Higher Retail Prices of Sugar-Sweetened Beverages 3 Months After Implementation of an Excise Tax in Berkeley, California

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Objectives. We assessed the short-term ability to increase retail prices of the first US 1-cent-per-ounce excise tax on the distribution of sugar-sweetened beverages (SSBs), which was implemented in March 2015 by Berkeley, California.

Methods. In 2014 and 2015, we examined pre- to posttax price changes of SSBs and non-SSBs in a variety of retailers in Berkeley and in the comparison cities Oakland and San Francisco, California. We examined price changes by beverage, brand, size, and retailer type.

Results. For smaller beverages (≤33.8 oz), price increases (cents/oz) in Berkeley relative to those in comparison cities were 0.69 (95% confidence interval [CI] = 0.36, 1.03) for soda, 0.47 (95% CI = 0.08, 0.87) for fruit-flavored beverages, and 0.47 (95% CI = 0.25, 0.69) for SSBs overall. For 2-liter bottles and multipacks of soda, relative price increases were 0.46 (95% CI = 0.03, 0.89) and 0.49 (95% CI = 0.21, 0.77). We observed no relative price increases for nontaxed beverages overall.

Conclusions. Approximately 3 months after the tax was implemented, SSB retail prices increased more in Berkeley than in nearby cities, marking a step in the causal pathway between the tax and reduced SSB consumption. (*Am J Public Health.* 2015;105:2194–2201. doi:10.2105/AJPH.2015.302881)

Consuming sugar-sweetened beverages (SSBs) increases the risk of obesity, diabetes, heart disease, and dental caries[1–4] and has been linked to approximately 184 000 deaths per year worldwide.[5] SSBs are also the largest source of added sugar in the US diet.[6,7] Thus, reducing SSB consumption has been identified as important in preventing obesity and chronic disease.[8–10]

Because of the success of tobacco taxation in reducing smoking prevalence and related diseases,[11] public health experts, including the Institute of Medicine, have recommended taxing SSBs as a means to reduce SSB consumption.[12–15] In 2013 and 2014, more than a dozen states and several cities proposed SSB tax legislation—so called soda taxes.[16] Only 1 proposal passed. On November 4, 2014, Berkeley, California, passed a 1-cent-per-ounce specific excise tax on the distribution of SSBs (Measure D), becoming the first US city to levy such a tax.[17]

Measure D is consistent with the type of tax public health experts have called for—an excise tax on SSBs.[12] Unlike a sales tax, which is added at the register and paid directly by the consumer, an excise tax is levied before the point of purchase (e.g., on distributors). Specific excise taxes are levied per volume of a product, whereas, ad valorem excise taxes are levied as a proportion of product price.[18] In response to an excise tax, distributors are expected to increase SSB prices for retailers, who, in turn, are expected to increase the shelf prices of SSBs paid by consumers. Excise taxes are thought to be more salient to consumers than are sales taxes because they result in higher shelf prices at the point of decision, thus deterring purchase.[12] The effectiveness of an excise tax in reducing SSB consumption hinges partly on its "pass-through rate," or the extent to which the tax is passed on to consumers through higher shelf prices.

In perfectly competitive markets with perfectly inelastic demand (i.e., changing price does not change demand), economic theory predicts perfect pass-through (i.e., a 1-cent excise tax leads to a 1-cent retail price increase).[19,20] However, research suggests that demand for SSBs is elastic[21]; thus, distributors or retailers may undershift the tax (increase prices by <1 cent/oz), either by absorbing the costs or distributing costs across untaxed products (e.g., food or diet soda). In fact, concerns have been raised that businesses might undershift the tax and lower their profit margins to sustain sales (known as "strategic pricing").[22] Undershifting results in lower than expected price increases, potentially undermining the public health benefit of a tax.[23] However, taxes may also be overshifted in monopolistic or oligopolistic markets.[20] Empirically, there is evidence of both over- and undershifting of taxes on cigarettes,[24–29] alcohol,[30,31] and saturated fat.[32] The few empirical studies on SSB excise taxes in other countries have found pass-through rates ranging from about 63% to more than 300%, depending on beverage type, brand, and retailer.[33–35] Because Berkeley's excise tax is the first of its kind in the nation, there is no empirical evidence on how such a tax will be passed-through to consumers in the United States.

We have provided the first early details of the pass-through of Berkeley's excise tax on SSBs. Using neighboring San Francisco and Oakland, California, as comparison cities, we estimated the effect of Berkeley's tax on retail prices of SSBs. Additionally, we examined price changes by beverage, brand, size, and retailer type because research in other countries has found varying pass-through across these variables.

