BOSTON, MA: Sugary Drink Excise Tax

CHOICES Learning Collaborative Partnership

Executive Summary

Sugary drink consumption has been linked to excess weight gain, obesity, incidence of type 2 diabetes, heart disease, and cancer. Federal, state, and local governments have considered implementing excise taxes on sugary drinks to reduce consumption, prevent obesity, and provide a new source of government revenue.[1-3] In Massachusetts, legislative measures to introduce a tiered sugary drink excise tax have been proposed.[4,5] The most recent proposed bills specify that tax revenue be dedicated to benefits, services, and programs, including universal free school meals and provision of healthy meals in Head Start and other high need early education settings, for communities most impacted by health inequity and burdened by chronic health outcomes related to sugary drink consumption.[4,5]

We modeled the impact of a statewide excise tax on sugary drinks on health outcomes among Boston residents. Consistent with current policy proposals, we assumed tiered tax rates depending on the sugar content of the beverage: $0.01/ounce for beverages with more than 7.5 but less than 30 grams of sugar per 12 fluid ounces and $0.02 for beverages with more than 30 grams of sugar per 12 fluid ounces. CHOICES cost-effectiveness analysis compared the costs and outcomes of implementing a tax with the costs and outcomes expected if the tax were not implemented over 10 years (2023-2032).

The sugary drink excise tax on distributors is projected to be cost-saving. This means that the tax would save more in future healthcare costs than it would cost to implement. This is without consideration of the potential revenue that would be generated, where a tiered $0.01-$0.02/ounce statewide excise tax on sugary drinks in Massachusetts could raise as much as $226 million to $322 million in annual revenue.[6] Among Boston residents, the tax is projected to decrease sugary drink consumption, prevent more than 6,000 cases of obesity, and save $91.2 million in health care costs. People who consume sugary drinks are projected to spend less on these drinks with the excise tax in place. We also project that Black and Hispanic/Latinx Boston residents will experience a greater reduction in obesity rates compared with White, non-Hispanic/Latinx residents after the tax is implemented. These results are summarized below and in the complete report. Projected results for a $0.02/ounce state excise tax based on the volume of sugary drinks were similar.

Health impact of a $0.01-$0.02/ounce state excise tax on sugary drinks *for the Boston population*

- **104 FEWER 12-OZ SUGARY DRINKS SERVINGS PER PERSON** in the first year
- **6,220 CASES OF OBESITY PREVENTED** in 2032
- **252 CASES OF DIABETES PREVENTED**
- **71,500 FEWER DECAYED, MISSING, OR FILLED TEETH** among Boston residents

Cost impact of a $0.01-$0.02/ounce state excise tax on sugary drinks *for the Boston population*

- **$135** DECREASE IN SPENDING ON SUGARY DRINKS PER HOUSEHOLD in the first year
- **$91.2 mill** HEALTH CARE COSTS SAVED
- **$5.57 mill** DENTAL DECAY TREATMENT COST SAVINGS

Suggested Citation: McCulloch SM, Barrett JL, Reiner JF, Cradock AL, Gortmaker SL. *Boston: Sugary Drink Excise Tax*. CHOICES Learning Collaborative Partnership at the Harvard T.H. Chan School of Public Health, Boston, MA; February 2024. For more information, please visit www.choicesproject.org.

The design for this report and its graphics were developed by Molly Garrone, MA and partners at Burness.

This work is supported by The JPB Foundation and the Centers for Disease Control and Prevention (U48DP006376), and the National Institutes for Health (R01HL146625). The findings and conclusions are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention or other funders.

$0.01-$0.02/OUNCE STATE EXCISE TAX ON SUGARY DRINKS

Background

Overconsumption of added sugars is common, with more than half of the United States population ages two years and older exceeding the daily recommended limit for added sugars put forth in the 2015-2020 Dietary Guidelines for Americans.[7] Sugary drinks (defined as all drinks with added caloric sweeteners) are the number one source of added sugars that Americans consume.[7]

In this report, Asian, Black or African American, White, and All Other Races race and ethnicity groups refer to people of non-Hispanic/Latinx ethnicity.

Asian includes people of Asian and Native Hawaiian and Pacific Islander races.

All Other Races includes people of American Indian and Alaska Native race and two or more races.

In 2018, the beverage industry spent $1 billion to advertise sugary drinks in television, digital platforms (internet and mobile), radio, magazines, newspapers, coupons, and outdoor venues in order to drive preferences and purchases of sugary beverages.[8] Beverage companies frequently target their sugary drink advertising towards youth, and are more likely to target Black and Hispanic/Latinx youth. Additionally, Black and Hispanic/Latinx populations are less likely to be the audience for marketing of healthy drinks like water.[8] According to recent estimates, approximately 71% of adolescents in Boston report consuming soda regularly, and 14% consume at least one serving of soda per day.[9] Higher than average sugary drink consumption levels are common among Hispanic/Latinx and Black Boston youth.[9]

Strong evidence links increased consumption of sugary drinks to higher risk for obesity and other diseases that are tied to what people eat, such as type 2 diabetes,[10,11] and the prevalence of these diseases are higher among people with lower income and Black and Hispanic/Latinx Boston residents.[12] An estimated 27% of adults and 18% of youth in Boston have obesity.[13,14]

Taxes have emerged as a promising strategy to reduce consumption of sugary drinks. In addition to the potential of a sugary drink tax to reduce obesity, it has cost implications as well. This report models the projected effect of a sugary drink excise tax on health, disease outcomes, and health care cost savings over the next decade.

Key Terms

Cost-saving: saves more in future health care costs than it costs to implement (not considering the potential tax revenues)

Excise tax: a consumption tax collected from retailers or distributors; it can bereflected in the posted price (a sales tax in contrast is applied after purchase of the item)

Pass-through rate: how much of the excise tax on retailers or distributors is passed on to consumers as an increase in shelf price; a percent ranging from 0% (none of the tax) to 100% (all the tax), or even greater than 100% (more than the amount of the tax)

Price elasticity of demand: how much consumer purchasing behavior changes following a change in price of an item

Projected Impact of a Sugary Drink Excise Tax in Boston

We modeled the health impacts of a statewide excise tax on sugary drinks for the Boston population, at a tax rate depending on the sugar content of the beverage (i.e., a tiered tax): $0.01/ounce for beverages with more than 7.5 but less than 30 grams of sugar per 12 fluid ounces and $0.02 for beverages with more than 30 grams of sugar per 12 fluid ounces. All drinks with added caloric sweeteners were considered to be taxed, while 100% juice, milk products, and beverages with 7.5 or fewer grams of sugar per 12 fluid ounces were considered exempt. As an alternative scenario, we modeled implementation of a $0.02/ounce state excise tax based on the volume of sugary drinks (i.e., a flat tax).

