Cost-Effectiveness of a National Sugar-Sweetened Beverage Tax to Reduce Cancer Burden and Disparities in the United States

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Abbreviations: BMI, Body Mass Index; CDC, Centers for Disease Control and Prevention; DiCOM, Diet and Cancer Outcome Model; NHANES, National Health and Nutrition Examination Survey; PSA, Probabilistic Sensitivity Analysis; SD, Standard Deviation; SE, Standard Error; SSB, Sugar-Sweetened Beverage; USDA, United States Department of Agriculture; UI, Uncertainty Interval
ABSTRACT

Background Sugar-sweetened beverage (SSB) consumption contributes to obesity, a risk factor for 13 cancers. While SSB taxes can reduce intake, the health and economic impact on reducing cancer burdens in the United States (US) are unknown, especially among low-income Americans with higher SSB intake and obesity-related cancer burdens.

Methods: We used the Dietary Cancer Outcome Model (DiCOM), a probabilistic cohort state-transition model, to project health gains and economic benefits of a penny-per-ounce national SSB tax on reducing obesity-associated cancers among US adults age 20+ years by income.

Results: A national SSB tax was estimated to prevent 22,075 (95% uncertainty interval [UI] = 16,040 to 28,577) new cancers cases and 13,524 (95% UI = 9,841 to 17,681) cancer deaths among US adults over a lifetime. The policy was estimated to cost $1.70 (95% UI = $1.50 to $1.95) billion for government implementation and $1.70 (95% UI = $1.48 to $1.96) billion for industry compliance, while saving $2.28 (95% UI = $1.67 to $2.98) billion cancer-related healthcare costs. The SSB tax was highly cost-effective from both a government affordability perspective (incremental cost-effectiveness ratio [ICER] = $1,486, 95% UI = -$3,516 to $9,265 per quality-adjusted life year [QALY]) and a societal perspective (ICER = $13,220, 95% UI = $3,453 to $28,120 per QALY). Approximately 4,800 more cancer cases and 3,100 more cancer deaths would be prevented, and $0.34 billion more healthcare cost savings would be generated among low-income (federal poverty-to-income ratio [FPIR] ≤1.85) than higher-income individuals (FPIR >1.85).

Conclusions: A penny-per-ounce national SSB tax is cost-effective for cancer prevention in the US, with the largest health gains and economic benefits among lower-income Americans.
Obesity is an established risk factor for 13 types of cancers.[1, 2] Overweight and obesity-associated cancers account for 40 percent of all new cancer cases diagnosed in 2014 in the United States (US).[3] The estimated medical spending for cancer care exceeds $130 billion in 2020.[4] The economic burden of cancer will further increase if the trends for obesity-associated cancers continue.[5] Thus, it is critical to identify effective and cost-effective strategies to reduce obesity-associated cancer burdens in the US.

High consumption of sugar-sweetened beverage (SSB) is an important contributor to the obesity epidemic in the US.[6, 7] Despite some recent declines,[8, 9] SSB consumption remains the largest source of added sugar in American’s diets.[9-12] High SSB consumption and obesity disproportionately affect individuals of low socioeconomic status,[9, 13, 14] contributing to widening health disparities.[1] Decreasing SSB consumption serves as an important target for preventing obesity-associated cancer burden and reducing cancer disparities in the US.

Taxes on SSBs have risen to the forefront of public health efforts and policy debates in recent years.[15, 16] The beverage industry has aggressively lobbied for the repeal of national taxes. [16-18] Understanding the potential health impacts, costs, and cost-effectiveness of such taxes for cancer prevention would inform policy discussions and debates in the US and elsewhere.

Although prior studies have evaluated the potential impact of a national SSB tax on cardiovascular diseases [19, 20], its potential effects on obesity-related cancer burdens remain unknown. To address this question, we used a population-based Dietary and Cancer Outcome Model (DiCOM) to estimate the health gains and cost-effectiveness of a national penny-per-ounce SSB tax, overall and by age, sex, race/ethnicity, and income on preventing obesity-associated cancer burden and reducing cancer disparities.
METHODS

Study Overview and Model

We utilized the DiCOM, a probabilistic cohort state-transition model, to evaluate the effect of a national penny-per-ounce SSB excise tax on reducing obesity-associated cancer burdens and disparities among US adults over a lifetime. The DiCOM projects the population impact of implementing nutrition policies on health and economic outcomes. Starting from cancer-free individuals representative of the US population, the model simulates the development and progression of cancer as they transition through different health states over a lifetime and tracks life expectancy, cancer-related quality of life, and health-related costs under alternative policy scenarios (Supplementary Figure 1).[21]

To assess policy impact, the model compared two scenarios: implementing a national penny-per-ounce SSB tax and status quo (no policy). The DiCOM incorporates data on national population demographics, SSB intakes, estimated effects of SSB intake on obesity and obesity on cancer risk, policy implementation costs, and health-related costs (Table 1). This study was exempt from the institutional review board review.

Population Characteristics

We estimated the frequency distribution of 32 population subgroups by age (20-44, 45-54, 55-64, 65+ years), sex, and race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Other) from the two most recent cycles (2013-2014 and 2015-2016) of the National Health and Nutrition Examination Survey (NHANES), a cross-sectional national survey representing the non-institutionalized population of the US. The population was further stratified by the federal
poverty-to-income ratio (PIR) into low-income (\(\leq 1.85\)) and higher-income (PIR > 1.85) groups. We also estimated the proportion of US adults with overweight or obese (body mass index \(\geq 25\) kg/m\(^2\)) in each subgroup and by income status. The NHANES survey weights were adjusted in all analyses.[22]

**Sugar-Sweetened Beverage Consumption**

SSBs were defined as any non-alcoholic, carbonated or non-carbonated, beverages with added “caloric” sugar including sodas, fruit drinks, sweetened teas, sports drinks, and energy drinks (Supplementary Methods and Supplementary Table 1).[23] We further defined “caloric” as \(\geq 5\) grams of added sugar per 12-ounce serving (Supplementary Table 2). The mean consumption of SSBs was estimated based on dietary data collected from one or two valid 24-hour diet recalls among participants of NHANES 2013-2016. Energy-adjusted mean intake of SSB consumption was estimated for each subgroup and by income status (Supplementary Table 3).[24]

**Policy Effects**

Reduction in SSB consumption post tax was estimated based on price elasticity estimates, which correspond to change in SSB consumption in response to an increase in SSB price (Supplementary Methods).[25] Higher price elasticity was applied to low-income compared to higher-income individuals.[25] Based on price elasticities and national average SSB price,[26] we estimated a 10.8%, 16.8%, and 8.3% decrease in SSB intake for the total US adult population, low-income, and higher-income individuals, respectively, in response to penny-per-ounce SSB tax (Supplementary Table 4). The policy was assumed to result in a one-time
reduction in SSB consumption during the first year and the policy effect was maintained in future years.

