

How do taxes on sugar-sweetened beverages affect health and health care costs?

Answer: Taxes on sugar-sweetened beverages (SSBs) can lead fewer people to buy this type of drink, but the magnitude of such taxes needs to be large to have a meaningful impact on consumption. Among children and adolescents, drinking SSBs is generally associated with negative health outcomes such as weight gain or increased likelihood of obesity; however, some recent studies found no impact. One important consideration is that the majority of studies finding no impact were funded by the beverage industry or do not report their funding source. No evidence directly links taxes on SSBs to reductions in health care costs, though simulations using assumptions about changes in dietary choices, chronic disease, and health care utilization show that taxes on SSBs could lead to reductions in overall health care costs.

Why we conducted this review

AcademyHealth undertook this review from the perspective of a policymaker trying to understand how taxes on sugar-sweetened beverages (SSBs) impact health and health care costs. Taxation of SSBs is a strategy employed by governments in the U.S. and abroad as a way to encourage individuals to reduce their sugar intake and improve their health. Excise taxes, which add a per ounce fee to the price of a beverage, are most common, though sales taxes, which appear as a line item at the bottom of a consumer's receipt, have also been implemented. Over the past decade, the public health and health care communities and the beverage industry have debated this issue, often citing existing research. Because of time constraints of this rapid review as well as the emphasis of recent policy initiatives, which focus on the significant health benefits of avoiding diabetes and obesity early in life, this review looks at the impact of SSBs on weight outcomes among children and adolescents only.

Supporting evidence

In order to investigate the link between taxes, health, and health care costs, we examined research on three interconnected questions below.

- (1) **How do taxes on SSBs affect consumption?** Two systematic reviews indicate that taxes on SSBs lead to modest reductions in consumption.^{1,2} Two recent primary studies evaluating excise taxes in Mexico and Berkeley, CA support this finding.^{3,4} However, authors of the systematic reviews noted that while demand for SSBs decreases based on increases in price, higher tax rates may be necessary to significantly impact consumption. Most of this literature uses self-reported survey or sales data from a subset of the target population to project the impact of a tax on a particular region. Systematic review and primary study authors noted that these types of non-experimental studies vary in quality and generalizability based on factors such as study design, available data, and local context.
- (2) **How does drinking SSBs affect health?** One recent review of systematic reviews⁵ and one systematic review⁶ found that the majority of primary studies and systematic reviews indicated a positive association between SSB consumption and risk of weight gain, being overweight, and obesity among children and adolescents. Among recent studies finding no association between SSB consumption and weight gain, the majority report a link to the beverage industry or do not report their funding source.
- (3) **How do taxes on SSBs affect health care costs?** We found no research that directly examines the impact of taxes on SSBs on health care costs. However, there are studies that use assumptions about changes in factors such as dietary choices, chronic disease, and health care utilization to make estimates about cost savings from taxes on SSBs. This evidence suggests that taxes on SSBs would lead to reductions in overall health care costs.^{12,13} An important consideration is that this literature reports simulated impacts based on assumed values for key variables and the relationships among them, rather than studies of actual experiences with the tax. Due to the limitations of this review, we do not report on these outcomes in further detail.

Additional considerations

- Evidence on the impact of taxes on the sale and consumption of SSBs is often based on projections that use self-reported surveys to predict consumption, rather than direct observations.
- Our ability to assess the impact of SSBs on health outcomes is limited by differences in design, sampling methods, inclusion criteria, data analyses, the definition of a SSB, and dietary measurement tools used across individual studies and systematic reviews.

AcademyHealth conducted this rapid review over a six-week period. It synthesizes existing peer-reviewed systematic reviews and peer-reviewed primary research studies published since the most recent systematic review.¹¹

Appendix 1: Summary of Evidence

(1) How do taxes on SSBs affect consumption?

