Review Article

Taxation for Reducing Purchase and Consumption of Sugar-Sweetened Beverages: A Systematic Review

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Abstract

Aims: Noncommunicable diseases (NCDs) are common in worldwide and lead to a dramatic rise in mortality. Excess consumption of sugar due to dietary changes can lead to arising calorie intake that contributes to weight gain, adiposity, and NCDs. Taxes, subsidies, and other economic executive policy have a key role in discouraging the consumption of unhealthy food. This study was aimed at a systematic review of recent research evidence about the tax impacts on the purchase and consumption of sugar-sweetened beverages (SSBs).

Materials and Methods: Five databases, including PubMed, Scopus, Science Direct, CENTRAL, and EMBASE, were systematically searched from 2000 to May 2017. Results: Seven studies were included in this review. In six of the seven experimental studies reviewed demonstrated that consumers can be responsive to changes in food and drink prices. Taxing SSBs effectively could decrease food purchases, increasing SSBs price, and reducing consumption. Reducing the consumption of these beverages results in reduced overweight, obesity, and body mass index among populations. Conclusion: The current evidence base appears to converge and suggests that the fiscal strategy is likely to reduce purchases of high sugar products at least in the short term and likely can lead to decreasing calorie intake.

Keywords: Soda, soft drink, sugar-sweetened beverages, tax

Introduction

Noncommunicable diseases (NCDs) are common in worldwide and lead to a dramatic rise in mortality.[1-3] Globally, the reports show that NCDs are responsible for >38 million deaths per year and 16 million premature mortality as well.[4] For these reasons, the reduction of NCDs is a sustainable goal for consideration of the Global Action Plan.[1,2,5] Because of staggering complications of NCDs, health-care policymakers pay attention to confronting and preventive action globally.[6] Obesity is one of the most serious risk factors for NCDs and is a significant health problem for disability and premature death. Furthermore, previous surveys showed that obesity leads to a deterioration quality of life in the people.[7] In this context, literatures show that obesity can increase the risk of cardiovascular disease, hypertension, hyperlipidemia, diabetes type 2, sleep apnea, and lead to decreasing life expectancy around 7 years.[8,9]

Global statistics show that >1.9 billion adults in the range of 18 years and older (39% of the total adult population aged 18 years and over) are placed in the overweight and obesity categories. Of these, over 650 million (13% of the total adult population aged 18 years and over) are in the obese category.[10] Overweight and obesity are the sixth most substantial known risk factors of disease in the world.[11] Genetic factors, inadequate daily activity, and increasing the consumption of unhealthy food (e.g., fast food) are the primary causes of overweight and obesity.[12-15] Socioeconomic status and sociopolitical changes may effect on the incidence and
prevalence of overweight and obesity by changing these factors.[16-19]

Dramatically, increment of NCDs and obesity and their complication in the worldwide should be alerted to practitioners and health politicians for the prevention of associated health risks.[10,20-22]

Excess consumption of sugar due to dietary changes can lead to arising calories intake that contributes to weight gain and adiposity.[23] Evidence shows that consumption of sugar-sweetened beverages (SSBs) is a risk factor for heart disease, obesity, and diabetes.[25-27]

The previous studies have shown that one of the factors in food selection is product price, which considers by food/nutrition policymaker for interventions aimed at changing population-level dietary consumption.[24] Taxes, subsidies, and other economic executive policy have a key role for discouraging the consumption of unhealthy food, which is contained harmful nutrients such as sugar, salt, and saturated fat and encouraging the consumption of healthy foods such as vegetables and fruits.[23] Taxes can be employed as a sales tax (applied at point of purchase as a proportion of the value of the good) or an excise tax (typically per unit and applied on the sale or production for sale of the good), on a specific nutrient, a combination of nutrients or on a category of food or drink such as SSBs.[26] A tax on SSBs can have an impact on the consumption of its and follow by a decrease in the prevalence of overweight and obesity.[27] SSBs taxes as one part of a comprehensive approach for the prevention of overweight and obesity[28,29] can have extensive potential health and social benefits.[27,30]

This study was aimed at a systematic review of recent research evidence about the tax impacts on the purchase and consumption of SSBs. This study included everyone who is consumer/purchaser of high sugar beverage in the community setting.