Cancer Statistics and Cancer Related Quality of Life

We obtained incidence rates for 13 obesity-related cancers in 2015 from the Surveillance, Epidemiology, and End Results (SEER) and the Centers for Disease Control and Prevention’s National Program of Cancer Registries (NPCR) (Supplementary Methods).[27] We projected future cancer incidence rates using the average annual percent change (AAPC) method for each cancer type over the next 15 years (from 2016 to 2030) and held the incidence rate constant for subsequent years.[4, 28] The five-year relative survival for each cancer type was obtained from SEER and converted to annual probabilities of dying assuming a constant hazard rate. The health-related quality of life (HRQOL) for each cancer type was extracted from published literature (Supplementary Methods and Supplementary Table 5).[29-31]

Diet-BMI and BMI-Cancer Effect Sizes

The effects of changes in SSB intake on changes in BMI were estimated from a pooled analysis of 120,977 men and women in three prospective cohort studies in the US, including separate estimates for individuals who were normal weight and overweight/obese at baseline.[32, 33] Relative risk (RR) estimates of BMI and cancer risk were based on meta-analysis and systematic reviews of cohort studies published by the World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) and International Agency for Research on Cancer (IARC) (Supplementary Table 6).[2, 34, 35]
Policy Costs

The total implementation costs of SSB tax included the government cost for tax administration and the beverage industry compliance costs to comply with tax regulations (Supplementary Methods and Supplementary Table 7). We estimated the overall cost of implementing the national SSB tax policy as 2% of the annual SSB tax revenue,[36-38] with 1% each for the government administrative and industry compliance costs.

Health-Related Costs

We estimated the health-related costs in 2015 including the direct healthcare costs and indirect patient time and productivity loss costs, estimated separately for individuals with and without cancer (Supplementary Methods). For individuals with cancer, the direct healthcare costs were obtained by age (<65 and 65+ years), sex and phase of cancer care (initial, continuing, and end-year of life) from nationally representative claim data of Medical Expenditure Panel Survey (MEPS) data and Medicare linked to SEER.[4] For individuals without cancer, the direct healthcare costs were estimated by age (<65 and 65+ years) and sex from the national MEPS data.[39] Health-related costs were projected from 2016-2025 with no further increase beyond 2025. All costs were adjusted to 2015 US dollars using the Personal Health Care (PHC) index.

Cost-Effectiveness Analysis

We used the DiCOM model to estimate the health gains including the number of new cancer cases prevented, cancer deaths averted, quality-adjusted life-years (QALYs) gained, total life-years saved, and the cost-effectiveness using the incremental cost-effectiveness ratio (ICER). The ICER was calculated as the ratio of net costs to QALYs gained, all discounted at 3%
annually. These net costs reflect cancer-related costs only and do not include health-related costs saved or spent on other diseases due to SSB tax. We evaluated the cost-effectiveness from both the government affordability and societal perspectives. The government affordability perspective included the government implementation costs and direct healthcare costs of cancer care. The societal perspective added industry compliance costs and indirect productivity loss and patient time costs. Willingness-to-pay thresholds were defined as cost-effective when falling below $150,000 per QALY and highly cost-effective if less than $50,000 per QALY.[40] We further compared the health gains, costs, and ICERs among age, sex, and race/ethnicity subgroups and by income status.

We performed one-way sensitivity analyses to address structural uncertainties in the model assumptions. We used empirical estimates synthesized from reported changes in SSB volume sold after SSB tax implemented in Philadelphia, Cook County, and Seattle as the policy effect (-11.4%) (Supplementary Methods). To explore to what extent the estimates were driven by assuming cancer incidence continuing with the current trend, we performed a sensitivity analysis by assuming no time trends in cancer incidence and survival over the study period. We also performed analyses with a shorter time horizon and evaluated at which year the policy would reach the cost-effectiveness threshold.[40] Besides, we conducted probabilistic sensitivity analyses that jointly accounted for the uncertainties around model inputs and assumptions. Following 1,000 model simulations, the results reported 95% uncertainty intervals. All analyses and model development were conducted in Stata, version 14 (College Station, TX) and R, version 3.3.1 (Vienna, Austria).[41, 42]

RESULTS
Population Characteristics and SSB Intake

The mean age of US adults was 47.7 (SE = 0.34) years old, about two thirds (65.3%) were non-Hispanic white, two thirds (70.3%) were overweight/obese, and one third (33.5%) were low income. The mean population mean intake of SSBs was 1.17 (SE = 0.05) servings per day among all US adults, with higher intakes among low-income (mean = 1.32, SE = 0.09 8-oz servings per day) than higher-income (mean = 1.05, SE = 0.04 8-oz servings per day) individuals.