Two systematic reviews published in 2013 and 2014 indicate that taxes on SSBs may lead to reductions in consumption (e.g., purchase) or demand for SSBs, with the impact being proportional to the tax imposed.^{1,2} The authors of the systematic reviews noted that while demand for SSBs decreases as price increases, taxes must be high to have a meaningful impact on consumption. The studies underlying this conclusion look at either the relationship between actual taxes and self-reported or observed purchases of SSBs, or survey respondents' reports of how potential changes in the price of SSBs would affect their consumption.

Both systematic reviews note that among the higher quality studies that take into account the effect of substitution (e.g., the ability of an individual to find a more affordable replacement), taxes on SSBs can lead to reductions in consumption. For example:

- Studies within one systematic review found consistent effects ranging from a 5 percent to 48 percent reduction in consumption, with proportionately larger effects for larger taxes.¹
- Three studies within that same review found little difference in consumption between states with and without state-based soft drink taxes, suggesting that higher taxes would be necessary to see any effect.¹

Two primary studies published since the systematic reviews found supporting evidence when they evaluated excise taxes in Mexico (a country-wide tax)³ and Berkeley, CA (a city-based tax).⁴ A third study conducted in Chile used survey data to estimate the potential response to a price increase in SSBs via a tax.¹⁸

- The study in Berkeley, CA, used a beverage frequency questionnaire to look at purchasing behavior before and after the implementation of a \$0.01/oz. tax on SSBs in 2015. The study found that consumption of SSBs decreased 21 percent in Berkeley and increased 4 percent in comparison cities four months after implementation of the tax.⁴
- The study in Mexico used household purchase data from a sample population to estimate changes in consumption from a 1 peso per liter tax on SSBs enacted in 2014. The study found that purchases of taxed beverages decreased 5.5 percent in 2014 and 9.7 percent in 2015, yielding an average reduction of 7.6 percent over the study period. Households at the lowest socioeconomic level had the largest decreases in purchases of taxed beverages in both years.³

Although the bulk of available evidence suggests taxes lead to reductions in consumption, authors from both systematic reviews noted that there was variation across the studies in exactly how responsive consumers would be to changes in price. Review authors note that some of these differences could be explained by variation across the studies in the local context, definition of SSBs (e.g., some studies only looked at soda versus others included fruit juice), and the population studied.

Most of this evidence models the impact of SSB taxes on consumption using previously reported state or local level price data, self-reported household expenditures, or surveys of consumers' purchasing behavior. These types of data vary in quality, and factors such as location-specific culture, behavioral patterns, and baseline tax rates are important contextual factors when considering each study. It is also important to note that not all studies looked at the role of substitution or the differences between consumption of certain types of SSBs (e.g., fruit juices versus soda).

(2) How does drinking SSBs affect health?

Two recent publications, a review of systematic reviews⁵ and a systematic review⁶ published by a subset of the same authors, found that most available evidence indicates SSB consumption increases the risk of weight gain, being overweight, and obesity among children and adolescents. However, the authors of these publications note that several systematic reviews and some recent primary studies within their analyses found no association. Each of the reviews evaluated the methodological quality of the included studies or systematic reviews, and drew conclusions about the collective findings in light of those assessments. For the purposes of this review, we focused on the relevant evidence for children and adolescents given the particular concern and focus on reducing

obesity among this population.⁷ We focus only on weight outcomes given the significant associated health benefits of avoiding diabetes and obesity early in life. Relevant findings from the reviews include:

Systematic review⁶

For each study included in the systematic review, the authors used the Quality Criteria Checklist⁸ to evaluate the study's methodological quality. The checklist includes 10 validity questions that address scientific soundness such as selection bias, outcomes definition, statistical analysis, and funding bias. The authors gave studies a rating of "positive", "neutral", or "negative" based on the results of the assessment. Positive indicates that the study has clearly addressed issues of inclusion/exclusion, bias, generalizability, and data collection and analysis. Neutral indicates that the report is neither exceptionally strong nor exceptionally weak. Negative indicates that the previously described issues have not been adequately addressed. Based on these criteria, the authors found:

- Five studies with positive quality ratings found an association between SSB consumption and risk of obesity or obesity (meaning, when SSB consumption increased, so did obesity). Four studies found mixed results (e.g. a positive association for boys but not girls.)
- Seven studies with a neutral quality rating found a positive association, nine found mixed results, and seven found no association.
- No studies found a negative association (i.e. no studies found that consumption of SSBs was associated with weight loss).
- The main methodological issues that led to a study receiving a neutral rating included the use of imprecise definitions of a SSB and inadequate measurement of exposure.

Review of systematic reviews and meta-analyses⁵

This review synthesized the evidence in 13 systematic reviews and meta-analyses and assessed the quality of included reviews using the Assessment of Multiple SysTemATic Reviews (AMSTAR) measurement tool.⁹ Relevant findings include:

- Nine reviews found there was a direct association between SSBs and obesity in children and adolescents, while four reviews did not.
- The quality of the included reviews was low to moderate, and the two reviews with the highest quality scores showed discrepant results.
- Methodological issues, such as inappropriate study and review design, energy adjustment, and differences in inclusion/exclusion criteria, can account for some of the differences in study findings.
- Challenges such as measuring dietary intake accurately among children may contribute to the inconsistent findings across studies.

Across the reviews and primary studies, authors note that the underlying reason for the generally observed association between SSB consumption and obesity continues to be subject for debate. In particular, some evidence questions whether the effects of sugar and calories from SSBs are worse than that of sugar and calories in other foods.¹⁰ Authors also note that SSB consumption may be a marker for a poor diet overall, and it is difficult in cohort studies to isolate the impact of SSBs from other dietary choices.

(3) How do taxes on SSBs affect health care costs?

We found no research that directly ties taxes on SSBs to observed reductions in health care costs. However, there are studies that use assumptions about changes in factors such as dietary choices, chronic disease, and health care utilization to make estimates about cost savings from taxes on SSBs. This evidence suggests that taxes on SSBs would lead to reductions in overall health care costs.^{12,13} An important consideration is that this literature reports simulated impacts based on assumed values for key variables and the relationships among them, rather studies of actual experiences with the tax. Due to the limitations of this review, we do not report on these outcomes in further detail.

Appendix 2: Definition of Terms

Excise tax: Excise taxes are taxes paid when purchases are made on a specific good, such as soda, and are often included in the price of the product. For sugar-sweetened beverages, an excise tax is usually an additional fee per ounce of the beverage.

Price elasticity of demand: A measure used in economics to show the responsiveness of the amount of a good demanded to a change in its price. It is reported as the percentage change in quantity demanded in response to a one percent change in price. As a basic necessity, food is generally seen as relatively inelastic, meaning that changes in price have relatively little effect on demand. However, this varies by food type based on the available substitutes.¹⁴

Substitute: An item or good would be a substitute for another if an individual perceives it as similar or comparable. When a particular good is taxed, individuals may choose to purchase substitutes at lower costs.

Sugar-sweetened beverages: According to the U.S. Department of Health and Human Services and the U.S. Department of Agriculture, sugar-sweetened beverages are any liquids that are sweetened with various forms of added sugars like brown sugar, corn sweetener, corn syrup, dextrose, fructose, glucose, high-fructose corn syrup, honey, lactose, malt syrup, maltose, molasses, raw sugar, and sucrose.¹⁵

Appendix 3: Search Terms and Databases

The following list shows the basic Boolean search term strategy used for the review. Searches were modified based on search functions within each database used.

Search term(s)		Search term(s)		Search term(s)
(Tax* OR Price*)	AND	(Obesity OR Body Mass Index OR Body Weight OR Weight)	AND	(Cost* OR Expenditure* OR Health Care Cost*)
				Sugar-sweetened beverage* OR soda OR pop OR beverage*

Databases: Health Systems Evidence, the Cochrane Library, Campbell Collaboration Library, EPPI-Centre Reviews, PubMed, Web of Science Core Collection, ProQuest Social Science Database, and EBSCO Social Sciences Full Text.

