for each beverage was then calculated by multiplying the frequency per day by the typical volume consumed (e.g., “2+ times per day” X “12 fl oz” = 24 oz per day for that beverage type). Taxed beverage consumption was the sum of daily fluid ounce consumption of 1) fruit-flavored drinks with sugar, 2) soda/pop with sugar, 3) prepared/bottled tea or coffee with sugar, 4) energy drinks with sugar, and 5) sports drinks with sugar. These beverage types were subject to the Seattle Sweetened Beverage Tax. Daily consumption of the remaining beverages on the questionnaire was summed to calculate the daily fluid ounce consumption of non-taxed beverages.

For most individuals and most individual beverages, we derived consumption from their responses on the beverage questionnaire. However, 2.3% of children’s beverages had missing consumption values at baseline (i.e., missing frequency or habitual volume responses for a beverage) and 1.0% were missing values at the 6-month follow-up and <1% at 12-month follow-up. Parents were missing 2.7% of beverage consumption values at baseline, 1.0% at 6-month follow-up, and <1.0% at 12-month follow-up. Therefore, we explored and implemented a data-driven process to fill in or impute missing values among individual beverages.

Retention and the 6-month and 12-month samples

The 6-month follow-up data collection occurred May-July, 2018 and started with re-contacting children/families who participated in baseline SeaSAW data collection. Participants were approached by the organization (Seattle Children’s or Ironwood Survey Group) who had contacted them and collected their data at baseline. The 12-month data collection sought to have each family complete surveys as close as possible to the 1-year anniversary of when they completed the baseline (before the tax) surveys. Therefore, 12-month follow-up data collection occurred November 2018-February 2019.

The strategies for re-contacting families and collecting the 6-month and 12-month follow-up data included:

- Families first received a re-contact letter inviting them to participate in the follow up. This letter included a link to be able to complete the follow-up surveys online. It also provided instructions for contacting the team if they wished to complete the survey by a different mode (phone or paper).
- After re-contact letters were sent, the research team contacted the participating families with reminder calls, texts, and emails at regular intervals to prompt survey completion.
- If surveys were not completed after several weeks, and contact had not been made with the participating parent/caregiver, paper survey packets were prepared for each family and delivered to their address.
- Based on the advice of community outreach workers, we arranged individual meetings or small events in community spaces to provide families an opportunity to complete their surveys in person with staff support.
- We re-visited regular distribution times at the foodbanks where we had recruited some families at baseline, to see if we might better connect with them there to complete surveys.
- Some SeaSAW families had been recruited into the co-occurring SeaSAW Oral Health study³ and were able to complete their 6-month SeaSAW surveys at SeaSAW Oral Health study visit.

The baseline results report provides information on the 527 children/families with baseline data. Among those, 6 were deemed to be duplicative, so 521 children/families were re-contacted to complete the 6-month follow-up. During 6-month follow-up data collection, 27 participants were identified as ineligible because they completed baseline past the eligible dates (January 8, 2018 for City of Seattle residents) or because of inaccurate information about where they lived or their child's age at baseline. Ultimately, 494 of the baseline families were deemed eligible to consider for including in the 6-month and 12-month follow ups. Among these, 408 (83%) of families responded to outreach at 6-month follow-up and 411 (83%) responded to outreach at 12-month follow-up. At 6-month follow-up, 4 were no longer eligible to participate; 2 had moved out of the study area entirely and 2 caregivers were no longer caring for the child they originally reported on at baseline. At 12-month follow-up, 8 were no longer eligible to participate. In addition, 14 families declined to participate at 6-month follow-up and 12 families declined to participate at 12-month follow-up. A total of 390 participants were eligible, were reached, and agreed to complete 6-month follow-up surveys. 384 participants completed all 6-month follow up surveys, and 6 completed either the child portion or the parent portion of the surveys. Overall, we had a 77% (384/494) survey response rate at 6-month follow-up for eligible families. A total of 391 participants were eligible, were reached, and agreed to complete 12-month follow-up surveys. Of the 391 who agreed to complete 12-month follow up surveys, 8 provided additional information that identified them as ineligible at baseline due to inaccurate information about their child's age or where they lived. Fourteen families were contacted and agreed to complete surveys, but never did. Of the 486 families still considered eligible for follow ups, 365 participants completed all 12-month follow up surveys, and 4 completed either the child portion or the parent portion of the surveys. Overall, we had a 77% (384/494)

³ The SeaSAW Oral Health study seeks to examine whether the Seattle Sweetened Beverage Tax has an impact over time on dental health and particularly dental caries among children living in Seattle versus the comparison area. Baseline data, which included dental exams and surveys, was collected in Spring 2018. The study is being conducted by Dr. Christy McKinney from Seattle Children's Research Institute and the University of Washington.

survey response rate at 6-month follow-up for eligible families and a 75% (365/486) survey response at 12-month follow-up for eligible families.