METHODS

To evaluate the pass-through of Berkeley's SSB excise tax, we compared changes in pre- versus posttax beverage prices in Berkeley to changes in beverage prices in the comparison cities Oakland and San Francisco. We selected these cities because of their proximity to Berkeley and their mix of residential and commercial environments. Using a longitudinal

design, we assessed prices of the same beverages in the same stores during pre- and posttax implementation periods.

Measure D levies a tax on the distribution of beverages with added sugar (equivalent to ≥ 2 kcals/oz), with the exception of milks and beverages for medical use.[36] Alcoholic beverages are exempt, and the tax does not apply to 100% fruit juices, water, or diet beverages without added sugar.[36] Although Measure D specified an implementation date of January 1, 2015, implementation was delayed until the first taxes were collected for March 2015.[37]

The primary outcome was change in beverage price between pre- and posttax periods. We collected pretax prices of most beverages in fall 2014 before the November 4, 2014, election. We collected pretax prices for fruit-flavored beverages and large sizes of soda from November 2014 through January 2015, before implementation. We collected posttax beverage prices from late May through June 2015, approximately 8 months after we collected most pretax data and approximately 3 months after the implementation of the tax. Trained research assistants collected beverage prices by recording visible prices from price tags. For beverages without visible prices, data collectors asked store clerks for prices. If clerks were uncooperative, data collectors purchased beverages and recorded prices from receipts. If a temporary promotional price was advertised, data collectors recorded both the promotional and regular price.

We collected prices for the following SSB categories: soda, energy drinks, sports drinks, sweetened water, presweetened tea, presweetened coffee, and fruit-flavored beverages (not 100% juice). We selected which brands to examine on the basis of industry reports[38,39] of top-selling beverages in the United States as well as researcher observations of commonly sold beverages in the San Francisco Bay Area. For comparison, we collected the prices of untaxed beverages: diet versions, reduced fat milk, water, and 100% orange juice brands from top-selling soda producers. In all stores, we collected prices of sizes typically consumed in a single sitting (e.g., 20-oz sodas) that were most commonly sold in local stores. We collected prices of larger sodas (e.g., 2 L) from a subsample of chain supermarkets and drugstores. Table 1 lists beverage brands and sizes for which we obtained prices.

Sampling was driven by a focus on health disparities. Low-income and minority residents are more likely to consume SSBs and suffer related health consequences[40,41]; thus, in Berkeley and San Francisco, we selected 2 large, low-income neighborhoods with the highest combined proportion of African American and Latino residents.[42] We selected neighborhoods in Oakland using census data to most closely match demographics in the San Francisco and Berkeley neighborhoods. In each neighborhood, we selected the highest foot traffic intersection to facilitate our administration of intercept surveys assessing beverage consumption in each neighborhood (for an ongoing study for which results are not included here).

Average proportions of African American and Latino residents living in the intersections' census tracts were, respectively, 24% and 27% in Berkeley, 28% and 54% in Oakland, and 26% and 43% in San Francisco; citywide percentages were 10% and 11% in Berkeley, 28% and 25% in Oakland, and 6% and 15%

TABLE 1—Beverages: Berkeley, Oakland, and San Francisco, CA; 2014 and 2015

Category	Brand	Size[a]
Regular and diet soda	Coke[b]	20.0 (12.0) oz[e]
	Pepsi[c]	20.0 (12.0) oz[e]
	Mountain Dew[c]	20.0 (12.0) oz[e]
	Dr Pepper[d]	20.0 (12.0) oz[e]
	Sprite[b]	20.0 (12.0) oz[e]
Sports	Gatorade[c]	20.0 (32.0) oz
Energy and diet energy	Red Bull	8.4 oz
Regular and diet sweetened water	Vitamin Water[b]	20.0 oz
Sweetened coffee	Bottled Starbucks Frappuccino[c]	9.5 (13.7) oz
Fruit flavored (not 100% juice)	Arizona	23.0 oz
	Brisk[f]	33.8 (24.0) oz
	Hawaiian Punch[f]	20.0 oz
	Minute Maid fruit drinks[b]	15.2 oz
	Minute Maid lemonade[b]	20.0 oz
	Ocean Spray cranberry juice cocktail	15.2 oz
	Simply lemonade[b]	11.2 oz
	Snapple fruit drinks[d]	16.0 oz
	Sunny Delight	16.0 (11.3) oz
	Sobe elixirs[c]	20.0 oz
	V8 Splash	16.0 oz
Sweetened tea and diet tea	Arizona	23.0 oz
	Snapple[d]	16.0 (20.0) oz
Water	Aquafina[c]	20.0 oz
	Dasani[b]	20.0 oz
100% orange juice	Minute Maid[b]	15.2 oz
	Tropicana[c]	12.0 (15.2) oz
2% milk	Various	14.0 (16.0) oz