**Materials and Methods**

In order to reproducibility of systematic review present study, its methods and results are reported according to the PRISMA guideline.[31] Five databases, including PubMed, Scopus, ScienceDirect, CENTRAL, and EMBASE were systematically searched from 2000 to May 2017. Articles in English were considered. Broad search terms were used in the database searches to ensure that all potentially relevant articles entered the screening process. Each database was searched using database-specific indexing terms [Table 1]. After removing duplicates, choosing studies that assessed the effect of the taxation for reducing the purchase and consumption of SSBs conducted. As shown in Figure 1, the selection of related studies conducted by reading titles, abstract, and full text independently by SRS and MB. By considering inclusion and exclusion criteria, related studies were selected. Modeling studies were included because of their high prevalence in this field and the likelihood that such evidence heavily influences policy-making in this area. Studies without English full text were removed. The reference lists of selected studies were searched to find any studies that not included in the electronic search. This process adds no more new studies.

For each study, the study’s country, year, population information, study design and intervention, findings, and the key conclusion of the study are summarized in the data Table 2. Studies were included if they reported on the impact of a change in SSB price on consumption/purchase/sales of high sugar beverages, calorie intake, weight, body mass index, and consumption/purchase/sales by empirical data. Repeated measure panel design-several pretests and posttest of the same group or randomized controlled trials were included.

The study is based on empirical data, excluding reviews, commentaries, editorials, and modeling study. General food taxes were excluded, but if there are separated information, they were entered into this study. Furthermore, studies without English full text were excluded.

We assessed the quality of all studies using a checklist derived from one recent review of the impact of a tax on SSBs study.[32] The quality criteria assessed were as follows: (i) prospective study of observed behavior; (ii) evaluation of an actual tax (rather than a hypothetical tax); (iii) price linked directly to purchase within same population; (iv) consideration of product compensation (cross-price elasticity); (v) long-run input data across time with sufficient variation in prices used to estimate price elasticities (for experimental studies this included data collected over a period of at least 1 month, for studies using existing data sets on SSB price this included data collected at intervals no <2 months apart for at least 12 months), (vi) valid and appropriate country-specific data, and (vii) reporting of uncertainty around price elasticity estimates. We report on all quality criteria for all studies and rate each study out of seven reflecting one point for each quality measure [Table 2].

**Results**

As shown in the PRISMA diagram of the present study [Figure 1], from 2042 first search results which 1134 irrelevant of them were

| Database      | Search strategy                                                                 |
|---------------|---------------------------------------------------------------------------------|
| PubMed        | “Beverages” [Mesh] AND “Taxes” [Mesh]                                           |
| Scopus        | ((TITLE-ABS-KEY (beverage)) OR TITLE-ABS-KEY (soda) OR TITLE-ABS-KEY ("soft drink")). AND (TITLE-ABS-KEY (tax*)) |
| ScienceDirect | TITLE-ABSTR-KEY (tax*) AND (TITLE-ABSTR-KEY (beverage) OR TITLE-ABSTR-KEY (soda) OR TITLE-ABSTR-KEY ("soft drink")). |
| CENTRAL       | “tax* in Title, Abstract, Keywords and (beverage OR soda OR “soft drink*”) in Title, Abstract, Keywords in Cochrane Reviews” |
| EMBASE        | “beverage”:ab, ti OR "soda":ab, ti OR “soft drink*”:ab, ti AND “tax*”:ab, ti |
removed in screening steps, 137 full texts were assessed. Finally, seven studies were included in the review as shown in Table 3.

In the study of Colchero et al., the impact of 1 peso/L tax on SSBs by the Mexican Congress as a part of the federal budget in September 2013 was examined. These taxes became effective on January 1, 2014. The outcome measure was the volume of taxed and nontaxed beverages purchased. The authors conducted a counterfactual difference-in-difference analysis of pretax and posttax trends and found that, relative to counterfactual in 2014 (what would have happened if the taxes were not implemented), the purchase of taxed SSBs decreased by 6% on an average or 12 mL/capita/day. This decrease in the purchase of taxed beverages kept growing through the posttax period, reaching 12% by December 2014. Although all socioeconomic groups saw a significant decline in the purchase of taxed beverages, the effect was the greatest among the poorest households. Meanwhile, the purchase of untaxed beverages (e.g., plain bottled water) has been increased by an average of 4%. This study concluded that the tax on SSBs was associated with fewer purchases of taxed beverages and more purchases of untaxed beverages.

In another study for investigation of this tax (1 peso/L tax on SSBs in Mexico), Colchero et al., estimate changes in sales of SSBs and plain water by using sales data from the Monthly Surveys of the Manufacturing Industry from January 2007 to December 2015. They found a decrease of 7.3% in per capita sales of SSB and an increase of 5.2% of per capita sales of plain water in 2014–2015 compared to the pretax period (2007–2013).