Some children/families with survey data at 6-month follow-up were excluded in the 6-month and 12-month follow-up analyses because they: 1) had moved between the City of Seattle and the comparison areas (or outside the area completely) between baseline and the 6-month follow-up; and 2) had baseline or 6-month total beverage consumption that was very low (<1st percentile) or very high (>99th percentile) and thus seemed not realistic. We also recategorized 35 families from living in “Seattle” to living in the “comparison area” because although they reported living in Seattle and had a Seattle mailing address, their home address was located in unincorporated parts of King County, just outside Seattle. Finally, the propensity score weighting process (see below) eliminates respondents without complete data for all of the variables included in the process. This resulted in a final baseline to 6-month analytic sample of 353 children and parents, and a final baseline to 12-month analytic sample of 315 children and parents. **Appendix Table 2** provides demographic characteristics for the 353 children/families who were included in baseline (before the tax) to 6-month follow-up (post-tax) analysis. **Appendix Table 3** provides demographic characteristics for the 315 children/families who were included in the baseline to 12-month follow-up (post-tax) analysis.

APPENDIX TABLE 2. UNWEIGHTED DEMOGRAPHIC INFORMATION FOR CHILDREN/PARENTS INCLUDED IN THE 6-MONTH FOLLOW-UP ANALYSIS

CHARACTERISTIC	SEATTLE RESIDENCE	COMPARISON AREA RESIDENCE
SAMPLE SIZE*	N=142	N=211
CHILD AGE AT 6-MONTH FOLLOW-UP MEAN IN YEARS (STANDARD DEVIATION))	10.7 (2.7)	10.9 (3.0)
CHILD SEX REPORTED AT BASELINE (%FEMALE)	47.4%	50.0%
CHILD ETHNICITY/RACE (REPORTED AT BASELINE)**		
- HISPANIC/LATINX	19.0%	35.1%
- NON-HISPANIC BLACK/AFRICAN-AMERICAN/AFRICAN ONLY	42.3%	25.6%
- NON-HISPANIC WHITE ONLY	19.0%	21.8%
- NON-HISPANIC ASIAN ONLY	9.9%	2.8%
- NON-HISPANIC AMERICAN INDIAN OR ALASKA NATIVE ONLY	0.7%	0.0%
- NON-HISPANIC NATIVE HAWAIIAN OR OTHER PACIFIC ISLANDER ONLY	0.0%	1.9%
- NON-HISPANIC TWO OR MORE RACES	9.2%	12.8%
PARENT AGE REPORTED AT BASELINE (MEAN IN YEARS (STANDARD DEVIATION))	41.0 (8.8)	38.8 (8.0)
PARENT SEX REPORTED AT BASELINE (%FEMALE)	87.5%	94.2%
HIGHEST LEVEL OF EDUCATION OF ANY ADULT IN HOUSEHOLD (REPORTED AT BASELINE)		
- DID NOT COMPLETE HIGH SCHOOL		
- COMPLETED HIGH SCHOOL OR GED	6.3%	7.1%
- SOME COLLEGE OR VOCATIONAL TRAINING	22.5%	22.3%
- COMPLETED COLLEGE OR UNIVERSITY	26.8%	31.8%
- COMPLETED GRADUATE OR PROFESSIONAL DEGREE	24.6%	28.0%
- NOT REPORTED	9.9%	9.0%
	9.9%	1.9%
ANNUAL HOUSEHOLD INCOME (REPORTED AT BASELINE)***		
- <130% FEDERAL POVERTY LEVEL		
- 130% - <200% FEDERAL POVERTY LEVEL	71.8%	46.0%
- 200% - <312% FEDERAL POVERTY LEVEL	11.3%	17.1%
- NOT REPORTED (SEE NOTE***)	13.4%	29.4%
	3.5%	7.6%
FOOD INSECURITY (% RESPONDING 'OFTEN TRUE' OR 'SOMETIMES TRUE' IN THE PAST MONTH)		
- WORRIED ABOUT FOOD RUNNING OUT		
- FOOD RAN OUT AND DID NOT HAVE MONEY FOR MORE	55.6%	45.5%
- HARD TO BUY HEALTHY FOODS	48.6%	41.2%
	57.0%	48.8%