Dates: All databases searched for literature from the period 1/1/2012 through 2/24/17 except for Health Systems Evidence, Cochrane Library, and Campbell Collaboration Library, for which no date restriction was applied.

Appendix 4: Evidence included in this rapid review

Table 4a: Systematic reviews on the impact of taxes on sugar-sweetened beverage consumption

Author and date	Focus of review	Methods	Relevant findings	Limitations and quality of the evidence as reported by the author	AMSTAR Quality Rating for Systematic Review ¹⁶
<p>Thow, Downs & Jan, 2014¹</p> <p><i>*This study is the most recent systematic review reporting exclusively on the impact of taxation on consumption.*</i></p>	<p>The effect of food taxes and subsidies on consumption.</p>	<p>Date range: January 2009 – March 2012</p> <p>Inclusion criteria: 1) study was based on empirical data, excluding reviews, commentaries, and editorials; 2) study examined a tax or subsidy intended to influence the price of a specific food product or nutrient; and 3) study assessed the effect of the tax on food and/or nutrient consumption, including modeling studies.</p> <p>Exclusion criteria: N/A</p> <p>Quality or strength of evidence assessment: Developed a tool based on the Cochrane Collaboration’s Hierarchy of Evidence.¹⁷</p>	<p>Key takeaway: Taxes on SSBs can lead to reductions in consumption that are proportional to the level of the tax, though most evidence uses modeling to match information about price with self-reported survey data. The most robust studies, that include purchase price and consider substitution, show consistent effects ranging from 10 to 20 percent, with proportionately larger effects for larger taxes.</p> <p>Studies included: Sixteen studies used data on previous consumer choices and state preferences to model the impact of taxes on SSBs. The studies looked at taxes ranging from 5 to 30 percent of the price.</p> <p>Impact on consumption: All studies showed a reduction in consumption of SSBs, ranging from 5 percent to 48 percent, demonstrating responses in consumption that were proportional to the taxes applied.</p> <p>Four studies that modeled substitution between SSBs and non-sweetened beverages (e.g., milk, tea) in response to taxes of 5 to 20 percent suggested that these taxes prompt consumers to reduce consumption of sugar-sweetened beverages. The researchers found reduced caloric intake from these beverages by 10 to 48 percent in adults and by 5 to 8 percent in children, and increased consumption of a variety of other beverages, such as milk, low-calorie beverages, tea, and coffee.</p> <p>Three studies of existing state-based soft drink taxes in the United States showed little difference in consumption between states with small taxes (around 5 percent) and states without such taxes.</p>	<p>Authors note that the existing evidence base is still reliant on modeling studies and extrapolated or surveyed – rather than observed – outcomes.</p> <p>Most studies within this review used modeling to estimate the effect of a tax using a wide variety of sources of data on previously measured consumer behavior (e.g., self-reported surveys and state-level price and consumption data).</p> <p>Review focused only on literature published in English.</p>	<p>7/11</p>