The City of Boston does not have the authority to implement a citywide excise tax on sugary drinks, so the model projects the health impacts of a statewide tax for the Boston population. Costs to implement the tax statewide are included, since statewide implementation is necessary to impact the health of the Boston population. See the Massachusetts: Sugary Drink Excise Tax report[15] for projected impacts of a statewide tax for the Massachusetts population.

Results: What Did We Find?

Results among the Boston Population

We project that implementation of a state excise tax on sugary drinks, at a tax rate of $0.01/ounce or $0.02/ounce depending on sugar content, has greater than a 99% likelihood of being cost-saving by saving more in future health care costs than it would cost to implement. Among the Boston population, it would prevent more than 6,000 cases of childhood and adult obesity, prevent new cases of diabetes, increase healthy life years, prevent tooth decay, and improve health equity. Projected results for a $0.02/ounce state excise tax based on the volume of sugary drinks were similar. For complete results, see the Appendix beginning on page 16.

Model results are presented as the most likely estimate as well as a 95% uncertainty interval (95% UI). The 95% UI can be thought of as a likely range that is estimated by considering uncertainty from data sources and population projections and calculating a central range in which 95 percent of the model results fell.

How many people would be affected by the tax?

This can be thought of as reach or the number of people affected by the strategy. Based on our modeling, the table below presents the estimated number of people affected by the tax in the first year and the number of people affected by the tax over 10 years.

Outcome	Number of people affected by the tax	95% UI
First Year Population Reach*	**641,000**	(639,000; 644,000)
10-Year Population Reach*	**703,000**	(698,000; 707,000)

The 95% uncertainty interval (95% UI) can be thought of as a likely range. It is estimated by running the model 1,000 times, taking into account uncertainty from data sources and population projections, and calculating a central range in which 95 percent of these model results fell.
Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.
**Not discounted.*

What effect would the tax have on sugary drink consumption and spending?

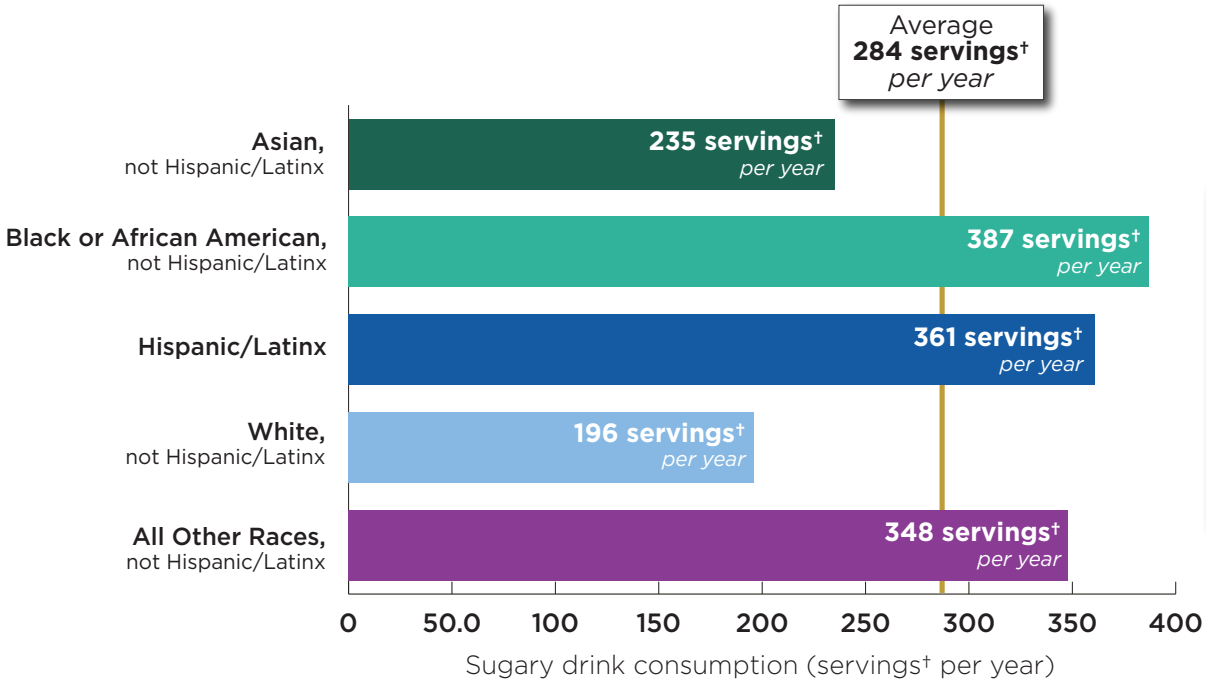
Economic studies indicate that with a sugary drink tax on distributors, consumers will buy less of these products.[16] Assuming fewer purchases result in lower consumption, a $0.01-$0.02/ounce tax will decrease the intake of sugary drinks. Compared to projections of sugary drink consumption without a tax, the tax is projected to result in lower levels of sugary drink consumption. In Boston, spending on sugary drinks without a tax is estimated to be $121 million per year. We project a 97% likelihood that individuals and households who purchase sugary drinks will spend less on sugary drinks after the tax is implemented.

Outcome	Impact of the tax on sugary drink consumption & spending	95% UI
Decrease in 12-oz Servings of Sugary Drinks per Person in the First Year*	**104**	(63; 201)
Decrease in Spending on Sugary Drinks in the First Year per Person Consuming Sugary Drinks*	**$58**	(-$1; $202) 97% likelihood of decrease in spending
Decrease in Spending on Sugary Drinks in the First Year per Household*	**$135**	(-$3; $475) 97% likelihood of decrease in spending
Decrease in Spending on Sugary Drinks in the First Year Overall in Boston*	**$22.8 million**	(-$569,000; $80.0 million) 97% likelihood of decrease in spending

The 95% uncertainty interval (95% UI) can be thought of as a likely range. It is estimated by running the model 1,000 times, taking into account uncertainty from data sources and population projections, and calculating a central range in which 95 percent of these model results fell.
Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.
**Not discounted.*