Note. *There is variability in sample size based on missing data; missing was not common (for most variables <5 respondents had missing values).

**For reporting of race/ethnicity, each child is represented only once; Hispanic/Latinx ethnicity was considered first and if the child was Hispanic/Latinx then the child's corresponding race (often missing) was not included in the tabulation for race.

***All families reported being <312% Federal Poverty level for household size (level at which families qualify for Apple Health - child health insurance) in the baseline screening questionnaire and were included in the sample, but some did not report a specific income level so are considered 'not reported' for annual household income

APPENDIX TABLE 3. UNWEIGHTED DEMOGRAPHIC INFORMATION FOR CHILDREN/PARENTS INCLUDED IN THE 12-MONTH FOLLOW-UP ANALYSIS

CHARACTERISTIC	SEATTLE RESIDENCE	COMPARISON AREA RESIDENCE
SAMPLE SIZE*	N=127	N=188
CHILD AGE AT 12-MONTH FOLLOW-UP MEAN IN YEARS (STANDARD DEVIATION)	11.2 (2.7)	11.4 (3.1)
CHILD SEX REPORTED AT BASELINE (%FEMALE)	48.0%	52.7%
CHILD ETHNICITY/RACE (REPORTED AT BASELINE)**		
- HISPANIC/LATINX	17.2%	34.8%
- NON-HISPANIC BLACK/AFRICAN-AMERICAN/AFRICAN ONLY	46.1%	24.1%
- NON-HISPANIC WHITE ONLY	18.8%	22.5%
- NON-HISPANIC ASIAN ONLY	8.6%	3.7%
- NON-HISPANIC AMERICAN INDIAN OR ALASKA NATIVE ONLY	0.8%	0.3%
- NON-HISPANIC NATIVE HAWAIIAN OR OTHER PACIFIC ISLANDER ONLY	0%	0.6%
- NON-HISPANIC TWO OR MORE RACES	8.6%	11.7%
PARENT AGE REPORTED AT BASELINE (MEAN IN YEARS (STANDARD DEVIATION))	41.1 (8.4)	38.3 (7.7)
PARENT SEX REPORTED AT BASELINE (%FEMALE)	82.8%	93.0%
HIGHEST LEVEL OF EDUCATION OF ANY ADULT IN HOUSEHOLD (REPORTED AT BASELINE)		
- DID NOT COMPLETE HIGH SCHOOL		
- COMPLETED HIGH SCHOOL OR GED	9.4%	8.0%
- SOME COLLEGE OR VOCATIONAL TRAINING	20.3%	19.8%
- COMPLETED COLLEGE OR UNIVERSITY	25.8%	32.1%
- COMPLETED GRADUATE OR PROFESSIONAL DEGREE	25.8%	28.3%
- NOT REPORTED	9.4%	10.2%
	9.4%	1.6%
ANNUAL HOUSEHOLD INCOME (REPORTED AT BASELINE)***		
- <130% FEDERAL POVERTY LEVEL		
- 130% - <200% FEDERAL POVERTY LEVEL	71.1%	47.1%
- 200% - <312% FEDERAL POVERTY LEVEL	12.5%	16.6%
- NOT REPORTED (SEE NOTE***)	14.8%	29.4%
	1.6%	7.0%
FOOD INSECURITY (% RESPONDING 'OFTEN TRUE' OR 'SOMETIMES TRUE' IN THE PAST MONTH)		
- WORRIED ABOUT FOOD RUNNING OUT		
- FOOD RAN OUT AND DID NOT HAVE MONEY FOR MORE	53.2%	43.7%
- HARD TO BUY HEALTHY FOODS	47.2%	38.6%
	56.1%	48.4%

Note. *There is variability in sample size based on missing data; missing was not common (for most variables <5 respondents had missing values).