Author and date	Focus of review	Methods	Relevant findings	Limitations and quality of the evidence as reported by the author	AMSTAR Quality Rating for Systematic Review ¹⁶
Maniadakis, Kapaki, Damianidi, Kourlaba, 2013 ² <i>*This systematic review was included in addition to the above review from Thow and colleagues because the reviews had overlapping timeframes for the literature search but slightly different search terms and strategy.*</i>	The effect of food taxation policies on consumption caloric intake, or weight outcomes.	Date range: January 1990 – February 2013 Inclusion criteria: Original studies including the four types of primary research methods – existing data, experiments, surveys, and observation. Studies published in English. Exclusion criteria: N/A	Key takeaway: Taxes on SSBs may lead to a reduction in consumption. Most studies found an elastic response to changes in price, though a few studies found conflicting evidence suggesting that demand for soda in particular was inelastic. Studies included: Five studies examined the association between beverage taxes and energy and weight outcomes. Nine studies examined the impact of taxes on consumption alone. Impact on consumption: The price elasticity of demand for beverages is in the range of -0.5 to -1.6 depending on the beverage considered, with most of the elasticities falling below 1.0. This implies that the percentage changes in the quantities demanded were proportionally lower than the corresponding changes in prices. Studies conducted in Mexico and Brazil found that demand for sodas after implementing a tax was elastic compared to other beverages (e.g., consumers indicated purchasing less), while a study from the U.S. found demand to be inelastic (e.g., consumers purchased similar amounts even after a price increase).	Differences in findings among the included studies could be partially explained by the significant heterogeneity in policy settings and in study designs employed to investigate the issue. Transformation of consumption figures to energy and weight outcomes was often based on extrapolation models, which are based on layered assumptions about human behavior and weight gain, which, if untrue in certain contexts, can impact the findings.	6/11

Table 4b: Research studies published since the most recent systematic review on the impact of taxes on sugar-sweetened beverage consumption

Author, date, and title	Methods	Study population	Focus of study/Key features of intervention	Relevant findings	Limitations in the study as reported by the author
Cochero <i>et al.</i> , 2017 ³	Researchers conducted a longitudinal analysis of Mexican urban households in order to estimate changes in the purchasing patterns for taxed and untaxed beverages.	Survey of 6,645 households from 53 cities in Mexico.	The study estimated changes in beverage purchases in Mexico for 2014 and 2015 resulting from the country's 1 peso per liter excise tax on SSBs that was implemented on January 1, 2014.	Key takeaway: Purchases of taxed beverages decreased 5.5 percent in 2014 and 9.7 percent in 2015, yielding an average reduction of 7.6 percent	Causality could not be established as this was a non-experimental study. An 8 percent ad valorem tax on nonessential energy-dense food was implemented concurrently with the tax on

Author, date, and title	Methods	Study population	Focus of study/Key features of intervention	Relevant findings	Limitations in the study as reported by the author
	<p>Two fixed-effects models were used to compare SSB purchase data (in mL per capita/day) from 2014 and 2015 to estimates for these years had the tax not been implemented using pretax trends from 2012-13, and adjusting for inflation, seasonality, and growth in the population.</p>		<p>The study used data for January 2012 – December 2015 on households' monthly store purchases from Nielsen's Mexico Consumer Panel Services.</p>	<p>Purchases of taxed sodas declined less than purchases of non-soda SSBs.</p> <p>Untaxed beverage purchases increased an average of 2.1 percent (5.3 percent increase in 2014 and 1.0 percent decrease in 2015).</p> <p>Analysis of data from the Monthly Surveys of the Manufacturing Industry found a 5.2 percent increase in production sales of bottled water two years post-tax, indicating that consumers may be replacing SSBs with other healthier, untaxed beverages.</p>	<p>SSBs, which could influence demand for beverages.</p> <p>Social pressures such as increased awareness of the effects of SSBs on health, as well as increased marketing by the beverage industry post-tax, likely influenced consumer habits. Fluctuations in SSB purchases may not be only attributable to the tax.</p> <p>Household surveys tend to underestimate average purchase data, but trends in the difference observed in the pre- and post-tax years would not change.</p>
<p>Guerrero-López <i>et al.</i>, 2017¹⁸</p>	<p>Used purchase data from the VII Family Budget Survey collected between November 2011 – October 2012, and estimated a linear approximation of an Almost Ideal Demand System Model to derive own and cross-price elasticities of various beverages and calorically dense foods.</p> <p>Sensitivity analyses were conducted using a quadratic almost ideal demand system and one-equation two-part model to test robustness of the findings.</p>	<p>Survey of 10,527 households in urban areas of Chile.</p>	<p>Estimated the price elasticity of demand for SSBs and high-energy dense foods in Chile's urban areas in order to estimate potential changes in consumption in response to price increases.</p>	<p>Key takeaway: The demand for soft drinks is price sensitive among Chilean households.</p> <p>Results showed that demands for soft drinks and SSBs is elastic in Chile, implying that a tax on these goods is capable of reducing consumption. Own price-elasticity for soft drinks was -1.37, which implies that a price increase of 10 percent is associated with a consumption reduction of 13.7 percent. The own price-elasticity of other SSBs was -1.67.</p> <p>Cross-price elasticities supported the idea that other food and beverages in the demand system behave as soft drink substitutes, as an increase in the price of soft drinks drove up demand for these other goods, especially plain water.</p>	<p>The survey data included limitations, such as the inability to distinguish between regular versus diet soft drinks. Additionally, the researchers could not adjust for geographic location size and seasonality.</p> <p>The cross-sectional nature of the study prevents conclusions about causation, and survey purchase data is often underreported.</p>