[a]Or alternate if main size was not available. This applies to a maximum of 3 stores for each beverage with an alternate size (other than milk). For milk, we collected the alternate size in 5 stores.
[b]The Coca-Cola Company.
[c]PepsiCo.
[d]Dr Pepper Snapple Group.
[e]For exploratory analyses, we also collected prices of regular soda sold in 2-L bottles and 12 packs of 12-oz cans (alternate sizes if 12 packs were not available: 6 packs of 12-oz cans or 6 packs of 16.9-oz bottles).
[f]Pepsi-Lipton Partnership.

in San Francisco.[42] Household median income for the intersections' census tracts versus the city as a whole was $47 000 versus $59 000 in Berkeley, $47 000 versus $50 000 in Oakland, and $50 000 versus $71 000 in San Francisco.[42]

As in previous studies of food environments,[43,44] we identified beverage retailers within a 0.5-mile radius of each intersection. Using a procedure developed by Morland et al.[45] to classify retailers on the basis of the North American Industry Classification System code,[46] we included chain supermarkets, drugstores, small grocery stores, liquor stores, and convenience stores from ReferenceUSA, a commercial business directory.[47] We sampled liquor stores because in the Bay Area they are also destinations for nonalcoholic beverage purchases. We limited drugstores sampled to the 2 chains present in all 3 cities. We also identified and verified retailers through corporate Web sites, Google Maps, Yellow Pages, and field observations. To be eligible, retailers had to stock at least 1 of the 5 top-selling sodas in the United States.[38] We classified retailers not listed in ReferenceUSA by brand recognition, keywords (e.g., liquor), or similarity to other retailers in a category.

We then selected beverage retailers using a random sample stratified by retailer type to achieve a minimum of the following near each intersection: 3 small grocery stores, 2 drugstores, 1 convenience store, and 2 liquor stores. If an insufficient number of retailers in a category were located within a 0.5-mile radius, we sampled the next closest retailer. In Berkeley, we sampled an additional 2 drugstores and 2 small grocery stores to increase power. Additionally, we sampled a store from all eligible chain supermarkets in Berkeley selling 1 of the 5 top-selling sodas (n = 3) and up to 2 supermarkets in those chains in both Oakland and San Francisco. We also intentionally sampled 7-Elevens in each city (n = 2 per city) because of their national prevalence. Finally, if we randomly sampled a chain convenience store (e.g., Shell), we sampled another retailer in the same chain from another city.

This sampling approach captured the stores at which vulnerable populations are likely to shop—walkable stores in the immediate neighborhood—as well as popular chains serving a broader customer base. Table 2 lists numbers of retailers sampled by city and type. In Berkeley, Oakland, and San Francisco, respectively, 14, 11, and 12 stores were chains, and 10, 9, and 9 stores were outside the 0.5-mile radii (the majority of which were chains).

For small grocery, convenience, and liquor stores, we sampled 50% of eligible stores in the selected neighborhoods in Berkeley, 52% in Oakland, and 31% in San Francisco. On the basis of ReferenceUSA-verified lists of retailers with primary North American Industry Classification System codes corresponding to our store definitions,[47] our sample represented 27%, 6%, and 3% of eligible retailers in Berkeley, Oakland, and San Francisco, respectively. However, retailers outside our selected neighborhoods were not researcher verified, so the denominators for citywide retailers (which include stores unlikely to carry top-selling sodas such as health food stores) may underestimate the proportion of relevant retailers sampled.

To examine differences between Berkeley and comparison cities in changes in beverage prices (i.e., pass-through), we regressed the difference between post- and pretax prices on indicators for the presence of the tax and the retailer type. Separate models examined relative price changes for specific beverage categories (regular soda, diet soda, sweetened tea, fruit-flavored beverages, water, milk, and orange juice), and the broader categories of SSBs (regular soda, sweetened tea, sweetened coffee, fruit-flavored beverages, sports drinks, energy drinks, sweetened water) and non-SSBs (water, milk, orange juice, diet versions).

We also examined changes in prices of regular soda relative to diet soda as well as prices of SSBs relative to non-SSBs (i.e., change in SSB price minus change in non-SSB price). In a sensitivity analysis, we examined whether promotional prices affected pass-through rates for soda, fruit-flavored drinks, and SSBs.

We also assessed relative price changes for specific brands and their diet version (when available): Coke, Pepsi, Mountain Dew, Dr Pepper, Sprite, Gatorade, Red Bull, Vitamin Water, and bottled Starbucks Frappuccino.