**For reporting of race/ethnicity, each child is represented only once; Hispanic/Latinx ethnicity was considered first and if the child was Hispanic/Latinx then the child's corresponding race (often missing) was not included in the tabulation for race.

***All families reported being <312% Federal Poverty level for household size (level at which families qualify for

Apple Health - child health insurance) in the baseline screening questionnaire and were included in the sample, but some did not report a specific income level so are considered 'not reported' for annual household income.

Data processing and analysis

Imputation for missing beverage consumption information

Since beverage consumption is the primary outcome for the child cohort study, we used a process to impute/fill in missing beverage consumption data. Imputation of missing data is often done in order to have a more complete dataset and increase the number of participants with complete data who can be included in the analysis. The imputation process is data driven in that it uses existing data within and across participants to provide information that helps fill in the best possible estimate of what a missing response would likely have been. If a child and/or parent did not participate in the 6-month or 12-month follow-up assessment (e.g., they could not be reached, declined participation), we did not impute their missing beverage consumption data at that follow-up. Imputation was designed to help estimate intermittent missingness (e.g., accidentally missed one survey response on an otherwise completed survey) among children and parents still available and willing to complete surveys, not to estimate consumption of all beverages at any time point.

The imputation process was done separately for baseline, 6-month, and 12-month follow-up data and separately for children and parents. We conducted the imputation process at the level of the individual beverage (e.g., filling in missing for tap water consumption, filling in missing for soda/pop with sugar consumption, etc).

The imputation process for missing individual beverage consumption included multiple steps:

- Removing the children and parents from the process who had total (sum of all beverages) beverage consumption <1st percentile or >99th percentile at either baseline or the follow-ups. These extremely low or high total beverage consumption values might distort the estimates for the missing values among other children and parents.
- Exploring what data elements were most related to beverage consumption using the non-missing data that were available. For example, we explored whether demographic information such as child and parent age or race/ethnicity were related to beverage consumption. Among the various data elements, we found a high correlation between beverage frequency (how often a beverage was reported being consumed) and consumption (frequency X habitual volume) of individual beverages and a moderate correlation within individuals between frequency and habitual volume. Demographics or other variables were not as strongly related to beverage consumption and were also limited by missing values themselves (e.g., household income had a relatively high missing rate).
- Based on the exploration, we concluded that child or parent's frequency of consuming other beverages (non-missing), child or parent's typical volume for other beverages (non-missing), and child or parent's consumption (frequency X volume) of other beverages (non-missing) were the best variables to use in the algorithm to fill in the missing individual beverage consumption data. Thus, we used these variables in the imputation model to estimate beverage consumption for those individual beverages with missing information among children and parents at baseline and follow-up.

Propensity score process

The primary analysis was focused on the difference-in-difference in child consumption of taxed beverages. That is, was there a difference between children living in Seattle versus the comparison area (one difference) from baseline to the 12-month follow-up (another difference) in the consumption of beverages subject to the Seattle Sweetened Beverage Tax?

The first step in the difference-in-difference process was to examine whether there were demographic or other baseline differences (e.g., in baseline beverage consumption) between the Seattle versus comparison area samples at baseline that would require adjustment to the difference-in-difference analysis of beverage consumption. Exploring and applying adjustments allow for a more accurate assessment of differences between the Seattle versus comparison area sample over time. As identified in the baseline results report, the Seattle versus comparison area samples had a somewhat different ethnic/racial makeup and highest adult education in the household distribution. In addition, more Seattle versus comparison area sample residents were in the <130% Federal Poverty level for annual household income. There were also baseline differences in the child and parent consumption of the to-be-taxed beverages between the Seattle versus comparison area samples, with the comparison area having higher averages values at baseline.

Therefore, we explored a propensity score process that sought to better align the Seattle and comparison area samples at baseline. Propensity score processes seek to find ways to help eliminate differences between samples through statistical adjustments that bring the unexposed group (i.e., the comparison area sample) closer to the exposed group (i.e., Seattle sample) on selected variables or sample characteristics. This is a statistical technique that is increasingly used in natural experiments (e.g., areas exposed to a policy versus areas not exposed to that policy) when the baseline characteristics are dissimilar between the two groups of interest. We explored both a propensity score *matching* process and a propensity score *weighting* process.