BOSTON, MA: Sugary Drink Excise Tax

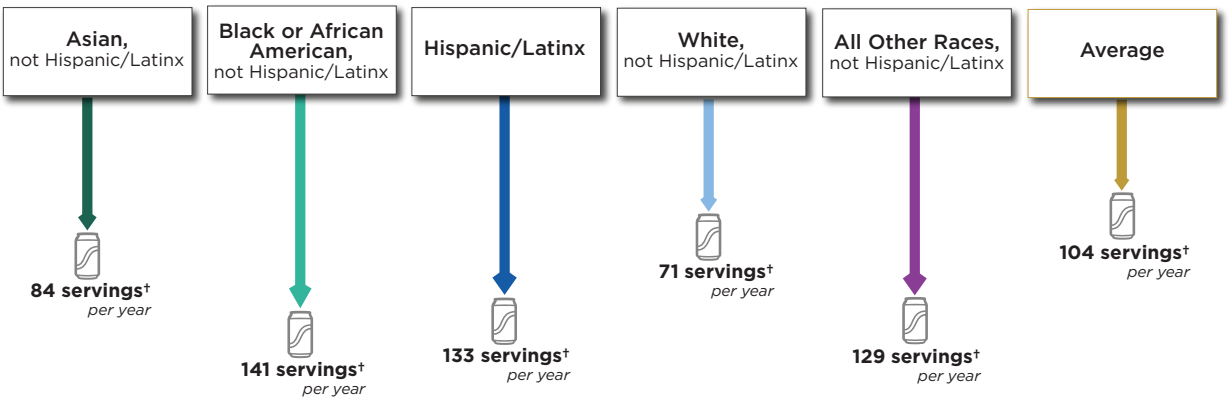
Average Annual Pre-Tax Sugary Drink Consumption per Person in Boston by Race and Ethnicity



While Boston residents, on average, consume 284 servings of sugary drinks each in a year, higher than average sugary drink consumption levels are common among Black and Hispanic/ Latinx Boston residents.

†Each serving is 12 ounces.
DATA SOURCES: Boston BRFSS 2013-2019, Boston YRBS 2013-2019, NHANES 2011-2016; Analysis by Boston Public Health Commission and the CHOICES Project, 2023.

Post-Tax Decrease in Sugary Drink Consumption per Person in Boston by Race and Ethnicity*



With a tax, sugary drink consumption would decrease the most among Black and Hispanic/Latinx Boston residents. On average, each Black person would reduce consumption by 141 servings per year, and each Hispanic/ Latinx person would reduce consumption by 133 servings per year.

*In the first year following a sugary drink excise tax of $0.01-$0.02/ounce based on sugar content.
†Each serving is 12 ounces.

What effect would the tax have on obesity and related health outcomes, overall and by race and ethnicity?

Compared to projections of obesity and related health outcomes without a tax, the tax is projected to result in fewer cases of obesity and fewer deaths over the 10-year period under consideration. Under the proposed tax, Black Boston residents will experience a preventive health benefit that is 26% greater than the population average, and Hispanic/Latinx Boston residents will experience a preventive health benefit that is 38% greater than the population average.

Outcome	Impact of the tax on obesity and related health outcomes	95% UI
Quality Adjusted Life Years (QALYs) Gained Over 10 Years	**2,660**	(1,270; 5,600)
Years of Life Gained Over 10 Years	**536**	(207; 1,250)
Deaths Prevented Over 10 Years*	**157**	(61; 366)
Years with Obesity Prevented Over 10 Years	**47,200**	(23,700; 95,200)
Cases of Obesity Prevented in 2032*	**6,220**	(3,080; 12,500)
Cases of Childhood Obesity Prevented in 2032*	**1,100**	(422; 2,440)
Cases of Obesity Prevented Per 100,000 in 2032*	**971**	(480; 1,950)

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Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.
**Not discounted.*

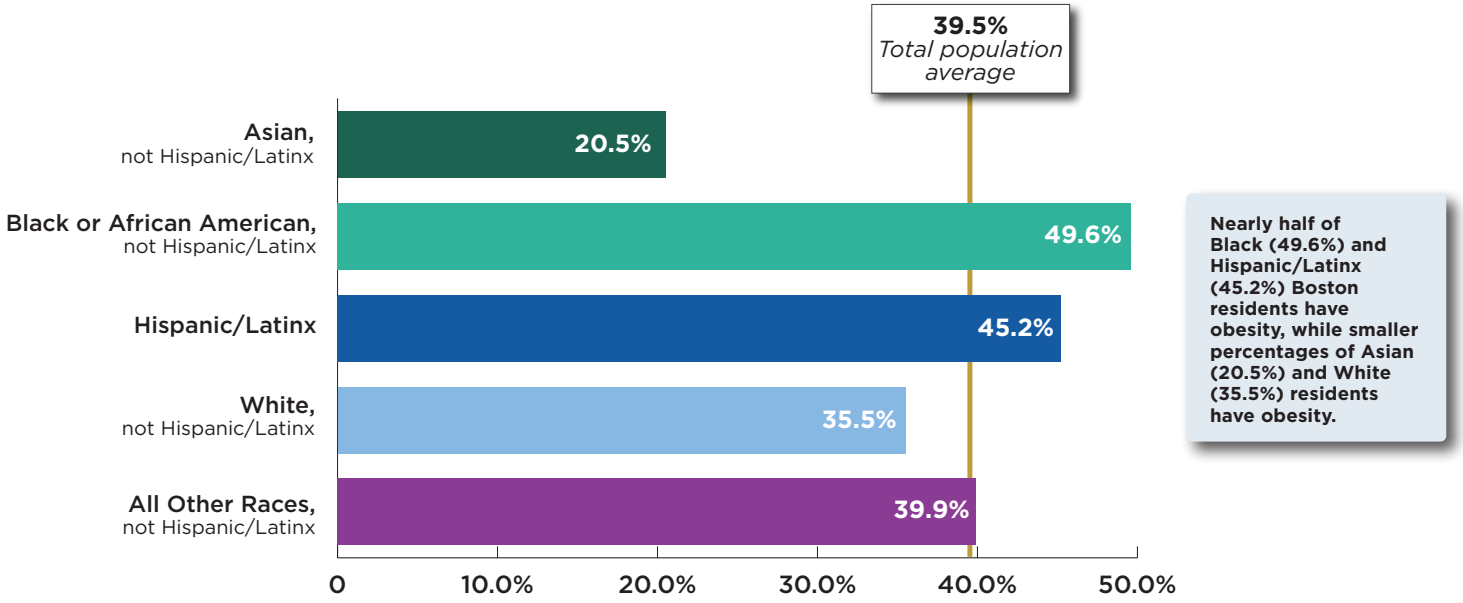
$0.01-$0.02/ounce state excise tax on sugary drinks