In the study of Falbe et al., the impact of the excise tax on SSB consumption in Berkeley, California, which became the first US jurisdiction to implement such a tax ($0.01/oz) was evaluated. A repeated cross-sectional design was used 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. Consumption of SSBs decreased 21% in Berkeley and increased 4% in comparison cities (P = 0.046). Water consumption increased more in Berkeley (+63%) than in comparison cities (+19%; P < 0.01). All in all, Berkeley’s excise tax reduced SSB consumption in low-income neighborhoods.

In the study of Colantuoni and Rojas, the effect of two tax events: a 5.5% sales tax on soft drinks imposed by the state of Maine in 1991 and a 5% sales tax on soft drinks levied in Ohio in 2003 was investigated by using sales data collected by scanner devices in the two states, where soda taxes where

Figure 1: PRISMA diagram
Table 2: The quality criteria for included studies

| Study (years)          | Prospective study of observed behavior | Evaluation of actual tax (rather than hypothetical) | Price linked directly to purchase in same population | Consideration of product compensation | Long-run input data | Valid and appropriate country specific data | Reporting of uncertainty around outcome estimates | Quality score (out of 7) |
|------------------------|---------------------------------------|-----------------------------------------------------|-----------------------------------------------------|-------------------------------------|--------------------|---------------------------------------------|---------------------------------------------------|------------------------|
| Colchero MA et al. (2016)                      | 1                                     | 1                                                   | 1                                                   | 0                                   | 0                  | 0                                           | 1                                                 | 4                      |
| Epstein L et al. (2015)                         | 1                                     | 1                                                   | 1                                                   | 0                                   | 0                  | 0                                           | 0                                                 | 3                      |
| Waterlander WE et al. (2014)                    | 1                                     | 1                                                   | 1                                                   | 1                                   | 1                  | 0                                           | 0                                                 | 5                      |
| Francesca Colantuoni et al. (2015)              | 1                                     | 1                                                   | 1                                                   | 0                                   | 0                  | 1                                           | 0                                                 | 4                      |
| M Arantxa Colchero et al. (2016)                | 1                                     | 1                                                   | 1                                                   | 1                                   | 1                  | 0                                           | 1                                                 | 6                      |
| Jennifer Falbe et al. (2016)                    | 1                                     | 1                                                   | 1                                                   | 0                                   | 1                  | 1                                           | 0                                                 | 5                      |
| Silver LD et al. (2017)                         | 1                                     | 1                                                   | 1                                                   | 1                                   | 1                  | 1                                           | 1                                                 | 7                      |

enacted as well as on neighboring states. Results suggest that sales tax had a statistically significant impact on the consumption of soft drinks.

In the study of Epstein et al., using a within-subjects design, selected low-nutrient-dense foods (e.g., sweetened beverages, candy, and salty snacks) were taxed, and fruits and vegetables and bottled water were subsidized by 12.5% or 25% in comparison to a usual price condition for 199 female shoppers in an experimental store. Results showed taxes reduced calories purchased of taxed foods and subsidies increased calories purchased of subsidized foods. However, no overall effect was observed on the total calories purchased. These results suggest that taxes and subsidies can influence energy purchased for products taxed or subsidized, but not total energy purchased.

Silver et al. examined the association of the first penny per ounce SSB excise tax in the United States, in Berkeley, California, with beverage prices, sales, store revenue/consumer spending, and usual beverage intake by comparison of pretaxation (before January 1, 2015) and first-year posttaxation (March 1, 2015–February 29, 2016). One year following implementation of the nation’s first large SSB tax, prices of SSBs increased in many, but not all, settings, SSB sales declined, and sales of untaxed beverages (especially water) and overall study beverages rose in Berkeley; overall consumer spending per transaction in the stores studied did not rise. Posttax self-reported SSB intake did not change significantly compared to baseline. Significant declines in SSB sales, even in this relatively affluent community, accompanied by revenue used for prevention suggest promise for this policy.

Waterlander et al. examined the effects of a price increase on SSBs on beverage and snack purchases using a randomized controlled design within a three-dimensional web-based supermarket. The trial contained two conditions: an increase in Dutch value added tax (VAT) from 6% to 19%; and a control condition with regular prices, n = 102. Results showed that participants in the price increase condition purchased significantly fewer SSBs than the control group (B = −0.90; 95% confidence interval = −1.70−−0.10 L per household per week). There were no significant effects on purchases in other beverage or snack food categories. This means that the higher VAT rate was effective in reducing SSB purchases and had no negative side-effects.