Author, date, and title	Methods	Study population	Focus of study/Key features of intervention	Relevant findings	Limitations in the study as reported by the author
Falbe 2016 ⁴	Used a repeated cross-sectional design to examine changes in pre- to post-tax beverage consumption in low-income neighborhoods in Berkeley versus in the comparison cities of Oakland and San Francisco, California.	990 Berkeley residents. Sampling focused on low-income and minority populations (two large, low-income neighborhoods).	A beverage frequency questionnaire was sent to participants before the tax and after the tax (approximately eight months after the vote and four months after implementation) to examine relative changes in consumption.	Key takeaway: Consumption of SSBs decreased 21 percent in Berkeley and increased 4 percent in comparison cities (P = .046) in the four-month period after implementation of the tax. Water consumption increased more in Berkeley (+63 percent) than in comparison cities (+19 percent; P < .01).	Berkeley is a single city of relatively high socioeconomic status and results may not generalize to other cities Assessment of all SSBs was not possible, including diet soda, limiting the ability to examine the substitution effect. Self-reported behaviors are vulnerable to social desirability bias. SSB sales data could provide complementary objective evidence.

Table 4c: Systematic reviews on the impact of sugar-sweetened beverages on weight gain, being overweight, and obesity among children and adolescents

Author and date	Focus of review	Methods	Relevant findings	Limitations and quality of the evidence as reported by the author	AMSTAR Quality Rating for Systematic Review ¹⁶
Bucher Della Torre, Keller, Depeyre & Kruseman 2016 ⁶	To systematically analyze the methodology of studies investigating the influence of SSB consumption on risk of obesity and obesity among children and adolescents, and the studies' ability to answer this research question.	Date range: All relevant cohort and experimental studies published through December 2013. Inclusion criteria: Cohort and experimental studies on the effects of exposure to SSBs on childhood/adolescent (less than 18 years old) weight gain, being overweight, and obesity. Exclusion criteria: (1) Studies looking at the impact of milk consumption, and (2)	Key takeaway: The review shows that the majority of studies with strong methodology indicated a positive association between SSB consumption and risk of obesity or obesity, especially among overweight children. Studies included: 32 studies total <ul style="list-style-type: none"> • 29 cohort studies • 3 randomized controlled trials (RCTs) Impact on weight gain and obesity: Among the 32 studies identified to answer the research question, 12 concluded that SSB consumption was associated with an increased risk of obesity in children or adolescents and 13 found	Assessment of the evidence using a quality tool may be subjective. The physiologic mechanisms underlying the association between SSB consumption and obesity are not yet completely understood, and whether the effect of sugar and calories from SSBs is worse than similar calories in other foods is	6/11