Lastly, in exploratory analyses (limited by sample size), we used stratified models to examine differences in the pass-through by retailer type. We also examined differences in price changes for larger soda sizes, adjusting for store type. We conducted analyses using Stata/IC version 13 (Stata Corp, College Station, TX).

RESULTS

Table 3 displays unadjusted baseline beverage prices, pre- to posttax changes in prices, and differences in price changes between Berkeley and comparison cities (i.e., pass-through estimates) for beverage sizes typically consumed in a single sitting. The increase in the price of soda in Berkeley over that in comparison cities was 0.69 cents per ounce (95% CI = 0.36, 1.03)—a pass-through rate of 69%. For fruit-flavored beverages, the pass-through was lower—0.47 cents per ounce (95% CI = 0.08, 0.87). For sweetened teas, the pass-through was the lowest: 0.32 cents per ounce (95% CI = 0.00, 0.65). For SSBs overall, the pass-through was 0.47 cents per ounce (95% CI = 0.25, 0.69). For categories of nontaxed

TABLE 2—Analytic Sample of Retailers: Berkeley, Oakland, and San Francisco, CA, 2014 and 2015

Retailer	Berkeley[a]	Oakland[b]	San Francisco[b]
Chain supermarket	3	3	5
Chain 1	1	2	2
Chain 2	1	1	2
Chain 3	1	0	1
Small grocery store	8	6	6
Drugstore	6	4	4
Chain 1	3	2	2
Chain 2	3	2	2
Convenience store	5	5	4
Chain 1	2	2	2
Chain 2	1	1	0
Chain 3	1	1	0
Other	1	1	2
Liquor store	4	4	4
Total	26	22	23

Note. For large sodas (2 L and multipacks), we sampled 3 chain supermarkets and 2 drugstores in Berkeley and 5 chain supermarkets and 4 drugstores in Oakland and San Francisco. This sample includes 1 store per city from each supermarket and drugstore chain sampled.
[a]City with a sugar-sweetened beverage excise tax, implemented March 2015.
[b]Comparison city without a sugar-sweetened beverage excise tax.

TABLE 3—Unadjusted Baseline Beverage Prices, Pre- to Posttax Price Changes, and Price Change Differences: Berkeley, Oakland, and San Francisco, CA, 2014 and 2015