We first selected demographic (child age, child sex, child race/ethnicity, whether the family reported receiving any state or federal financial assistance or benefits), recruitment source (Seattle Children's staff or Ironwood Survey Group), and baseline child and parent consumption of taxed beverages and non-taxed beverages to include in the propensity score process. We selected these variables because the evaluation team considered them important, they differed between the Seattle and comparison area, and there was a low rate of missing data (e.g., the survey question about receiving financial assistance had fewer missing values than reported level of household income).

In the propensity score *matching* process, comparison area participants are selected using information from these variables to best match Seattle area participants. That is, comparison area participants that were more similar on these variables were selected and those more dissimilar from the Seattle sample on these variables were not selected. This *matching* process resulted in a selected subset in the Seattle and comparison area samples that were very similar on demographics and baseline beverage consumption. However, the *matching* process reduces the sample size available for the difference-in-difference analysis for beverage consumption. Indeed, more than 100 participants were not selected in the *matching* process and thus excluded from the corresponding analysis.

We decided to use the propensity score *weighting* process. In the *weighting* process, participants are not simply included or excluded based on the selected baseline variables, but rather are given weights such that once the weights are applied, baseline demographic and consumption characteristics between Seattle and the comparison area are more similar. For example, participants in the comparison area that were more similar to the Seattle sample on the baseline characteristics were given higher weights than

comparison area participants who were less similar to the Seattle sample. The propensity score *weighting* process generated a weight for each participant, then this weight was applied to that participant's data in the difference-in-difference analysis for beverage consumption. Unlike the propensity score *matching* process, the *weighting* process does not exclude or drop any participants, thus maximizing the sample size available for the difference-in-difference beverage consumption analysis.

Propensity score weighting was also applied to secondary analyses. Secondary analyses were conducted for examining: 1) child changes in taxed beverage consumption to 6-month follow-up, 2) child consumption of non-taxed beverages, 3) parent consumption of taxed and non-taxed beverages. In addition, consistent with other reports on changes in consumption, we examined 1) changes in the proportion of high consumers of taxed beverages in two ways (consuming on average ≥ 8 ounces per day of taxed sugary drinks and consuming a taxed sugary drink 1+ times per day), and 2) changes in children's consumption of common foods with added sugar.

We fit linear or Poisson models using generalized estimating equations with the outcome of beverage consumption (separate models for child and parent, separate models for average consumption and percentage of high consumers) and children's added sugar consumption to estimate the effects of location (Seattle versus comparison area) over time (baseline to either the 6-month or to the 12-month follow-up). For linear models, the difference-in-difference was a difference in the absolute change in consumption between Seattle and the comparison area over time. For Poisson models, the difference-in-difference in beverage consumption was tested using ratios. The 'time ratio' for each location was the ratio of consumption at follow-up relative to the baseline consumption. For example, if average total beverage consumption was 4 fluid ounces per day at baseline and 3 fluid ounces per day at 6-month follow-up, the time ratio would be 0.75 (3 oz/4 oz). If the time ratio was equal or close to 1, this suggests no or little change in consumption from baseline to follow-up. A time ratio significantly greater than 1 would suggest a significant increase from baseline to follow-up in beverage consumption, whereas a time ratio significantly less than 1 would suggest a significant decrease from baseline to follow-up in beverage consumption.

Within Poisson models, the difference-in-difference is represented by a ratio-of-ratios we are labeling the 'time by location ratio', which is the ratio of the Seattle time ratio relative to the comparison area time ratio (the Seattle time ratio divided by the comparison area time ratio). For example, if Seattle's time ratio was 0.75 (e.g., baseline consumption average = 4 ounces, 6-month consumption average = 3 ounces) and the comparison time ratio was 0.90 (baseline consumption average of 5 ounces, 6-month consumption average = 4.5 ounces), then the time by location ratio would be 0.83 (0.75/0.90). A time by location ratio equal or close to 1 would suggest that there was no significant differential change between Seattle and the comparison area in the change in beverage consumption from baseline to 6-month follow-up. A time by location ratio significantly less than 1 would suggest that Seattle changing consumption more than the comparison area over time. A time by location ratio significantly greater than 1 would suggest that the comparison area is changing consumption more than Seattle over time.