Author and date	Focus of review	Methods	Relevant findings	Limitations and quality of the evidence as reported by the author	AMSTAR Quality Rating for Systematic Review ¹⁶
		<p>studies that did not look at the impact of SSBs directly.</p> <p>Quality or strength of evidence assessment: Quality Criteria Checklist: Primary Research of the Academy of Nutrition and Dietetics.⁸ The analysis allowed for the classification of the studies into three categories: Positive (indicates that the report has clearly addressed issues of inclusion/exclusion, bias, generalizability, and data collection and analysis); Neutral (indicates that the report is neither exceptionally strong nor exceptionally weak); or Negative (indicates that the previously described issues have not been adequately addressed).</p>	<p>mixed results, e.g., an increase in obesity among girls but not in boys; among overweight children but not in average-weight children.</p> <p>Seven studies found no association between SSB consumption and risk of obesity. No study found a negative association.</p> <p>Methodological quality assessment: Neutral rating: Twenty-three studies received a neutral quality rating, mostly due to methodological issues around how the study assessed and measured dietary intake and defined SSBs. Positive rating: Two RCTs and six cohort studies received a positive quality rating.</p> <p>The first RCT found that children who drank SSBs had higher BMI scores compared with children who drank artificially sweetened SSBs.</p> <p>The second RCT showed that the replacement of SSB consumption by non-SSBs (e.g., water) slowed down the increase in BMI significantly in adolescents already overweight or obese.</p>	<p>unclear.</p> <p>In order to better measure the impact on weight, studies need to employ more consistent definitions of SSBs.</p> <p>Limiting inclusion to published studies only means that publication bias cannot be excluded, because studies with positive results tend to be more easily published.</p>	
Keller & Bucher Della Torre, 2015 ⁵	The effect of SSB consumption on weight gain, being overweight, and obesity in children and adolescents between 0.5 and 19 years old.	<p>Date range: 1990 – August 2013</p> <p>Inclusion criteria: Systematic reviews or meta-analyses that focused on the effects of exposure to SSBs on childhood/adolescent (ages 6 months – 19 years old) weight gain, being overweight, and obesity.</p> <p>Exclusion criteria: All nonsystematic reviews; reviews including only adults; reviews not specific to SSBs</p>	<p>Key takeaway: Nine reviews concluded that there was a direct association between SSBs and obesity in children and adolescents, while four reviews did not. The quality of the included reviews was low to moderate, and the two reviews with the highest quality scores showed discrepant results.</p> <p>Studies included: Thirteen reviews and meta-analyses that studied the impact of SSB consumption on weight gain, being overweight, and obesity in children and adolescents.</p> <ul style="list-style-type: none"> • 8 systematic reviews • 3 combined systematic reviews and meta-analyses • 2 meta-analyses 	<p>The included reviews and meta-analyses stated limitations due to differences in design, sampling methods, inclusion criteria, data analyses, and dietary measurement tools used across studies and reviews, as well as a lack of homogeneity in the definition of SSBs.</p> <p>Two of the reviews were funded by the beverage industry, which may cause an inherent bias.</p>	7/11

Author and date	Focus of review	Methods	Relevant findings	Limitations and quality of the evidence as reported by the author	AMSTAR Quality Rating for Systematic Review ¹⁶
		and obesity and/or weight gain. Quality or strength of evidence assessment: AMSTAR (conducted independently by two researchers) was used to assess the methodological quality of the included reviews. ⁹	Impact on weight gain and obesity: Nine reviews concluded that there was a direct association between SSB consumption and weight gain, being overweight, and obesity in children and adolescents. Two reviews concluded that there was no association. Two other reviews from the same group of authors found that the data was insufficient to draw any conclusions, and that more studies must be conducted. Five reviews assessing effect sizes of SSB intake found an increase of 0.03 to 0.14 BMI units and a decrease of 0.007 to 0.329 BMI units per daily serving of SSB consumed or reduced, respectively. Two of the four meta-analyses evaluating effect sizes found a statistically significant increase in BMI as a result of SSB increase, and three found a significant decrease in BMI as a result of reducing SSBs. However, the authors mention that discrepant results are likely due to heterogeneity in research, design, and analytical methods used (i.e. energy adjustments).	Two additional reviews reported conflicts of interest: one review was publicly funded but reported receiving gifts or grants from beverage or food industry organizations and the other review did not state the source of funding. All four of these reviews were the only ones that did not show a direct association between SSB intake and weight outcomes. Review only included literature published in English.	