Discussion

The present study that reviewed recent research evidence about the tax impacts on the purchase and consumption of SSBs indicated that tax can be effective in promoting desired dietary changes. The available evidence on sales data from countries that have implemented a tax on SSB also aligns with these findings to suggest that purchases have reduced since the tax was implemented. In six of the seven experimental studies reviewed demonstrated that consumers can be responsive to changes in food and drink prices.

Encourage the consumption of healthy foods such as fruits and vegetables and discourage the consumption of unhealthy nutrients such as salt, sugar, and saturated fat can be implemented with food and nutrition economic policies which employed in some countries. It should be noted that health outcomes associated with food consumption is nonlinear and is influenced by a set of decisive factors that interact at an individual, community, and population level. On the other hand, human behavior is very different in choices of food and...
Table 3: Data extraction table

| Study (years)         | Study design (data, outcome measure)                                                                 | Population (n, age)                                                                 | Setting                            | Intervention                  | Findings                                                                 | Key conclusions                                                                                     |
|-----------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|------------------------------------|------------------------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| Colchero MA et al. (2016) | Compare sales data before and after tax in 2014 by using the data from January 2007 to December 2015 | Manufacturing Industry sale Mexico                                                 | 1 peso/L excise SSB tax            | Per capita sales of SSB     | Differences: 7.3% decrease in 2014-2015 compared to the pretax period (2007-2013) | The tax was associated with a reduction in per capita sales of SSB                                 |
| Epstein L et al. (2015)   | Using a within subjects design/calories purchased/6 weeks Receipts from all foods purchased during the 2 weeks prior to starting the study and throughout the duration of the study were collected to compare | 199 females shopper Age: Mean=42.8 Shoppers in an experimental store           | Taxed by 12.5% or 25% in comparison to a usual price condition Fruits and vegetables and bottled water were subsidized by 12.5% or 25% in comparison to a usual price condition | Reduced calories purchased of taxed foods | Coefficient: −6.61 CI: −11.94−1.28 | Taxes and subsidies can influence energy purchased for products taxed or subsidized, but not total energy purchased |
| Waterlander WE et al. (2014) | Randomized controlled trial/the purchased quantity (l) of SSBs measured per household per week       | 102 (control=49, experiment=46) Participants were randomized and purchased groceries on a single occasion at a three-dimensional virtual supermarket | 19% tax/every participant was then asked to conduct a typical shop for his/her household for 1 week in the web-based supermarket | Liter SSB per household per week | B=−0.90 CI=−1.70−0.10 L per household per week | This means that the higher value added tax rate was effective in reducing SSB purchases |
| Francesca Colantuoni et al. (2015) | look at the effect of two tax events: a 5.5% sales tax on soft drinks imposed by the state of Maine in 1991 and a 5% sales tax on soft drinks levied in Ohio in 2003 by using sales data collected by scanner devices in the two states | Two states USA                        | 5.5% sales tax on soft drinks imposed by the state of Maine on July 16, 1991 | Total volume sales           | Volume change (SE): −0.02 (0.04) | Neither sales tax had a statistically significant impact on the consumption of soft drinks |
| M Arantxa Colchero et al. (2016) | Observational study, to test whether the posttax trend in purchases was significantly different from the pretax trend, the authors used a difference in difference fixed effects model | 6253 households Mexico                  | 1 peso/L (approximately a 10% price increase based on 2013 prices) | Purchases of taxed beverages | Decreased by an average of 6% (−12 mL/capita/day) - Decreased at an increasing rate up to a 12% decline by December 2014 | The tax on sugar sweetened beverages was associated with reductions in purchases of taxed beverages and increases in purchases of untaxed beverages |
| Jennifer Falbe et al. (2016) | 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 participants before the tax and 1689 after the tax USA                        | $0.01/oz Consumption of SSBs       | Decreased 21%, increased 4% in comparison cities (P=0.046) Ratio of post- to pre-tax consumption in Berkeley relative to comparison cities (r=0.2679), Bb (95% CI): 0.76 (0.58-0.995) | Berkeley’s excise tax reduced SSB consumption in low-income neighborhoods | |
patterns of consumption, so for implementation a new tax on SSBs, all aspects should be well implemented should be carefully scrutinized and well-planned.