Health Gains

Over a lifetime, a national penny-per-ounce SSB tax would prevent 22,075 (95% uncertainty interval [UI] = 16,040 to 28,577) new cancers cases, avert 13,524 (95% UI = 9,841 to 17,681) cancer deaths, and gain 86,542 (95% UI = 62,220 to 113,147) QALYs (Table 2). Approximately 4,800 more new cancer cases and 3,100 more cancer deaths were averted among low-income adults (15,806, 95% UI = 12,888 to 19,020 new cancer cases; 9,714, 95% UI = 7,904 to 11,805 cancer deaths) than higher-income adults (10,965, 95% UI = 7,577 to 14,884 new cancer cases; 6,609, 95% UI = 4,594 to 9,018 cancer deaths) (Table 2 and Figure 1). Per one million population, greater health gains were observed among low-income (201, 95% UI = 164 to 241 new cancer cases; 123, 95% UI = 100 to 150 cancer deaths) compared to higher-income adults (70, 95% UI = 48 to 95 new cancer cases; 42, 95% UI = 29 to 58 cancer deaths), overall and across age, sex, and race/ethnicity subgroups (Figure 2). The QALYs gained and life years saved were also consistently greater among low- than higher-income individuals (Table 2). Women and minorities were estimated to have the largest health gains among all populations subgroups (Figure 3).
Cost-Effectiveness

Implementation of a national penny-per-ounce SSB tax was estimated to cost the government $1.70 billion (95% UI = 1.50 to 1.95) in administrative costs and the beverage industry $1.70 billion (95% UI = 1.48 to 1.96) in compliance costs (Figure 4). At the same time, the policy was estimated to save $2.28 billion (95% UI = 1.67 to 2.98) in cancer-related healthcare costs from fewer new cancer cases and deaths. Cancer-related healthcare costs saved were $1.60 billion (95% UI = 1.33 to 1.92) among lower-income adults, which was approximately 0.34 billion more than the healthcare costs saved ($1.26 billion, 95% UI = 0.88 to 1.74) among higher-income adults.

From a government affordability perspective, the SSB tax was estimated to be highly cost-effective (ICER = 1,486/QALY; 95% UI = -$3,516 to $9,265 per QALY), not including the tax revenues generated (Table 2). From a societal perspective (omitting the tax revenues and adding industry compliance costs along with indirect costs saved due to fewer cancer cases and deaths), the SSB tax was also highly cost-effective (ICER = $13,220/QALY; 95% UI = $3,453 to $28,120/QALY) (Figure 5). Among low-income individuals, the SSB tax was cost-saving, with net savings of $422 million (95% UI = $223 to $639) and $272 million (95% UI = -$28 to $580) from the government affordability and societal perspectives, respectively. Among higher-income individuals, the policy was highly cost-effective from the government affordability (ICER = $2,486/QALY; 95% UI = -$3,733 to $13,458/QALY) and societal perspectives (ICER = $16,203/QALY; 95% UI = $3,902 to $36,085/QALY).

Sensitivity Analyses
Using empirical evidence from implementing SSB taxes as the policy effect size, the number of new cancer cases and cancer deaths prevented among US adults over a lifetime would double, with $1.11 (95% UI = $0.55 to $1.74) billion and $683 (95% UI = -$142 to $1,619) million net savings from the government affordability and societal perspectives, respectively (Supplementary Table 8). Assuming no trends in cancer incidence and survival over time, the estimated health gains and economic impact of the SSB tax were smaller but remained highly cost-effective (Supplementary Table 9). When a shorter time horizon was modeled, the policy was highly cost-effective at both 10 and 15 years from the government affordability perspective. From the societal perspective, the policy was not cost-effective over 10 years but achieved cost-effectiveness over 15 years (ICER = $136,837/QALY; 95% UI = $84,127 to $219,067/QALY) (Supplementary Table 10).

DISCUSSION

Our nationally representative simulation model estimated that a national penny-per-ounce excise tax on SSB would prevent over 22,000 new cancer cases and 13,500 cancer deaths, and save $2.28 billion in healthcare costs for cancer care among US adults over a lifetime. Accounting for costs of policy implementation, the SSB tax is highly cost-effective from both government affordability and societal perspectives (not including $6.6 billion in tax revenues). Greater health gains and economic benefits were consistently seen among low-income compared to higher-income individuals.

Based on strong evidence linking body fatness and cancer risk,[35] the latest WCRF/AICR Expert Report includes maintaining a healthy weight and avoiding weight gain in adulthood as one of the key recommendations for cancer prevention. Similarly, the American
Society of Clinical Oncology considers obesity to be an underappreciated risk factor for cancer and advocates for effective strategies to help patients lose weight and make other healthy lifestyle changes.[43] Yet, obesity-related cancer burdens have been increasing in the US, particularly among younger adults.[44] If the current trends continue, it is estimated that obesity will become the leading cause of preventable cancer-related death.[44] However, the public remains generally unaware of the strong links between obesity and cancer.[45] Cost-effective population-based strategies are needed to reduce obesity and related cancer burdens in the US.

Leading US health organizations including the American Heart Association and American Academy of Pediatrics have endorsed the implementation of SSB taxes.[46] Both feasibility and effectiveness in reducing SSB intakes are supported by the seven US cities/locales that have adopted volume-based SSB taxes.[18, 47] Berkeley, California was the first city in the US to levy a penny-per-ounce SSB tax in 2015 and has resulted in a 19.8% reduction in SSB consumption after one year of policy implementation.[48] Two years later, Philadelphia, Pennsylvania enacted a 1.5 cents-per-ounce tax that was associated with a 38% reduction in the volume of taxed beverages sold.[49] The most recent publications on SSB taxes reported a 21% reduction in SSB sales after implementing a penny-per-ounce tax in Cook County, Illinois, and a 22% reduction in SSB sales after implementing a 1.75 cents-per-ounce tax in Seattle, Washington.[50] We modeled a much more conservative policy effect size (10.8% reduction overall, including 16.8% among lower-income adults and 8.3% among higher-income adults). When the empirical evidence from the SSB taxes currently implemented in the US cities/locales was used, the estimated health gains doubled, and the policy became cost-saving.

Our findings suggest that a national SSB tax would reduce cancer disparities in the US, with larger benefits among low-income populations. These findings are consistent with the
empirical experience following Mexico’s national SSB tax [51, 52] and a modeling study in Australia.[53] Additionally, we found that women would experience larger health benefits than men, related to post-menopausal breast cancer and especially endometrial cancer. Overall, the estimated health gains and economic benefits for a national penny-per-ounce SSB tax were smaller than those estimated for cigarette taxes.[54] The greater benefits of cigarette taxes could be due to a larger disease burden attributable to cigarette smoking.[55] The cigarette is also taxed at a much higher rate (nearly half of the pre-tax price)[56] than the current SSB tax (about 20% of the pre-tax price).[57] Compared to other food tax policies such as 10% excise tax on processed meat,[21] the impact of SSB tax was also smaller, which is likely due to a much larger relative risk (RR) estimate of high processed meat [35] vs. high SSB consumption on cancer risk [32, 33].