6,220 CASES OF OBESITY PREVENTED
in 2032

1,100 CASES OF CHILDHOOD OBESITY PREVENTED
in 2032

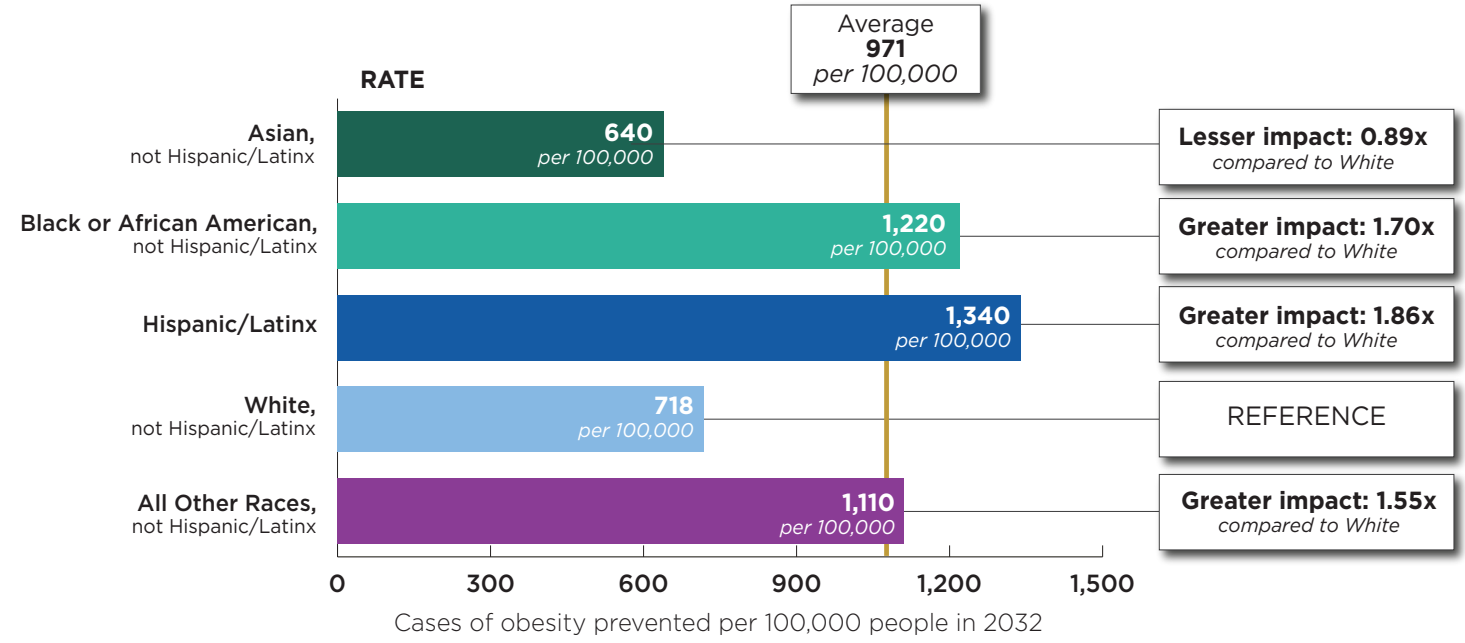
BOSTON, MA: Sugary Drink Excise Tax

Pre-Tax Obesity Prevalence in Boston by Race and Ethnicity



DATA SOURCES: NHANES 2011-2016, NSCH 2003-2018, Massachusetts School BMI Screening 2009-2016; Analysis by the CHOICES Project, 2023.

Comparative Projected Impact of a Sugary Drink Excise Tax in Boston by Race and Ethnicity*



Percentage of the Boston Population by Race and Ethnicity

- 8%: Asian, not Hispanic/Latinx
- 22% Black or African American, not Hispanic/Latinx
- 20% Hispanic/Latinx
- 44% White, not Hispanic/Latinx
- 5% All Other Races, not Hispanic/Latinx

*With a sugary drink excise tax of $0.01-$0.02/ounce based on sugar content.

BOSTON, MA: Sugary Drink Excise Tax

	Boston: Impact of the tax on behavior and health, by race and ethnicity**				
Outcome	**Asian**, not Hispanic/Latinx† **Mean** 95% UI	**Black or African American**, not Hispanic/Latinx **Mean** 95% UI	**Hispanic/Latinx** **Mean** 95% UI	**White**, not Hispanic/ Latinx **Mean** 95% UI	**All Other Races**, not Hispanic/ Latinx† **Mean** 95% UI
Decrease in 12-oz Servings of Sugary Drinks per Person in the First Year*	**84** (51; 169)	**141** (86; 276)	**133** (82; 256)	**71** (43; 140)	**129** (79; 245)
Quality Adjusted Life Years (QALYs) Gained Over 10 Years	**162** (74.9; 359)	**797** (381; 1,720)	**679** (337; 1,360)	**865** (409; 1,870)	**156** (74.9; 314)
Years of Life Gained Over 10 Years	**27.6** (4.58; 72.2)	**221** (80.4; 532)	**98.0** (30.2; 230)	**162** (56.7; 393)	**28.2** (3.44; 71.7)
Years with Obesity Prevented Over 10 Years	**2,580** (1,220; 5,520)	**13,000** (6,320; 26,500)	**13,600** (6,840; 26,700)	**15,200** (7,490; 31,400)	**2,790** (1,440; 5,380)
Cases of Obesity Prevented in 2032*	**341** (162; 734)	**1,710** (823; 3,530)	**1,790** (891; 3,530)	**2,010** (991; 4,130)	**373** (184; 743)
Cases of Childhood Obesity Prevented in 2032*	**39** (14; 91)	**271** (102; 616)	**390** (140; 903)	**315** (124; 690)	**87** (32; 203)
Cases of Obesity Prevented Per 100,000 in 2032*	**640** (303; 1,370)	**1,220** (587; 2,510)	**1,340** (663; 2,660)	**718** (354; 1,480)	**1,110** (551; 2,200)
Comparison of Cases of Obesity Prevented per 100,000 in 2032 vs. White*‡	**0.89** (0.69; 1.11) 82% likelihood of lesser impact	**1.70** (1.48; 2.03) >99% likelihood of greater impact	**1.86** (1.56; 2.39) >99% likelihood of greater impact	**1.00 (Reference)** N/A	**1.55** (1.26; 2.02) >99% likelihood of greater impact
Comparison of Cases of Obesity Prevented per 100,000 in 2032 vs. Average*‡	**0.66** (0.51; 0.83) >99% likelihood of lesser impact	**1.26** (1.15; 1.40) >99% likelihood of greater impact	**1.38** (1.24; 1.57) >99% likelihood of greater impact	**0.74** (0.65; 0.81) >99% likelihood of lesser impact	**1.14** (0.99; 1.39) 97% likelihood of greater impact

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Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.
**Not discounted.*
**During the modeling period, 2023-2032.
†Asian includes people of Asian and Native Hawaiian and Pacific Islander race. All Other Races includes people of American Indian and Alaska Native race and two or more races.
‡The ratio of the projected reduction in obesity prevalence in a particular group compared to the projected reduction in the reference group. A value greater than 1 indicates that the group is projected to see a greater reduction in obesity levels compared to the reference group.