Multispectral strategies such as taxation of unhealthy foods and subsidy of healthy foods are the usual advocated policy for preventive health, promoting diets, and prevent NCDs which had a high cost in the healthcare system.\[41\] A public health priority to improve diet is decreasing SSB consumption and applying a tax on SSB can be effective with regard to their high-calorie and low-nutrient content and role in obesity, diabetes, and dental caries.

Rate optimal tax is an important consideration for SSB taxes. While some studies such as Waterlander et al. showed the link between existing soda sales taxes and weight outcomes is small.\[39\] However, other natural experiment studies have generally determined that soda sales taxes (ranging from 1% to 8%) are too low to effect in any population.\[42-44\] Experimental research that suggests the tax level should be at least 20%\[39\] or 25%\[45\] to be effective.

This suggests that taxing SSBs effectively could decrease their choice in food purchases and increasing SSBs price is a good idea for reducing consumption. Reducing the consumption of these beverages results in reduced overweight, obesity, and body mass index among populations.\[46-47\] A minor decreasing in caloric intake will change the weight status of adults who are marginally overweight or obese and can decrease in point prevalence for overweight (−0.045) and obesity (−0.03), particularly in adults that have a high weekly and daily intake.\[48,49\]

The complex nature of diet-related behavior and its association with health outcomes such as obesity should be carefully considered in terms of how a tax on high sugar foods and drinks is implemented.\[41\]

Modeling studies emphasize the large taxes have good potential and suggest a 20% increasing price or a penny per ounce tax on SSB.\[49-51\]

On the other hand, more moderate taxes might also have important positive effects. A review of the price elasticity of demand for major food categories showed that an 8%–10% reduction in purchases when the price of soft drinks would rise by only 10%.\[52\] Hence, consideration of price elasticity of SSBs demand is essential before formulating tax policies.

Consideration of the right communication to inform about taxation can be very important to reach to maximize the effects of this policy.\[53\] Furthermore, it is very important that studies monitor the long-term effects of fiscal strategies on public health.\[54\]

Substitution effect of SSBs tax is another important point that be considered when evaluating its effects. A modeling study showed taxation in SSBs has a positive effect on fruit juice, low-fat milk, coffee, and tea purchases.\[54\]

This study also has limitations. First, studies without English full text were excluded, and databases were systematically searched from 2000 to 2017. Due to these filters applied in the study selection, relevant studies might have been excluded. In addition, other factors such as the economic crisis, greater information or awareness of consumers, the influence of different customs in each country, or the effect of the season which can have the effect on SSB purchases, did not consider in the study.

Several problems encountered in the beverage industry-related increase of tax. The beverage industry undoubtedly opposes taxation of sugar drinks. Industry disagreement to these price initiatives generally focuses on political, rather than legal, arguments. Industry reasons, among other things, that taxes will have an unequal and unfair impression on low-income consumers, and may cause losing jobs of workers SSBs manufacture.\[55\] Industry also declares that it is unfair to only out the consumption of sugar drinks as a cause of the obesity prevalent and that fiscal policy will not yield significant health benefits.

### Table 3: Contd...

| Study (years) | Study design (data, outcome measure) | Population (n, age) | Setting | Intervention | Findings | Key conclusions |
|--------------|-------------------------------------|--------------------|---------|--------------|----------|----------------|
| Silver LD et al. (2017) | Comparison of pretaxation (before 1 January 2015) and first-year posttaxation (March 1, 2015-February 29, 2016) | Two supermarket chains covering three Berkeley and six control non-Berkeley large supermarkets in adjacent cities, telephone survey of 957 adult, beverage prices at 26 Berkeley stores | USA | One cent per ounce | 1. SSB sales 2. Dietary intake | 1a. 9.6% decrease compared to estimates if the tax were not in place 1b. Rose 6.9% (P<0.001) for nontax state 2b. −19.8% in mean daily SSB intake (g) 2c. −13.3% in mean calories from SSBs 1a. P=0.001 1b. P<0.001 2a. P=0.49 2b. P=0.56 | 1 year following implementation of the nation’s first large SSB tax, prices of SSBs increased in many, but not all, settings, SSB sales declined |

SSBs: Sugar-sweetened beverages, SE: Standard error, CI: Confidence interval
CONCLUSION

The current evidence base appears to converge and suggests that a fiscal strategy is likely to reduce purchases of high sugar products at least in the short term and likely can lead to decreasing calorie intake.

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Conflicts of interest

There are no conflicts of interest.

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