Nevertheless, a national penny-per-ounce SSB tax is still a highly cost-effective approach for cancer prevention. In response to the increasing attention around SSB taxes, the beverage industry has been focusing its efforts to prevent additional soda taxes from being implemented.[17] Establishing and operating campaigns and lobbying against SSB taxes is a well-established strategy of the industry.[58-60] A national SSB excise tax would eliminate the heterogeneity across states and locales and the threat of state preemption. If the estimated $6.6 billion annual tax revenues could be used for programs to increase access to affordable and healthy foods for low-income families or towards educational campaigning,[61, 62] greater health gains and economic benefits could be obtained at the national level. Additionally, a higher tax rate (e.g., 2 cents per oz) or tiered volume tax could also generate greater health gains and economic benefits than the penny-per-ounce tax.
Potential limitations should also be considered. First, while using the best available data, the actual magnitude of the policy effect depends on the validity of data inputs used. We conducted probabilistic sensitivity analyses to account for uncertainties around the model inputs and one-way sensitivity analyses to evaluate the extent to which structure uncertainties in the model assumptions affect the results. Second, we did not model health gains from reduced cardiovascular diseases, type 2 diabetes, or dental carries that are associated with high SSB consumption [19, 20, 61, 63-65] and potential health gains resulting from leveraging the SSB tax revenue for other public health actions. On the other hand, policy implementation may lead to increases in healthcare costs (and thus fewer savings) if the policy contributes to a longer lifespan as a result of lower cancer incidence. The overall policy impact remains unknown and our findings only represent costs and health gains for obesity-associated cancers. Third, our analysis did not account for potential policy impacts on reducing SSB consumption in children and subsequent childhood obesity. This was largely due to the lack of well-established evidence on how the trajectory of childhood obesity lasts into adulthood and the lack of evidence on childhood obesity and cancer risk. Thus, the current policy effect could be underestimated. Fourth, we did not consider alternative SSB tax structures such as tiered volume taxes or sugar content taxes, which may incentivize manufacturers to reformulate products and partly reduce the sugar content.[65] Fifth, we did not integrate changes in population demographics such as income, education, and race/ethnicity over time. However, the main results of cost-effectiveness will remain relatively stable regardless of demographic shifts, because the analysis is comparing the policy scenario to a “status quo,” which tends to cancel out the demographic changes because they equally occur in both scenarios.
Despite these limitations, our study provides the first-line estimates that incorporated nationally representative data on demographics, SSB consumption, and cancer incidence. We evaluated multiple phases of cancer including initial diagnosis and treatment, continuous care, and, end of life, incorporating health transitions and healthcare costs of 13 types of obesity-related cancer. Our model integrated conservative policy effect estimates and included etiologic effects of BMI on cancer risk from well-conducted systematic reviews and meta-analyses of prospective cohort studies. In addition to direct healthcare costs, we also incorporated the indirect costs of patient time and productivity loss to provide a societal perspective. We compared the health gains and economic impacts by age, sex, race/ethnicity, and income to assess whether the policy may reduce cancer disparities.

A national penny-per-ounce SSB tax is estimated to be cost-effective on reducing cancer burden and disparities in the US, with the largest health gains and economic benefits among lower-income Americans.

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REFERENCES

1. Siegel RL, Miller KD, and Jemal A, Cancer statistics, 2019. CA: a cancer journal for clinicians, 2019. 69(1): p. 7-34.
2. Lauby-Secretan B, Scoccianti C, Loomis D, et al., Body fatness and cancer—viewpoint of the IARC Working Group. New England Journal of Medicine, 2016. 375(8): p. 794-798.
3. Steele CB, Thomas CC, Henley SJ, et al., Vital signs: trends in incidence of cancers associated with overweight and obesity—United States, 2005–2014. MMWR. Morbidity and mortality weekly report, 2017. 66(39): p. 1052.
4. Mariotto AB, Robin Yabroff K, Shao Y, Feuer EJ, and Brown ML, Projections of the cost of cancer care in the United States: 2010–2020. Journal of the National Cancer Institute, 2011. 103(2): p. 117-128.
5. Sung H, Siegel RL, Rosenberg PS, and Jemal A, *Emerging cancer trends among young adults in the USA: analysis of a population-based cancer registry*. Lancet Public Health, 2019. 4(3): p. e137-e147.
6. Hu FB, *Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases*. Obesity reviews, 2013. 14(8): p. 606-619.
7. Malik VS, Pan A, Willett WC, and Hu FB, *Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis*. The American journal of clinical nutrition, 2013. 98(4): p. 1084-1102.
8. Bleich SN, Vercammen KA, Koma JW, and Li Z, *Trends in beverage consumption among children and adults, 2003-2014*. Obesity, 2018. 26(2): p. 432-441.
9. Kit BK, Fakhouri TH, Park S, Nielsen SJ, and Ogden CL, *Trends in sugar-sweetened beverage consumption among youth and adults in the United States: 1999–2010*. The American journal of clinical nutrition, 2011. 98(1): p. 180-188.
10. Welsh JA, Sharma AJ, Grellinger L, and Vos MB, *Consumption of added sugars is decreasing in the United States–*. The American journal of clinical nutrition, 2011. 94(3): p. 726-734.
11. Bailey R, Fulgoni V, Cowan A, and Gaine P, *Sources of added sugars in young children, adolescents, and adults with low and high intakes of added sugars*. Nutrients, 2018. 10(1): p. 102.
12. Huth PJ, Fulgoni VL, Keast DR, Park K, and Auestad N, *Major food sources of calories, added sugars, and saturated fat and their contribution to essential nutrient intakes in the US diet: data from the national health and nutrition examination survey (2003–2006) *. Nutrition journal, 2013. 12(1): p. 116.
13. Han E and Powell LM, *Consumption patterns of sugar-sweetened beverages in the United States*. Journal of the Academy of Nutrition and Dietetics, 2013. 113(1): p. 43-53.
14. Rosinger A, Herrick K, Gahche J, Park S, and Frenk SM, *Percentage of Total Daily Kilocalories Consumed from Sugar-Sweetened Beverages Among Children and Adults, by Sex and Income Level-National Health and Nutrition Examination Survey, United States, 2011-2014*. 2017, Centers for Disease Control and Prevention 1600 Clifton Rd, Atlanta, GA 30333 USA.
15. Backholer K, Vandevijvere S, Blake M, and Tseng M, *Sugar-sweetened beverage taxes in 2018: a year of reflections and consolidation*. Public health nutrition, 2018. 21(18): p. 3291-3295.
16. Backholer K, Blake M, and Vandevijvere S, *Sugar-sweetened beverage taxation: an update on the year that was 2017*. Public health nutrition, 2017. 20(18): p. 3219-3224.
17. Du M, Tugendhaft A, Erzse A, and Hofman KJ, *Focus: Nutrition and Food Science: Sugar-Sweetened Beverage Taxes: Industry Response and Tactics*. The Yale Journal of Biology and Medicine, 2018. 91(2): p. 185.
18. Pomeranz JL, Wilde P, Huang Y, Micha R, and Mozaffarian D, *Legal and administrative feasibility of a federal junk food and sugar-sweetened beverage tax to improve diet*. American journal of public health, 2018. 108(2): p. 203-209.
19. Wilde P, Huang Y, Sy S, et al., *Cost-Effectiveness of a US National Sugar-Sweetened Beverage Tax With a Multistakeholder Approach: Who Pays and Who Benefits*. American journal of public health, 2019. 109(2): p. 276-284.
20. Long MW, Gortmaker SL, Ward ZJ, et al., Cost effectiveness of a sugar-sweetened beverage excise tax in the US. American journal of preventive medicine, 2015. 49(1): p. 112-123.