BOSTON, MA: Sugary Drink Excise Tax

What effect would the tax have on diabetes?

Decreasing the intake of sugary drinks has other health implications. We estimated the impact of the tax on diabetes incidence using the projected estimates of decline in sugary drink consumption. In Boston, the proposed sugary drink excise tax on distributors could lead to a 9% reduction in diabetes incidence after the first two years of implementation.

$0.01-$0.02/ounce state excise tax on sugary drinks: impact on Boston

- **9% REDUCTION IN DIABETES INCIDENCE**
- **252 CASES OF DIABETES PREVENTED**

What effect would the tax have on tooth decay?

Higher intake of sugar, including in sugary drinks, is associated with increased decayed, missing, and filled teeth (i.e., tooth decay).[17,18] In Boston, we estimated that reduced sugary drink intake resulting from a $0.01-0.02/ounce tiered tax would lead to 71,500 fewer decayed, missing, and filled teeth and $5.57 million in savings over 10 years due to a reduction in treatment of tooth decay. A recent study of dental patients indicated that the sugary beverage tax in Philadelphia led to reductions in decayed, missing and filled teeth among both children and adults on Medicaid. These results validate our projections, and also indicate likely improvements in health equity.[19]

$0.01-$0.02/ounce state excise tax on sugary drinks: impact on Boston

- **71,500** FEWER DECAYED, MISSING, OR FILLED TEETH
- **$5.57 mill** DENTAL DECAY TREATMENT TOTAL COST SAVINGS

over 10 years

Results Statewide in Massachusetts

How much would the tax cost to implement in Massachusetts?

To implement the proposed policy in Massachusetts, the Massachusetts Department of Revenue would need to process tax statements and conduct audits. Businesses would also need to prepare tax statements and participate in audits, which would require labor from private tax accountants. The Massachusetts Department of Public Health would also lead a communications campaign to promote healthy beverage consumption and health equity. Cost information is based on data from localities with planned or implemented excise taxes on sugary drinks[20] and from programs previously implemented in Massachusetts. The cost and benefit estimates do not include expected tax revenue from distributors (discussed below). Below we include annual and 10-year implementation costs.

Outcome	Massachusetts Costs	95% UI
Annual Implementation Cost	**$380,000**	($327,000; $429,000)
Annual Implementation Cost per Person	**$0.06**	($0.05; $0.07)
Total Intervention Implementation Cost Over 10 Years	**$3.80 million**	($3.27 million; $4.29 million)

The 95% uncertainty interval (95% UI) can be thought of as a likely range. It is estimated by running the model 1,000 times, taking into account uncertainty from data sources and population projections, and calculating a central range in which 95 percent of these model results fell.
Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.

How much would the tax save in health care costs compared to what it costs to implement in Massachusetts?

Since we project that the tax saves more in future health care costs than it costs to implement, the tax would be cost-saving. We project a greater than 99% likelihood of cost savings with the tax. The estimated reduction in excess weight attributable to the tax leads to lower projected health care costs, offsetting tax implementation costs and resulting in a net cost savings. The difference between total health care costs with no tax implementation and lower health care costs associated with the implementation of a tiered sugary drink tax on distributors represents the health care costs saved; these savings can be compared to the cost of implementing the tax to arrive at the metric of health care costs saved per $1 invested.

Outcome	Costs	95% UI
Health Care Costs Saved Over 10 Years	**$937 million**	($397 million; $2.19 billion)
Among the Boston Population	**$91.2 million**	($38.4 million; $208 million)
Net Costs Difference Over 10 Years	**-$933 million**	(-$2.19 billion; -$393 million)
Health Care Costs Saved per $1 Invested Over 10 Years	**$246.39**	($102.30; $592.99)

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Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.

Would the tax be a good value in Massachusetts?

We project that the tax would improve health and save more in future health care costs than it costs to implement, making it cost-saving.

The tax would be cost-saving on the basis of the key statewide cost-effectiveness metrics:

- **Cost per year with obesity prevented over 10 years**
- **Cost per quality adjusted life year (QALY) gained over 10 years**
- **Cost per year of life gained over 10 years**
- **Cost per death averted over 10 years**

For projected impacts of a statewide tax for the Massachusetts population, see the Massachusetts: Sugary Drink Excise Tax report.[15]

Key Considerations for Health Equity

Community members have raised concern that the tax would have a disproportionate economic impact on households with lower incomes. Recent studies of existing sugary drink taxes[19,21] and conclusions from health economists[22] suggest that populations with low income benefit substantially from sugary drink taxes. A recent study from England indicates the tiered tax there resulted in reduced obesity in young girls, with the greatest impacts upon those living in the most deprived areas.[21] Another recent study of dental patients indicated that the sugary beverage tax in Philadelphia led to reductions in decayed, missing and filled teeth among both children and adults on Medicaid.[19]

Economic studies indicate that with a sugary drink tax, consumers will buy less of these products.[16] This change in purchasing is substantial, so that consumers can be expected to spend less on sugary drinks after a tax is implemented. Using sales data from the Rudd Center Revenue Calculator for Sugary Drink Taxes,[6] we estimate that $121 million is spent annually on sugary drinks in Boston. With a tiered $0.01-$0.02/ounce tax in place in Massachusetts, we project that spending on sugary drinks in Boston will decrease by $22.8 million in the first year. A typical person in Boston who consumes sugary drinks would spend $58 less per year on sugary drinks after a tiered $0.01-$0.02/ounce tax, and a typical household would spend $135 less per year. This would free up disposable income for other consumer purchases. A typical person in Boston who continues to drink sugary drinks after the tax is in place would be expected to pay a tax of about $1.09 per week, or $57 per year.

In addition to these changes in spending, reductions in obesity rates due to the tax are projected to be greatest among individuals from households with low income. We also project that there would be greater reductions in obesity rates among Black and Hispanic/Latinx Boston residents compared with non-Hispanic/non-Latinx residents of Asian or White race. Based on local data on sugary drink consumption, the average daily consumption of sugary drinks among people in Boston varies by race and ethnicity group (see pre-tax graphs on pages 4 and 6). Under the proposed tax, Hispanic/Latinx Boston residents would see a 38% greater than average reduction in obesity rates, and Black residents would see a 26% greater than average reduction in obesity rates. On that basis, the modeled tax could decrease disparities in obesity outcomes and improve health equity by race and ethnicity in Boston.