	Taxed City: Berkeley			Comparison Cities: Oakland and San Francisco			
Beverage	No.	Pretax Price, Cents/Oz, Mean ±SD	Price Change, Cents/Oz, Mean ±SD	No.	Pretax Price, Cents/Oz, Mean ±SD	Price Change, Cents/Oz, Mean ±SD	Difference in Change Between Berkeley and Comparison Cities, B (95% CI)[a]
Means of beverages							
Soda	26	8.66 ±1.08	0.78 ±0.64	45	8.69 ±1.07	0.12 ±0.71	0.69*** (0.36, 1.03)
Diet soda	24	8.80 ±0.86	0.40 ±0.49	41	8.66 ±1.13	0.25 ±0.80	0.15 (−0.21, 0.50)
Difference in regular and diet soda	24	0.02 ±0.29	0.41 ±0.63	41	0.05 ±0.49	−0.12 ±0.61	0.56** (0.24, 0.88)
Sweetened tea	21	6.07 ±2.06	0.23 ±0.69	41	6.15 ±1.56	−0.07 ±0.51	0.32* (0.00, 0.65)
Fruit-flavored beverages	21	9.50 ±3.07	0.38 ±0.93	40	8.65 ±1.32	−0.11 ±0.57	0.47* (0.08, 0.87)
Water	12	8.37 ±1.17	0.45 ±0.48	23	7.43 ±1.69	0.31 ±0.60	0.08 (−0.28, 0.45)
Milk	12	10.58 ±1.75	0.15 ±0.54	23	11.14 ±1.75	−0.09 ±1.26	0.22 (−0.60, 1.04)
100% orange juice	16	14.47 ±2.08	0.17 ±0.90	33	13.27 ±1.87	0.28 ±1.61	−0.16 (−1.03, 0.71)
Overall SSBs[b]	26	10.91 ±2.09	0.57 ±0.59	45	10.35 ±1.48	0.14 ±0.40	0.47*** (0.25, 0.69)
Overall non-SSBs[c]	24	12.24 ±2.63	0.29 ±0.74	45	11.39 ±3.12	0.28 ±0.60	0.00 (−0.32, 0.33)
Difference in SSB and non-SSB	24	−0.99 ±2.46	0.29 ±0.75	45	−1.04 ±2.66	−0.14 ±0.62	0.46** (0.13, 0.79)
Brands							
Coke	26	8.71 ±1.27	0.87 ±0.81	44	8.85 ±1.05	0.07 ±0.56	0.83*** (0.50, 1.16)
Diet Coke	22	8.74 ±0.89	0.50 ±0.55	38	8.82 ±1.03	0.18 ±0.52	0.32* (0.02, 0.61)
Pepsi	19	8.90 ±0.91	0.57 ±0.53	41	8.79 ±1.12	0.04 ±0.85	0.55* (0.11, 0.98)
Diet Pepsi	18	8.95 ±0.91	0.24 ±0.34	34	8.89 ±0.94	0.08 ±0.63	0.17 (−0.15, 0.50)
Mountain Dew	19	8.94 ±0.92	0.67 ±0.74	34	8.79 ±1.20	0.04 ±0.79	0.68** (0.24, 1.12)
Diet Mountain Dew	12	9.10 ±0.79	0.13 ±0.20	21	9.05 ±0.79	0.13 ±0.25	0.02 (−0.12, 0.17)
Dr Pepper	20	8.81 ±0.76	0.84 ±0.71	33	8.70 ±1.07	0.25 ±0.86	0.56* (0.11, 1.02)
Diet Dr Pepper	12	8.93 ±0.81	0.35 ±0.57	24	8.94 ±0.81	0.23 ±0.45	0.15 (−0.19, 0.49)
Sprite	21	9.03 ±1.24	0.79 ±0.74	39	8.70 ±1.14	0.16 ±0.84	0.73** (0.31, 1.15)
Sprite Zero	6	9.21 ±0.77	0.21 ±0.25	10	8.54 ±1.65	0.42 ±1.23	−0.50 (−1.66, 0.66)
Gatorade	18	8.32 ±1.04	0.29 ±0.78	29	7.65 ±2.05	0.13 ±0.97	0.19 (−0.39, 0.77)
Vitamin Water	16	9.02 ±0.76	0.43 ±0.52	33	8.69 ±1.86	0.19 ±1.28	0.42 (−0.21, 1.04)
Vitamin Water Zero	9	9.04 ±0.85	0.63 ±0.54	12	8.80 ±0.79	−0.01 ±0.75	0.72* (0.02, 1.41)
Starbucks Frappucino	14	26.08 ±4.87	−0.51 ±1.76	33	24.64 ±4.02	0.32 ±4.00	−1.16 (−3.29, 0.97)
Red Bull	23	28.75 ±2.92	0.68 ±2.88	38	27.26 ±2.70	0.86 ±2.35	−0.27 (−1.64, 1.11)
Red Bull Sugarfree	20	28.50 ±2.64	0.38 ±2.97	32	27.37 ±2.62	1.00 ±2.54	−0.53 (−2.10, 1.04)

Note. CI = confidence interval; SSBs = sugar-sweetened beverages.

[a]Estimate is from linear regression models, adjusting for retailer type in which the dependent variable was price change (posttax price minus pretax price) and the independent variable was a binomial indicator for tax. We collected posttax prices from late May through June 2015, and we collected most pretax prices in fall 2014 (we collected fruit-flavored beverage prices from November 2014 through January 2015). Analyses included sizes typically consumed in a single sitting (e.g., 20-oz soda).

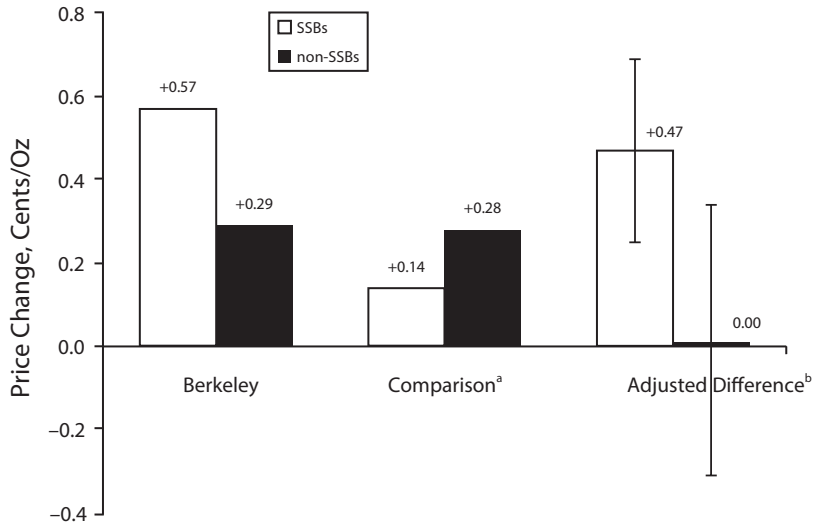
[b]Includes all regular soda, sweetened teas, fruit-flavored beverages, Gatorade, Vitamin Water, Starbucks Frappucino, and Red Bull.