21. Kim DD, Wilde PE, Michaud DS, et al., Cost Effectiveness of Nutrition Policies on Processed Meat: Implications for Cancer Burden in the U.S. Am J Prev Med, 2019. 57(5): p. e143-e152.

22. Centers for Disease Control and Prevention; National Center for Health Statistics. National Health and Nutrition Examination Survey: Analytic Guidelines, 2011-2016. [cited 2019 July 26].

23. Centers for Disease Control and Prevention, The CDC guide to strategies for reducing the consumption of sugar-sweetened beverages. Atlanta: CDC, 2010.

24. Tooze JA, Kipnis V, Buckman DW, et al., A mixed-effects model approach for estimating the distribution of usual intake of nutrients: the NCI method. Statistics in medicine, 2010. 29(27): p. 2857-2868.

25. Wada R, Han E, and Powell LM, Associations between soda prices and intake: Evidence from 24-h dietary recall data. Food Policy, 2015. 55: p. 54-60.

26. Powell L, Isgor Z, Rimkus L, and Chaloupka F, Sugar-sweetened beverage prices: Estimates from a national sample of food outlets. Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago, 2014.

27. Centers for Disease Control and Prevention. United States Cancer Statistics (USCS). Public Use Databases; Available from: https://www.cdc.gov/cancer/uscs/public-use/.

28. Clegg LX, Hankey BF, Tiwari R, Feuer EJ, and Edwards BK, Estimating average annual percent change in trend analysis. Statistics in medicine, 2009. 28(29): p. 3670-3682.

29. Longworth L, Yang Y, Young T, et al., Use of generic and condition-specific measures of health-related quality of life in NICE decision-making: a systematic review, statistical modelling and survey. Health Technol Assess, 2014. 18(9): p. 1-224.

30. Naik H, Howell D, Su S, et al., EQ-5D Health Utility Scores: Data from a Comprehensive Canadian Cancer Centre. Patient, 2017. 10(1): p. 105-115.

31. Pickard AS, Jiang R, Lin HW, Rosenbloom S, and Cella D, Using Patient-reported Outcomes to Compare Relative Burden of Cancer: EQ-5D and Functional Assessment of Cancer Therapy-General in Eleven Types of Cancer. Clin Ther, 2016. 38(4): p. 769-77.

32. Micha R, Shulkin ML, Penalvo JL, et al., Etiologic effects and optimal intakes of foods and nutrients for risk of cardiovascular diseases and diabetes: Systematic reviews and meta-analyses from the Nutrition and Chronic Diseases Expert Group (NutriCoDE). PloS one, 2017. 12(4): p. e0175149.

33. Mozaffarian D, Hao T, Rimm EB, Willett WC, and Hu FB, Changes in diet and lifestyle and long-term weight gain in women and men. New England Journal of Medicine, 2011. 364(25): p. 2392-2404.

34. Zhang FF, Cudhea F, Shan Z, et al., Preventable Cancer Burden Associated with Poor Diet in the United States. JNCI Cancer Spectrum, 2019. 3(2): p. pkz034.

35. World Cancer Research Fund/American Institute for Cancer Research, Continuous Update Project Expert Report 2018. Body fatness and weight gain and the risk of cancer. 2018.