Table 4d: Modeling studies on the direct impact of taxing SSBs on health care costs

Author, date, and title	Methods	Study population	Focus of study/Key features of intervention	Relevant findings	Limitations in the study as reported by the author
Cobiac <i>et al.</i> , 2017 ¹²	The researchers used a population model of dietary-related diseases and health care costs and food price elasticities to measure the health and cost effects of taxes on unhealthy foods and subsidies for healthy foods in Australia. Used data from the Australian Institute of	Baseline for the model was the Australian population, using data from the Australian Health Survey for 2011-12.	The study modelled the changes in dietary patterns, risk factor exposure, disease incidence, and general future population health because of the combined taxes and subsidies. The researchers also performed a cost-effectiveness analysis to determine the net value of this intervention for the health sector.	Results suggest that taxes on unhealthy food products and subsidies for healthier alternatives can be combined to improve population health and cost-savings. The combination of taxes and subsidies were estimated to avert 470,000 DALYs (disability adjusted life year, or one lost year of "healthy" life), with a net savings of AU\$3.4 billion. Taxes on unhealthy foods were also modelled individually, with the	The magnitude of health benefits is sensitive to measures of price elasticity, so further modelling that incorporates potential costs/benefits associated with changes in other products must be done. The researchers completed analyses using price elasticities from New Zealand and the U.K. due to limitations in data from the Australian

Author, date, and title	Methods	Study population	Focus of study/Key features of intervention	Relevant findings	Limitations in the study as reported by the author
	Health and Welfare to calculate cost-effectiveness for the Australian health sector using repeated Monte Carlo analysis.			sugar tax producing the greatest gains in health, followed by taxes on salt, saturated fat, and SSBs (in that order). Subsidies for fruits and vegetables did not produce health benefits on their own (only when combined with the tax).	Health Survey, which can introduce confounding due to cultural and wealth differences.
Long <i>et al.</i> , 2015 ¹³	A cohort model was used to simulate the effect of a SSB tax on BMI, health care costs, and quality-adjusted life-years (QALYs) and disability-adjusted life-years (DALYs).	Baseline for the model was the U.S. population in 2015, 2 years of age and older.	<p>Quantified the expected health and economic benefits of a national SSB excise tax of \$0.01/oz. over 10 years. A simulation model adapted from the Australian Assessing Cost-Effectiveness (ACE)-Obesity and ACE-Prevention framework was adapted to simulate the U.S. population in 2015, 2 years and older, over the course of 10 years.</p> <p>Data from the National Health and Nutrition Examination Survey and the Medical Expenditure Panel Survey were used in the Markov cohort model to estimate national changes in health quality and health care expenditures with and without the tax.</p>	<p>The simulation found that a tax on SSBs could significantly reduce BMI and health care costs, as well as increase healthy life expectancy.</p> <p>Although the tax implementation would cost an estimated \$430 million over 10 years, it would generate \$12.5 billion in revenue and result in \$23.6 billion in health care cost savings as well.</p> <p>The tax was estimated to reduce SSB consumption by 20 percent and decrease BMI in children by 0.16 and 0.08 in adults. Additionally, the tax would avert 101,000 DALYs and gain 871,000 QALYs.</p>	<p>The model does not account for potential completely compensatory effects in which consumers may replace taxed SSBs with other untaxed calorie-dense beverages, such as fruit drinks.</p> <p>The relationship between changes in SSB consumption and BMI from studies may not accurately represent tax-induced changes in a free-living population.</p> <p>Societal savings are likely underestimated because the model does not incorporate indirect costs of obesity, such as disability, increased absenteeism, and reduced productivity.</p>

Endnotes

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