Implementation Considerations

A tiered $0.01-$0.02/ounce statewide excise tax on sugary drinks in Massachusetts could raise as much as $226 million to $322 million in annual revenue.[6] Revenue raised from a sugary drink tax could be invested in communities with lower incomes if the legislature earmarks the tax for this type of use. Cities with current sugary drink taxes in the U.S. have allocated these revenues in a variety of ways, including "increasing access to healthy food and water, educating about nutrition and healthy beverage choices, providing health services, and expanding opportunities for physical activity. Others address social determinants of health such as early childhood education or maintenance of libraries, parks, and recreation centers."[23] Public support for such taxes generally increases with earmarking for preventive health activities.[24]

There is opposition from the food and beverage industry, which spends billions of dollars promoting their products.[25] One concern is the impact on employment. In U.S. cities with sugary drink taxes in place, there is no evidence that the tax has negatively impacted employment.[26,27] Relatively small beverage excise taxes are currently applied across many states. The proposed tax is likely to be sustainable if implemented based on the successful history of tobacco excise taxes. There is potential for a shift in social norms of sugary drink consumption based on evidence from tobacco control tax and regulatory efforts.[28]

Modeling Assumptions & Summary of the CHOICES Microsimulation Model

How does an excise tax on distributors affect the price paid by consumers?

An excise tax is incorporated directly into a beverage's shelf price. We assume 100% pass-through of the tax over 10 years and assume the tax rate would be adjusted annually for inflation. Our pass-through rate estimate is supported by empirical studies of excise taxes in Mexico and France that demonstrate near-complete pass-through rates to consumers[29] and consistent evidence in the U.S. indicating that beverage taxes increase prices, although there is some variation by store type.[30-33]

The expected change in sugary drink price was estimated based on national sugary drink prices[34] and regional sales data for several categories of sugary drinks (i.e., soda, sports drinks, fruit drinks, energy drinks, sweetened teas, sweetened coffees, and enhanced water).[6] In Massachusetts, including Boston, we assume the average price of sugary drinks is $0.068/ounce, and 72% of the taxable sugary drinks that people consume would be taxed at $0.02/ounce, with 28% taxed at $0.01/ounce, so a tiered tax would raise prices by about 25%. This means that, for example, the price of a 12-ounce can of soda would increase from $0.82 to $1.02/can post-tax.

How does increasing the price of sugary drinks change individual sugary drink consumption?

How much consumers will change their purchases in response to price changes is called price elasticity of demand. We assume for every 10% increase in the price of sugary drinks, there will be a 12% reduction in purchases (a mean own-price elasticity of demand of -1.21).[16] Research on existing sugary drink taxes find price elasticities consistent with this estimate.[35-39] In Boston, we assume a tiered $0.01-0.02/ounce tax that raises prices by 30% would reduce purchases by 36%. We assume this 36% reduction in purchases results in a 36% reduction in consumption.

To estimate current sugary drink consumption levels in Boston, we used national estimates of sugary drink consumption by sugar content from NHANES 2011-2016 adjusted to the demographic makeup of the Boston population by age, sex, race, and ethnicity and adjusted to local estimates of soda and other sugary drink consumption by race and ethnicity group.[40,41]

What are the health effects of decreasing sugary drink consumption?

Research has shown that decreasing sugary drink consumption can have positive effects on health in youth and adults.

ASSUMPTIONS ABOUT SUGARY DRINKS AND OBESITY RISK

We estimated the impact of a change in sugary drink intake on body mass index (BMI), accounting for dietary compensation, based on rigorous studies identified in evidence reviews.[20,42] We assumed that people with higher BMI experience greater reductions in excess weight after reducing sugary drink intake, compared with people with lower BMI.[43-45] The relationship among adults was modeled based on the range of estimated effects from four large, multi-year longitudinal studies, which indicated that a one-serving reduction in sugary drinks was associated with an average BMI decrease of 0.21 kg/m^2 to 0.57 kg/m^2 in adults over a 3-year period.[11,46-48] Among youth, we used evidence from a double-blind randomized controlled trial conducted over 18 months, which found that an additional 8-ounce serving of sugary drinks led to a 2.2 pound greater weight gain on average.[49]

ASSUMPTIONS ABOUT SUGARY DRINKS AND DIABETES RISK

We estimated the impact of the tax-induced reduction in sugary drink intake on diabetes incidence for adults ages 18-79 years using a published meta-analysis of the relative risk of developing diabetes due to a one-serving change in sugary drink consumption[50] as well as national estimates of diabetes incidence by race and ethnicity,[51] and local estimates of diabetes incidence overall[52] and prevalence by race and ethnicity.[40] On average, each 8.5-ounce serving of sugary drinks per day increases the risk of diabetes by 18%.[50]

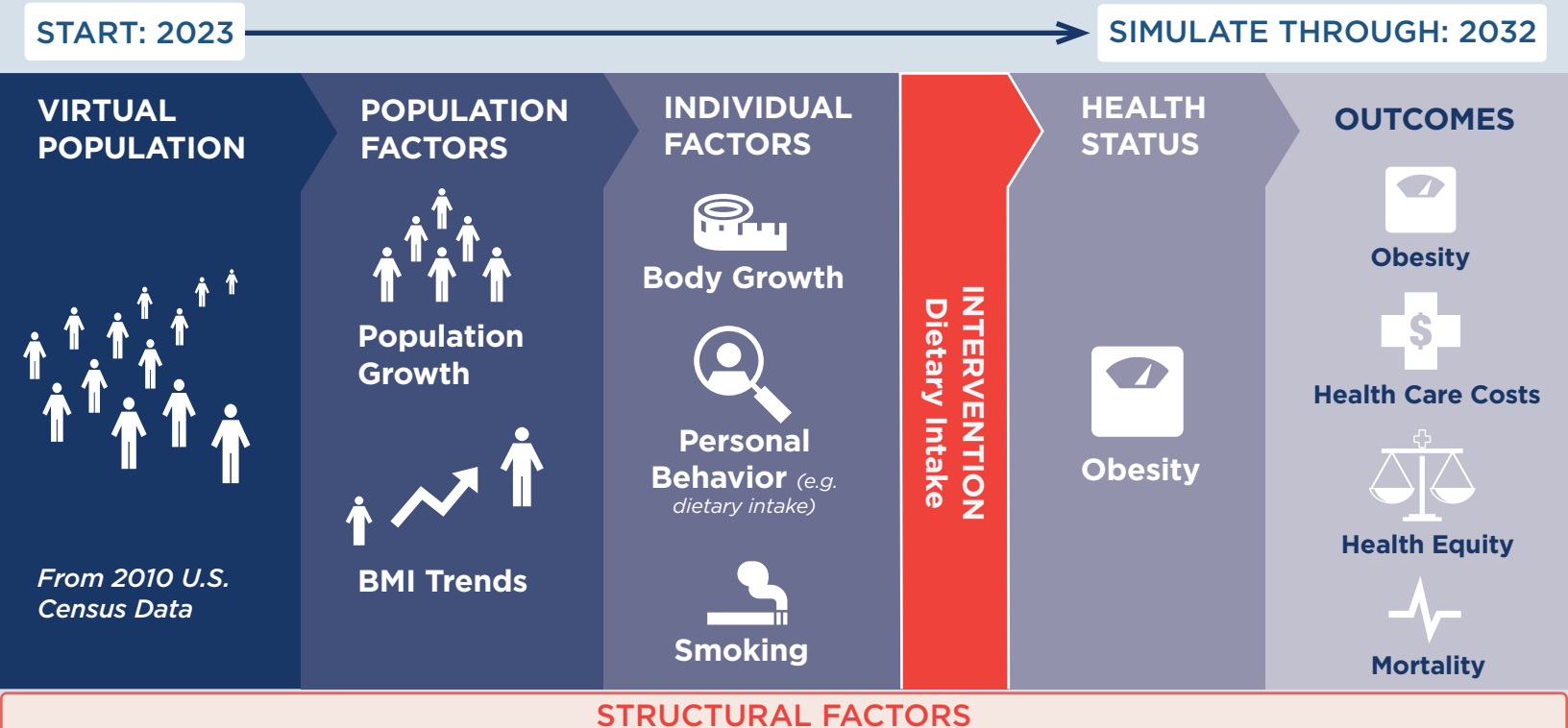
ASSUMPTIONS ABOUT SUGARY DRINKS AND TOOTH DECAY