36. Framework A, Table 5.3 Cost of collection ratios (administrative costs/net revenue), in Tax Administration Comparative Information on OECD and Other Advanced and Emerging Economies. 2013.
37. World Health Organization, Scaling up action against NCDs: How much will it cost. 2011.
38. Aaron H and Gale W, Economic effects of fundamental tax reform. 2010: Brookings Institution Press.
39. Hogan C, Lunney J, Gabel J, and Lynn J, Medicare beneficiaries’ costs of care in the last year of life. Health affairs, 2001. 20(4): p. 188-195.
40. Anderson JL, Heidenreich PA, Barnett PG, et al., ACC/AHA statement on cost/value methodology in clinical practice guidelines and performance measures: a report of the American College of Cardiology/American Heart Association Task Force on Performance Measures and Task Force on Practice Guidelines. Journal of the American College of Cardiology, 2014. 63(21): p. 2304-2322.
41. Schwingshackl L, Hoffmann G, Schwedhelm C, et al., Consumption of Dairy Products in Relation to Changes in Anthropometric Variables in Adult Populations: A Systematic Review and Meta-Analysis of Cohort Studies. PLoS One, 2016. 11(6): p. e0157461.
42. Schnabel RB, Maas R, Wang N, et al., Asymmetric dimethylarginine, related arginine derivatives, and incident atrial fibrillation. Am Heart J, 2016. 176: p. 100-6.
43. Ligibel JA, Alfano CM, Courneya KS, et al., American Society of Clinical Oncology position statement on obesity and cancer. Journal of clinical oncology, 2014. 32(31): p. 3568.
44. Sung H, Siegel RL, Rosenberg PS, and Jemal A, Emerging cancer trends among young adults in the USA: analysis of a population-based cancer registry. The Lancet Public Health, 2019. 4(3): p. e137-e147.
45. Merom D, Gebel K, Fahey P, et al., Neighborhood walkability, fear and risk of falling and response to walking promotion: The Easy Steps to Health 12-month randomized controlled trial. Prev Med Rep, 2015. 2: p. 704-10.
46. Muth ND, Dietz WH, Magge SN, et al., Public policies to reduce sugary drink consumption in children and adolescents. Pediatrics, 2019. 143(4): p. e20190282.
47. Cawley J, Thow AM, Wen K, and Frisvold D, The Economics of Taxes on Sugar-Sweetened Beverages: A Review of the Effects on Prices, Sales, Cross-Border Shopping, and Consumption. Annual review of nutrition, 2019. 39.
48. Silver LD, Ng SW, Ryan-Ibarra S, et al., Changes in prices, sales, consumer spending, and beverage consumption one year after a tax on sugar-sweetened beverages in Berkeley, California, US: A before-and-after study. PLoS medicine, 2017. 14(4): p. e1002283.
49. Roberto CA, Lawman HG, LeVasseur MT, et al., Association of a beverage tax on sugar-sweetened and artificially sweetened beverages with changes in beverage prices and sales at chain retailers in a large urban setting. Jama, 2019. 321(18): p. 1799-1810.
50. Powell LM and Leider J, The impact of Seattle’s Sweetened Beverage Tax on beverage prices and volume sold. Econ Hum Biol, 2020. 37: p. 100856.
51. Colchero MA, Molina M, and Guerrero-López CM, After Mexico implemented a tax, purchases of sugar-sweetened beverages decreased and water increased: difference by place of residence, household composition, and income level. The Journal of nutrition, 2017. 147(8): p. 1552-1557.
52. Colchero MA, Popkin BM, Rivera JA, and Ng SW, Beverage purchases from stores in Mexico under the excise tax on sugar sweetened beverages: observational study. bmj, 2016. 352: p. h6704.
53. Lal A, Mantilla-Herrera AM, Veerman L, et al., Modelled health benefits of a sugar-sweetened beverage tax across different socioeconomic groups in Australia: A cost-effectiveness and equity analysis. PLoS medicine, 2017. 14(6): p. e1002326.
54. Ahmad S and Franz GA, Raising taxes to reduce smoking prevalence in the US: a simulation of the anticipated health and economic impacts. Public Health, 2008. 122(1): p. 3-10.
55. U.S. Department of Health and Human Services. The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General. 2014 [cited 2020 May 4]; Available from: https://www.cdc.gov/tobacco/basic_information/health_effects/index.htm.
56. Boonn A, Campaign for Tobacco-Free Kids: State Excise and Sales Taxes per Pack of Cigarettes Total Amounts and State Rankings. 2020.
57. Powell LM IZ, Rimkus L, and Chaloupka FJ, Sugar-Sweetened Beverage Prices: Estimates from a National Sample of Food Outlets. 2014, Bridging the Gap Program, Health Policy Center, Institute for Health Research and Policy, University of Illinois at Chicago: Chicago, IL.
58. Ronayne K. Capital Rivals: The Cola Wars in Washington. 2011; Available from: https://www.opensecrets.org/news/2011/09/the-cola-wars-in-washington/.
59. Taylor BE, McClave SA, Martindale RG, et al., Guidelines for the Provision and Assessment of Nutrition Support Therapy in the Adult Critically Ill Patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). Crit Care Med, 2016. 44(2): p. 390-438.
60. Bistrian BR, Comment on "Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient". JPEN J Parenter Enteral Nutr, 2010. 34(3): p. 348-9; author reply 350-2.
61. Mozaffarian D, Liu J, Sy S, et al., Cost-effectiveness of financial incentives and disincentives for improving food purchases and health through the US Supplemental Nutrition Assistance Program (SNAP): A microsimulation study. PLoS medicine, 2018. 15(10): p. e1002661.
62. Peñalvo JL, Cudhea F, Micha R, et al., The potential impact of food taxes and subsidies on cardiovascular disease and diabetes burden and disparities in the United States. BMC medicine, 2017. 15(1): p. 208.
63. Wang YC, Coxson P, Shen Y-M, Goldman L, and Bibbins-Domingo K, A penny-per-ounce tax on sugar-sweetened beverages would cut health and cost burdens of diabetes. Health Affairs, 2012. 31(1): p. 199-207.
64. Veerman JL, Sacks G, Antonopoulos N, and Martin J, The impact of a tax on sugar-sweetened beverages on health and health care costs: a modelling study. PloS one, 2016. 11(4): p. e0151460.
65. Lee Y, Mozaffarian D, Liu J, et al., Health Impact and Cost-effectiveness of Volume, Tiered, and Sugar Content Sugar-sweetened Beverage Tax Policies in the US: A Micro-simulation Study (OR28-04-19). 2019, Oxford University Press.
66. Zheng Z, Yabroff KR, Guy GP, et al., Annual medical expenditure and productivity loss among colorectal, female breast, and prostate cancer survivors in the United States. JNCI: Journal of the National Cancer Institute, 2016. 108(5).
67. Guy Jr GP, Ekwueme DU, Yabroff KR, et al., Economic burden of cancer survivorship among adults in the United States. Journal of Clinical Oncology, 2013. 31(30): p. 3749.
68. Yabroff KR, Guy Jr GP, Ekwueme DU, et al., Annual patient time costs associated with medical care among cancer survivors in the United States. Medical care, 2014. 52(7): p. 594.
Table 1. Key Input Parameters and Data Sources for the Dietary and Cancer Outcome Model (DiCOM)