[c]Includes all diet sodas, diet teas, bottled waters, reduced fat milk, 100% orange juice, Vitamin Water Zero, and Red Bull Sugarfree.

*$P < .05$; **$P < .01$; ***$P < .001$.

beverages, including diet soda, water, milk, orange juice, and non-SSBs overall, differences in price changes between Berkeley and the comparison cities were not significant (range: −0.16 to 0.22 cents/oz; $P > .05$). Figure 1 shows price changes for SSBs and non-SSBs overall and differences in these changes between Berkeley and comparison cities. In sensitivity analyses, pass-through rates were similar when including promotional prices for soda, fruit-flavored beverages, and SSBs overall (results not shown).

Table 3 shows results for price increases of SSBs relative to non-SSBs. The price of regular soda increased relative to the price of diet soda by 0.56 cents per ounce (95% CI = 0.24, 0.88) more in Berkeley than in the comparison cities. The price of SSBs overall increased relative to the price of non-SSBs by 0.46 cents per ounce (95% CI = 0.13, 0.79) more in Berkeley than in comparison cities.



Note. SSB = sugar-sweetened beverage. We estimated price change differences using linear regression models and adjusting for retailer type. Error bars show 95% confidence intervals. We collected posttax prices from late May through June 2015, and we collected most pretax prices in fall 2014. We collected fruit-flavored beverage prices from November 2014 through January 2015. Our analyses included sizes typically consumed in a single sitting (e.g., 20-oz soda).

[a]Absolute price increases in Oakland and San Francisco.

[b]Difference in price change between Berkeley and comparison cities.

FIGURE 1—Price changes of SSBs and non-SSBs overall and differences in changes between Berkeley and comparison cities: Berkeley, Oakland, and San Francisco, CA; 2014 and 2015.

Among brands (Table 3), Coke (Coca-Cola Company) had the highest pass-through (0.83 cents/oz), followed by Sprite (Coca-Cola Company; 0.73 cents/oz), Mountain Dew (PepsiCo; 0.68 cents/oz), Dr Pepper (Dr Pepper Snapple Group; 0.56 cents/oz), and Pepsi (PepsiCo; 0.55 cents/oz; $P<.05$). The price of Diet Coke also increased significantly in Berkeley relative to comparison cities (0.32 cents/oz; 95% CI = 0.02, 0.61). Relative price changes for other diet sodas (range = –0.50 to 0.17 cents/oz), Gatorade (0.19 cents/oz), Red Bull (–0.27 cents/oz), and Vitamin Water (0.42 cents/oz) were not significant ($P>.05$).

In exploratory analyses examining pass-through by retailer type (Table 4), drugstores generally had the lowest pass-through rates, with similar, nonsignificant price changes for regular (0.18 cents/oz) and diet (0.21 cents/oz) soda, and virtually no price changes for SSBs and non-SSBs overall in Berkeley relative to comparison cities ($P>.05$). For other retailers, pass-through for soda ranged from 0.59 cents per ounce (95% CI = 0.05, 1.01) for small grocery stores to 1.35 cents per ounce (95% CI = –0.40, 3.10) for liquor stores. Pass-through for SSBs overall ranged from 0.42 cents per ounce (95% CI = 0.00, 0.85) in small grocery stores to 0.97 cents per ounce (95% CI = 0.43, 1.51) in liquor stores.

Also in exploratory analyses, price increases for 2-liter bottles and multipacks of regular soda in Berkeley were 0.46 (95% CI = 0.03, 0.89) and 0.49 (95% CI = 0.21, 0.77) cents per ounce higher, respectively, than were those in comparison cities. Pass-through estimates for these beverages, which we assessed only in supermarkets and drugstores, were similar to the pass-through for 20-ounce bottles sold in supermarkets and drugstores (0.37 cents/oz; 95% CI = 0.13, 0.60). However, when considering promotional prices, the pass-through for 2-liter bottles dropped to 0.24 cents per ounce (95% CI = –0.46, 0.94), whereas pass-through for multipacks became 0.56 cents per ounce (95% CI = –0.21, 1.34).