We estimated the impact of a sugary drink excise tax on tooth decay and tooth decay treatment costs using a longitudinal analysis of the relationship between intake of sugars and tooth decay in adults. On average, for every 10 grams higher intake of sugar per day, there is an increase in decayed, missing, and filled teeth (i.e., tooth decay) of approximately 0.10 over 10 years.[17] There are many studies showing a similar relationship between higher intake of sugars and tooth decay in children and youth[18] and thus we assume the same relationship as found in adults. We used the allowable fees for dental services provided to individuals on public insurance set forth in the Code of Massachusetts Regulations (101 CMR 314.00) in 2018[53] to estimate the cost of treating tooth decay as: $637.83 for a permanent crown and $119.77 for a filling for children and $504.83 for a permanent crown and $86.08 for a filling. These codes reflect treatment for one to four surfaces but do not reflect the actual frequency of multi-surface treatment among people receiving treatment or for higher reimbursement rates due to temporary crowns or potential flat tax schedules. Using the allowable fees may underestimate the total cost savings of tooth decay treatment projected here as dental providers may charge higher amounts to patients. Based on analysis of data on tooth decay, fillings, and crowns for the U.S. population from NHANES 1988-1994 (the last year crowns and fillings were separately reported),[54] we estimate that 78.9% of tooth decay in children and 43.5% of tooth decay in adults is treated. Using this same data set, we estimate that 97% of treatment for children is fillings and 82.5% of treatment for adults is fillings.

CHOICES Microsimulation Model

The CHOICES microsimulation model was used to calculate the costs and effectiveness of a statewide tax impacting Boston over 10 years (2023-2032). We forecasted what would happen to a virtual population of residents in Boston with and without a sugary drink tax to model changes in disease and mortality rates and health care costs due to the tax. Cases of obesity prevented were calculated at the end of the model period in 2032. The model was based on peer-reviewed CHOICES methodology,[20,55-57] with updated assumptions and data sources based on new data available and methodological refinements made over time.[58] We created a virtual population of residents in Boston using data from: the U.S. Census, American Community Survey, Behavioral Risk Factor Surveillance System, NHANES, National Survey of Children's Health,[57] the Medical Expenditure Panel Survey, multiple national longitudinal studies, and obesity prevalence data provided by Massachusetts Department of Public Health. Impacts on diabetes and tooth decay on sugary drinks were calculated based on summary results from the model, not directly via microsimulation.

Of note, the CHOICES microsimulation model does not include annual revenue generation from a state excise tax on sugary drinks in any of the cost-effectiveness calculations. The Rudd Center Revenue Calculator for Sugary Drink Taxes estimates potential annual revenues from excise taxes on sugary drinks and is "intended to provide a rough estimate" for municipalities to consider.[6] The Rudd Center calculator provides revenue estimates for taxes based on beverage volume only, not those based on sugar content like the tax modeled for Boston. Since we assume 72% of taxed sugary drinks consumed fall into the highest sugar content tier, we assume revenue for a $0.0175/ounce volume tax approximates estimated revenue for a $0.01-$0.02/ounce tiered tax. According to the Rudd Center,[6] a $0.0175/ounce excise tax in Massachusetts could raise as much as $322 million in 2032. Accounting for 10-30% non-compliance as the Rudd Center advises, annual revenue estimates may be $226 – $322 million.



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APPENDIX

This appendix includes results of a $0.02/ounce state excise tax based on the volume of sugary drinks (i.e., a flat tax).

Table A1. Results of a $0.02/ounce state excise tax based on the volume of sugary drinks for the Boston population, 2023-2032

Outcome	Number of people affected by the tax	95% UI
First Year Population Reach*	**641,000**	(639,000; 644,000)
10-Year Population Reach*	**703,000**	(698,000; 707,000)
Outcome	**Impact of the tax on sugary drink consumption and spending**	**95% UI**
Decrease in 12-oz Servings of Sugary Drinks per Person in the First Year*	**117**	(71; 222)
Decrease in Spending on Sugary Drinks in the First Year per Person Consuming Sugary Drinks*	**$68**	(-$1; $229) 97% likelihood of decrease in spending
Decrease in Spending on Sugary Drinks in the First Year per Household*	**$159**	(-$3; $537) 97% likelihood of decrease in spending
Decrease in Spending on Sugary Drinks in the First Year Overall in Boston*	**$26.8 million**	(-$588,000; $90.6 million) 97% likelihood of decrease in spending
Outcome	**Impact of the tax on obesity and related health outcomes**	**95% UI**
Quality Adjusted Life Years (QALYs) Gained Over 10 Years	**3,030**	(1,450; 6,170)
Years of Life Gained Over 10 Years	**604**	(236; 1,380)
Deaths Prevented Over 10 Years*	**117**	(70; 400)
Years with Obesity Prevented Over 10 Years	**53,800**	(26,600; 104,000)
Cases of Obesity Prevented in 2032*	**7,080**	(3,560; 13,800)
Cases of Childhood Obesity Prevented in 2032*	**1,270**	(506; 2,800)
Cases of Obesity Prevented Per 100,000 in 2032*	**1,110**	(557; 2,160)
Health Care Costs Saved Over 10 Years	**$104 million**	($44.0 million; $237 million)