| Model Input Parameters                                                                 | Description                                                                                           | Data Sources                      |
|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------|
| Population demographic characteristics of US adults                                    | Age, sex, and race/ethnicity distribution among US adults aged 20+ years, stratified by income          | NHANES 2013-2016                  |
| Percent of overweight or obese (BMI ≥ 25 kg/m²) among US adults                        | Age-, sex-, and race/ethnicity-specific prevalence of overweight and obesity among US adults aged 20+ years, stratified by income | NHANES 2013-2016                  |
| SSB consumption among US adults                                                       | Age-, sex-, and race/ethnicity-specific SSB consumption among US adults aged 20+ years, stratified by income | NHANES 2013-2016                  |
| Policy specification                                                                  | The national penny-per-ounce tax on SSB                                                                | Supplementary Table 2             |
| Policy effect size estimates, % (95 % CI)                                              | Change in SSB intake per 10% change in price                                                            | Supplementary Methods             |
| Total US adult population                                                              | -0.66 (-0.95 to -0.36)                                                                                 | Supplementary Table 4             |
| Low-income US adults (PIR ≤ 1.85)                                                     | -1.03 (-1.58 to -0.47)                                                                                | Wada, 2015 [25]                  |
| Higher-income US adults (PIR >1.85)                                                   | -0.51 (-0.95 to -0.36)                                                                                |                                   |
| Policy implementation costs, $ millions, annually                                       | 1% of SSB tax revenue                                                                                  | Supplementary Methods             |
| Government administration costs                                                        | 1% of SSB tax revenue                                                                                  | Supplementary Table 5             |
| Industry compliance costs                                                              | 1% of SSB tax revenue                                                                                  | Reports from Muni services         |
| Cancer incidence and survival                                                          | Incidence and 5-year relative survival rates for each cancer type by age, sex, and race/ethnicity       | SEER                              |
| Effect size estimates of SSB-BMI, kg/m²                                                | β (95 % CI), per 1 serving/d increase in SSB                                                            | Supplementary Methods             |
| Individuals with BMI <25 kg/m²                                                         | 0.10 (0.05 to 0.15)                                                                                   | Mozzafarian, 2011 [33]            |
| Individuals with BMI ≥ 25 kg/m²                                                        | 0.23 (0.14 to 0.32)                                                                                   |                                   |
| Relative risk (95%CIs) of BMI-cancer risk, per 5 kg/m² increase in BMI                 |                                                                                                        |                                   |
| Endometrial cancer                                                                     | 1.50 (1.42 to 1.59)                                                                                   |                                   |
| Esophageal adenocarcinoma                                                              | 1.48 (1.35 to 1.62)                                                                                   |                                   |
| Kidney cancer                                                                         | 1.30 (1.25 to 1.35)                                                                                   |                                   |
| Liver cancer                                                                          | 1.30 (1.16 to 1.46)                                                                                   |                                   |
| Gallbladder cancer                                                                    | 1.25 (1.15 to 1.37)                                                                                   |                                   |
| Stomach cancer (gastric cardia)                                                        | 1.23 (1.07 to 1.40)                                                                                   |                                   |
| Female breast cancer (post-menopausal)                                                | 1.12 (1.09 to 1.15)                                                                                   | WCRF/AICR, 2018 [35]             |
| Pancreatic cancer                                                                     | 1.10 (1.07 to 1.14)                                                                                   | Lauby-Secretan, 2016 [2]          |
| Multiple myeloma                                                                      | 1.09 (1.03 to 1.16)                                                                                   |                                   |
| Advanced prostate cancer                                                              | 1.08 (1.04 to 1.12)                                                                                   |                                   |
| Thyroid cancer                                                                        | 1.06 (1.02 to 1.10)                                                                                   |                                   |
| Ovarian cancer                                                                        | 1.06 (1.02 to 1.11)                                                                                   |                                   |
| Colorectal cancer                                                                     | 1.05 (1.03 to 1.07)                                                                                   |                                   |
| Health-related costs, $ millions, per year                                            | Health-related cost estimates for individuals with cancer for each cancer type and the general population based on published literature | Supplementary Methods             |
| Direct medical costs                                                                  | Direct medical costs associated with cancer by the phase of care (initial, continuing, and end year of life) for individuals with cancer, and direct medical cost for the general population, by sex and age (<65; ≥65) | SEER-Medicare Mariotto, 2011 [4]  |
|                                                                                  |                                                                                                        | Hogan, 2001 [39]                  |
| Productivity loss costs                                                               | Productivity loss costs for individuals with cancer and the general population                          | MEPS                             |
|                                                                                  |                                                                                                        | Zheng, 2016 [66]                  |
|                                                                                  |                                                                                                        | Guy, 2013 [67]                    |
| Patient time costs                                                                   | Patient time cost for individuals with cancer and the general population                                | MEPS                             |
|                                                                                  |                                                                                                        | Yabroff, 2014 [68]                |
| Health-related quality of life (HRQOL)                                                | HRQOL estimates for each cancer type based on published literature assessing HRQOL using EQ-5D          | Supplementary Methods             |
|                                                                                  |                                                                                                        | Supplementary Table 7             |
Abbreviations: AICR, American Institute for Cancer Research; BMI, body mass index; MEPS, Medical Expenditures Panel Survey; NHANES, National Health and Nutrition Examination Survey; PIR, Poverty Income Ratio; RR, Relative Risk; SEER, Surveillance, Epidemiology, and End Results Program; SSB, Sugar-Sweetened Beverages; WCRF, World Cancer Research Fund.