DISCUSSION

Approximately 3 months after implementation of the Berkeley SSB excise tax, we found early evidence that the tax was passed-through to higher SSB retail prices, a meaningful step toward reducing SSB consumption. Pass-through rates in Berkeley were significant for soda (69%), fruit-flavored beverages (47%), and SSBs overall (47%). For soda, this means that a 20-ounce soda costing $1.75 would cost an average of $1.89 after the tax (a 14-cent increase). Pass-through was highest for soda, particularly for Coke (83%). However, the price of Diet Coke also increased more in Berkeley than in comparison cities, though by only 39% of the relative price increase of Coke. Broader categories of untaxed beverages (diet soda, water, milk, orange juice, and non-SSBs) did not significantly increase in price in Berkeley relative to comparison cities.

At this early stage of implementation, we found signs of varying pass-through by retailer type; however, sample size was limited within retail categories. Drugstores exhibited the lowest pass-through rates, suggesting that drugstores may have used regional (rather than store-specific) pricing, distributed tax-related costs across multiple products, or absorbed costs. By contrast, Dollar Tree, a national chain selling products for $1, reacted to the tax by discontinuing SSB sales at its 2 Berkeley locations in January 2015.[48]

For larger soda sizes (assessed only in supermarkets and drugstores), pass-through rates were lower than for 20-ounce sodas on average but were similar to the pass-through rate of 20-ounce sodas from supermarkets and drugstores. However, when considering promotional prices, pass-through for 2-liter bottles was markedly lower. Retailers may have used temporary promotional pricing to maintain SSB demand in the face of SSB taxes.

Because we collected posttax data only 3 months after implementation, we expect to see further price changes in response to the tax. When we spoke with managers of nonchain stores to collect prices, some indicated they planned to change prices whereas others were still uncertain about which beverages were affected and which distributors had raised prices. One manager noted, “It takes a lot to add [the cost of a] new tax for every item. We’re still going through the process, and it’s June. I think that it would take at least 6 months.” As retailers become more aware of the tax and added costs charged by

TABLE 4—Difference in Pre- vs Posttax Beverage Price Changes (Cents/Oz) by Retailer Type: Berkeley, Oakland, and San Francisco, CA; 2014 and 2015

	Supermarket		Small Grocery		Drugstore		Convenience		Liquor	
Beverage	No.	b (95% CI)[a]	No.	b (95% CI)	No.	b (95% CI)	No.	b (95% CI)	No.	b (95% CI)
Soda	11	0.66** (0.21, 1.11)	20	0.59* (0.11, 1.08)	14	0.18 (−0.05, 0.40)	14	0.86* (0.05, 1.67)	12	1.35 (−0.40, 3.10)
Diet soda	11	0.17 (−0.31, 0.65)	16	−0.05 (−0.82, 0.72)	14	0.21 (−0.06, 0.48)	14	0.55 (−0.19, 1.29)	10	−0.19 (−2.17, 1.79)
Difference in regular and diet soda	11	0.50 (−0.06, 1.05)	16	0.74 (−0.01, 1.50)	14	−0.04 (−0.25, 0.18)	14	0.31 (−0.05, 0.67)	10	1.51 (−0.15, 3.17)
Fruit-flavored drinks	6	0.71 (−1.33, 2.75)	17	−0.07 (−1.07, 0.93)	12	0.13 (−0.29, 0.56)	14	1.04 (−0.02, 2.10)	12	0.83* (0.24, 1.42)
Overall SSBs[b]	11	0.58 (−0.32, 1.48)	20	0.42 (0.00, 0.85)	14	0.01 (−0.35, 0.37)	14	0.53 (−0.02, 1.08)	12	0.97** (0.43, 1.52)
Overall non-SSB[c]	11	0.31 (−0.15, 0.76)	18	−0.25 (−0.69, 0.18)	14	−0.08 (−0.59, 0.43)	14	0.49 (−0.18, 1.15)	12	−0.32 (−1.98, 1.33)
Difference in SSB and non-SSB	11	0.27 (−0.61, 1.15)	18	0.65** (0.21, 1.09)	14	0.09 (−0.28, 0.47)	14	0.04 (−0.40, 0.49)	12	1.30 (−0.36, 2.96)

Note. CI = confidence interval; SSBs = sugar-sweetened beverages.
[a]Difference in price changes between Berkeley and comparison cities. From linear regression models in which the dependent variable was price change (posttax price minus pretax price) and the independent variable was a binomial indicator for tax. We collected posttax prices from late May through June 2015, and we collected most pretax prices in fall 2014 (we collected fruit-flavored beverage prices from November 2014 through January 2015). Analyses included sizes typically consumed in a single sitting (e.g., 20-oz soda).
[b]Includes all regular soda, sweetened teas, fruit-flavored beverages, Gatorade, Vitamin Water, Starbucks Frappucino, and Red Bull.
[c]Includes all diet sodas, diet teas, bottled waters, reduced fat milk, 100% orange juice, Vitamin Water Zero, and Red Bull Sugarfree.
*$P < .05$; **$P < .01$; ***$P < .001$.

distributors, we anticipate pass-through rates will increase, especially among small grocery and liquor stores.