The 95% uncertainty interval (95% UI) can be thought of as a likely range. It is estimated by running the model 1,000 times, taking into account uncertainty from data sources and population projections, and calculating a central range in which 95 percent of these model results fell.
Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.
**Not discounted.*

Table A1. (continued) Results of a $0.02/ounce state excise tax based on the volume of sugary drinks for the Boston population, 2023-2032

Outcome	Impact of the tax on diabetes	--
Reduction in Diabetes Incidence*	**10%**	--
Cases of Diabetes Prevented*	**285**	--
Outcome	**Impact of the tax on tooth decay**	**95% UI**
Reduction in Decayed, Missing, or Filled Teeth	**80,200**	(38,000; 170,000)
Dental Decay Treatment Cost Savings over 10 years*	**$6.27 million**	($3.06 million; $12.7 million)

The 95% uncertainty interval (95% UI) can be thought of as a likely range. It is estimated by running the model 1,000 times, taking into account uncertainty from data sources and population projections, and calculating a central range in which 95 percent of these model results fell.
Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.
**Not discounted.*
***There is a 100% likelihood that these metrics are cost-saving.*

Table A2. Statewide costs and cost-effectiveness of a $0.02/ounce state excise tax based on the volume of sugary drinks in Massachusetts, 2023-2032

Outcome	Costs	95% UI
Annual Implementation Cost	**$380,000**	($328,000; $431,000)
Annual Implementation Cost per Person	**$0.06**	($0.05; $0.07)
Total Intervention Implementation Cost Over 10 Years	**$3.80 million**	($3.28 million; $4.31 million)
Health Care Costs Saved Over 10 Years	**$1.09 billion**	($470 million; $2.47 billion)
Net Costs Difference Over 10 Years	**-$1.09 billion**	(-$2.46 billion; $466 billion)
Health Care Costs Saved per $1 Invested Over 10 Years	**$286.84**	($123.74; $656.77)
Outcome	**Cost-effectiveness metrics**	
Cost per Year with Obesity Prevented Over 10 Years	**Cost-saving***	
Cost per Quality Adjusted Life Year (QALY) Gained Over 10 Years	**Cost-saving***	
Cost per Year of Life Gained Over 10 Years	**Cost-saving***	
Cost per Death Averted Over 10 Years	**Cost-saving***	

The 95% uncertainty interval (95% UI) can be thought of as a likely range. It is estimated by running the model 1,000 times, taking into account uncertainty from data sources and population projections, and calculating a central range in which 95 percent of these model results fell.
Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.
** We project a >99% likelihood that the tax is cost saving, since it saves more in obesity-related health care costs than it costs to implement.*

For projected impacts of a statewide tax for the Massachusetts population, see the Massachusetts: Sugary Drink Excise Tax report.[15]

Table A3. Results of a $0.02/ounce state excise tax based on the volume of sugary drinks for the Boston population, by race and ethnicity, 2023-2032

	Impact of the tax on sugary drink consumption, by race and ethnicity				
Outcome	**Asian**, not Hispanic/Latinx† **Mean** 95% UI	**Black or African American**, not Hispanic/Latinx **Mean** 95% UI	**Hispanic/Latinx** **Mean** 95% UI	**White**, not Hispanic/Latinx **Mean** 95% UI	**All Other Races**, not Hispanic/Latinx† **Mean** 95% UI
Decrease in 12-oz Servings of Sugary Drinks per Person in the First Year*	**95** (57; 191)	**158** (96; 306)	**150** (91; 281)	**81** (49; 155)	**144** (87; 267)
Quality Adjusted Life Years (QALYs) Gained Over 10 Years	**186** (82.7; 409)	**907** (431; 1,880)	**773** (379; 1,520)	**987** (463; 2,070)	**177** (87.0; 349)
Years of Life Gained Over 10 Years	**30.5** (4.78; 79.5)	**250** (92.2; 555)	**110** (36.5; 260)	**182** (63.1; 431)	**32.0** (5.68; 85.3)
Years with Obesity Prevented Over 10 Years	**2,970** (1,400; 6,040)	**14,800** (7,150; 29,400)	**15,500** (7,690; 29,100)	**17,400** (8,400; 35,100)	**3,160** (1,580; 6,150)
Cases of Obesity Prevented in 2032*	**391** (179; 800)	**1,940** (948; 3,930)	**2,040** (1,000; 3,940)	**2,290** (1,130; 4,650)	**422** (209; 797)
Cases of Childhood Obesity Prevented in 2032*	**47** (18; 106)	**307** (118; 693)	**450** (175; 1,020)	**372** (143; 803)	**99** (37; 225)
Cases of Obesity Prevented Per 100,000 in 2032*	**734** (338; 1,490)	**1,390** (682; 2,810)	**1,520** (745; 2,940)	**820** (406; 1,660)	**1,250** (623; 2,340)
Comparison of Cases of Obesity Prevented per 100,000 in 2032 vs. White*‡	**0.89** (0.70; 1.11) 81% likelihood of lesser impact	**1.69** (1.47; 2.01) >99% likelihood of greater impact	**1.86** (1.56; 2.36) >99% likelihood of greater impact	**1.00 (Reference)** N/A	**1.53** (1.25; 1.97) >99% likelihood of greater impact
Comparison of Cases of Obesity Prevented per 100,000 in 2032 vs. Average*‡	**0.66** (0.52; 0.84) 99% likelihood of lesser impact	**1.25** (1.14; 1.39) >99% likelihood of greater impact	**1.38** (1.25; 1.57) >99% likelihood of greater impact	**0.74** (0.66; 0.81) >99% likelihood of lesser impact	**1.13** (0.98; 1.37) 95% likelihood of greater impact

The 95% uncertainty interval (95% UI) can be thought of as a likely range. It is estimated by running the model 1,000 times, taking into account uncertainty from data sources and population projections, and calculating a central range in which 95 percent of these model results fell.
Costs and health outcomes are discounted at 3% per year, unless otherwise noted. Discounting estimates the present value of costs and health outcomes that are spent or received in the future, given that they are worth more today than they would be tomorrow.
**Not discounted.*
† Asian includes people of Asian and Native Hawaiian and Pacific Islander race. All Other Races includes people of American Indian and Alaska Native race and two or more races.
‡ The ratio of the projected reduction in obesity prevalence in a particular group compared to the projected reduction in the reference group. A value greater than 1 indicates that the group is projected to see a greater reduction in obesity rates compared to the reference group.