1. SSBs were defined as any non-alcoholic, carbonated or non-carbonated, beverages with added caloric sweetener including sodas, energy drinks, sports drinks, and fruit drinks.[23] Dietary intake of SSBs was derived from one or two valid 24-hour dietary recalls using NHANES 2013-2016 data. The mean intake of 8oz serving/day of SSB consumption was estimated for each of the 32 demographic subgroups and by income status.
Table 2. Estimated Health Gains, Costs, and Cost-Effectiveness of a Penny-Per-Ounce National Sugar-Sweetened Beverage Tax on Reducing Cancer Burden Among US Adults Aged 20 years or Above Over a Lifetime

| Health Gains and Cost-Effectiveness | Total US Adults | Low- Income Adults¹ | Higher-Income Adults¹ |
|------------------------------------|-----------------|---------------------|----------------------|
|                                    | Median (95% UI) | Median (95% UI)     | Median (95% UI)      |
| (n= 235,162,844)                   |                 |                     |                      |
| Overall health outcomes            |                 |                     |                      |
| New cancer cases prevented         | 22,075 (16,040 to 28,577) | 15,806 (12,888 to 19,020) | 10,965 (7,577 to 14,884) |
| Cancer deaths averted              | 13,524 (9,841 to 17,681)  | 9,714 (7,904 to 11,805)  | 6,609 (4,594 to 9,018) |
| Life years saved                  | 60,407 (43,089 to 79,594) | 44,768 (36,171 to 54,390) | 31,186 (21,479 to 42,304) |
| QALYs gained                      | 86,542 (62,220 to 113,147) | 63,277 (51,833 to 76,727) | 44,980 (31,148 to 61,632) |
| Policy implementation costs, $ millions² |                 |                     |                      |
| Government administration costs    | 1,704 (1,502 to 1,948)  | 670 (586 to 774)     | 1,000 (880 to 1,133) |
| Industry compliance costs          | 1,695 (1,476 to 1,955)  | 666 (576 to 772)     | 994 (871 to 1,135) |
| Cancer-related healthcare costs, $ millions³ |                 |                     |                      |
| Direct medical costs               | -1,586 (-2,069 to -1,160) | -1,092 (-1,306 to -019) | -879 (-1,209 to -015) |
| Productivity loss costs            | -607 (-794 to -435)   | -441 (-529 to -364)  | -331 (-451 to -266) |
| Patient time costs                 | -98 (-129 to -69)    | -71 (-84 to -58)     | -54 (-75 to -36)    |
| Net Costs, $ millions³             | 125 (-383 to 605)    | -422 (-639 to -223)  | 111 (-225 to 421)   |
| Government affordability perspective | 1,126 (388 to 1,814) | -272 (-580 to 28)   | 723 (236 to 1,145) |
| Societal perspective³              | 1,486 (-3,516 to 9,265) | cost-saving         | 2,486 (-3,733 to 13,458) |
| ICER, $                            | 13,220 (3,453 to 28,120) | cost-saving         | 16,203 (3,902 to 36,085) |

Abbreviations: ICER, incremental cost-effectiveness ratio; QALYs, quality-adjusted life years; UI, uncertainty interval

1. Low-income was defined as the federal poverty-to-income ratio (PIR) ≤1.85, and higher-income was defined as PIR >1.85
2. Policy implementation costs represent the net present value over a lifetime with a 3% discount rate. The tax policy was assumed to have a one-time effect on reducing SSB consumption that lasts for subsequent years with no further reduction.
3. The government affordability perspective reflects the difference between the government costs for implementing the policy and direct healthcare costs saved for cancer care. The societal perspective reflects the difference between the policy implementation costs (including both government administration costs and industry compliance costs) and the health-related costs saved (including direct healthcare costs, productivity loss costs, and patient time costs).
Figure titles and legends

Figure 1. Estimated Number of New Cancer Cases and Cancer Deaths Averted over a Lifetime Among US Adults by A Nationwide Penny-Per-Ounce Sugar-Sweetened Beverage Tax Among Low-Income and Higher-Income Individuals. Low-income was defined as the federal poverty-to-income ratio (PIR) ≤1.85 and higher-income as PIR >1.85.

Figure 2. Estimated Number of New Cancer Cases and Cancer Deaths Averted over a Lifetime Among US Adults Per 1,000,000 by A Penny-Per-Ounce National Sugar-Sweetened Beverage Tax Among Low-Income and Higher-Income Individuals. Low-income was defined as the federal poverty-to-income ratio (PIR) ≤1.85 and higher-income as PIR >1.85.

Figure 3. Estimated Health Gains Per 1,000,000 US Adults Over a Lifetime by A Penny-Per-Ounce National Sugar-Sweetened Beverage Tax by Age, Sex, Race/Ethnicity, and Income. Low-income was defined as the federal poverty-to-income ratio (PIR) ≤1.85 and higher-income as PIR >1.85.

Figure 4. Estimated Costs and Net Costs of a Penny-Per-Ounce National Sugar-Sweetened Beverage Tax on Reducing Cancer Burden Among US Adults Over a lifetime by Income Status. The net costs ($ millions in 2015 US dollars) under the government affordability perspective were calculated as the difference between government costs for implementing the policy and direct medical costs for cancer care. The net savings under the societal perspective were calculated as the difference between policy implementation costs (including both
government costs and industry compliance costs) and health-related cancer costs (including direct medical costs, productivity loss, and patient time costs). Low-income was defined as the federal poverty-to-income ratio (PIR) ≤1.85 and higher-income as PIR >1.85.

Figure 5. Estimated Incremental Cost-Effectiveness Ratio (ICER) of a Penny-Per-Ounce National Sugar-Sweetened Beverage Tax Among US Adults Over a Lifetime by Income Status. ICER was calculated as the ratio of net costs ($ millions in 2015 US dollars) divided by QALYs gained. Blue dots correspond to the ICERs among the total US adult population, green dots among low-income adults, and red dots among higher-income adults. Low-income was defined as the federal poverty-to-income ratio (PIR) ≤1.85 and higher-income as PIR >1.85.
Figure 1

A. New Cancer Cases Prevented

B. Cancer Deaths Averted
Figure 2

A. New Cancer Cases Prevented Per 1,000,000

- Endometrial
- Liver
- Kidney
- Female Breast (Postmenopausal)
- Pancreatic
- Esophageal Adenocarcinoma
- Colorectal
- Multiple Myeloma
- Thyroid
- Stomach (Cardia)
- Gallbladder
- Advanced Prostate
- Ovarian

B. Cancer Deaths Averted Per 1,000,000

- Liver
- Female Breast (Postmenopausal)
- Endometrial
- Kidney
- Pancreatic
- Esophageal Adenocarcinoma
- Colorectal
- Stomach (Cardia)
- Multiple Myeloma
- Gallbladder
- Advanced Prostate
- Ovarian
- Thyroid
Figure 3

A. Number of New Cancer Cases Prevented and Cancer Deaths Averted

B. QALYs Gained and Life Years Saved