Although excise taxes on SSBs have not been implemented elsewhere in the United States for public health purposes, other countries have adopted similar taxes. Effective January 2014, Mexico's peso per liter excise tax on SSBs resulted in a 12% increase in retail prices of soda[35] and a 12% reduction in purchases of taxed SSBs 1 year later.[49] In January 2012, France implemented an 11-euro-cent-per-1.5-liter SSB excise tax that was fully shifted for sodas but undershifted for fruit drinks and flavored waters 6 months later, with pass-through rates varying across retailers.[33] We observed similar patterns of higher pass-through for soda and variability in price changes across retailers. In Denmark, where excise taxes on soft drinks increased in 1998 and 2001, researchers also detected heterogeneity in price changes by retailer as well as overshifting.[34]

These previous empirical studies of SSB tax pass-through have not included concurrent control communities because taxes were implemented in an entire country at the same time.[33–35] We compared price changes in Berkeley to those in nearby cities, allowing us to account for other factors potentially affecting beverage prices at the time of implementation. Another strength of this study is that we collected most pretax prices before the November 2014 elections, reducing the likelihood that baseline data were contaminated by businesses increasing prices in anticipation of the tax.

Limitations

This study has several limitations. We assessed beverage prices at only 2 time points and were unable to assess all beverage types and sizes or nonbeverage items (e.g., food) to which retailers could shift costs. Other data, such as proprietary scanner data, would be necessary to feasibly analyze a broader set of products and sizes; however, such data do not exist for many nonchain stores. Data on changes in the price that distributors charge retailers will be necessary to fully understand pass-through of the tax, because without distributor price increases, retail price increases are unlikely.

At least some large distributors, including a Coke bottler,[50] have increased prices, and our future work will examine variability in distributor response. Although we examined pass-through by retailer type, our sample size limited our ability to test for statistically significant differences in pass-through by retailer type. Additionally, in several stores without price tags, store clerks recalled prices from memory, which may have introduced random error into price data. Lastly, our evaluation did not include all neighborhoods in each city; thus it is possible our sample does not represent pass-through in all geographies. However, all eligible Berkeley supermarket and drugstore chains and 4 national convenience store chains were represented. Thus, our sample contains a mix of centrally located chains and stores in lower-income, minority neighborhoods.

Conclusions

Our finding that Berkeley's SSB excise tax has already resulted in higher retail prices is of major public health importance. This first empirical evidence of early pass-through at the city level foretells pass-through of SSB excise taxes in other cities. As the pass-through in Berkeley evolves and other locations implement SSB taxes, it will be important to continually monitor retail prices because higher prices mediate the effect of excise taxes on consumption. A recent study estimated that a 50% to 150% pass-through rate of a 1-cent-per-ounce excise tax would result in a 10%–30% reduction in consumption.[51] However, it will be crucial to empirically study changes in beverage consumption following such taxes, because this has not yet been done in the United States or at a city level. Additionally, future research can explore whether patterns observed for excise taxes on tobacco, such as lower pass-through rates in areas near

jurisdictions with lower tax rates, occur for SSB excise taxes.[25,29]

Of further importance is the health impact of revenues generated from excise taxes, which hold great promise as a means to sustainably fund public health programs. Lastly, understanding how and why distributors and retailers react to the tax can inform how other jurisdictions develop and implement SSB excise tax legislation. Already results suggest that more information to retailers before implementation might lead to quicker and more complete pass-through. Our ongoing work focuses on measuring changes in SSB consumption between pre- and posttax periods and gathers qualitative information about tax implementation.

Approximately 3 months after implementation of the Berkeley excise tax on SSBs, we found early evidence that SSB retail prices had increased more in Berkeley than in nearby cities, with soda exhibiting the largest price increase. Higher SSB retail prices mark the first step in the causal pathway toward reduced SSB consumption, which could considerably reduce the burden of chronic disease attributed to obesity and other SSB-related health conditions. ■

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Contributors

J. Falbe and K. A. Madsen designed and conceptualized the study and interpreted the data. J. Falbe, A. H. Grummon, and K. A. Madsen conducted the analysis and drafted the article. N. Rojas contributed to analysis and to article revision.

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Human Participant Protection

No protocol approval was necessary because this research was an analysis of price data and therefore no human participants were involved.

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