

OVERVIEW

Obesity and overweight in all age groups are at historically high levels in Canada (1, 2). Over half of adults in Canada and over a quarter of Canadian children and adolescents are classified as overweight or obese (3-5). Dietary intake of sugar sweetened beverages (SSBs) is one factor associated with excess weight (6).

SSBs are beverages that contain added sugar, corn syrup or other caloric sweeteners and include soft drinks, fruit drinks, sports drinks, energy drinks, vitamin water, sweetened iced tea, and lemonade (8), among other beverages. More than half of all calories consumed from beverages by Canadian adults are from SSBs (9). Further, in 2004, teenage boys (14-18 years old) consumed the highest quantity of SSBs a day (172 grams per day) (10). The World Health Organization has recently proposed to lower added sugar recommendations, suggesting that added sugar should not contribute to more than 5% of an individual's total caloric intake (approximately 25 grams/day for an adult) (11).

SSBs are unlike other food and beverages because they offer no benefits when consumed and are only linked to health risks (12). Although they provide energy, they contain virtually no nutrients. When SSBs are consumed, individuals do not typically adjust their dietary intake to compensate for these liquid calories and, for this reason, it is believed that SSB intake may lead to weight gain (6). Evidence supporting this relationship in both children and adults has been mounting over the last few years with several studies demonstrating a link between SSB intake and increased risk of overweight and chronic disease (6, 13-17). Independent of weight gain, SSB intake has been linked to an increased risk of heart disease (18, 19), hypertension (19), and diabetes (20). SSBs may also displace nutritionally superior beverages such as milk (21), decreasing dietary quality (22).

Discrepancies in the cost of healthy and unhealthy beverages (as a result of inflation rates varying by product between 1995 and 2012) may promote consumer intake of SSBs (23, 24). In 2012, 2% milk cost 2.5 times more than soft drinks (23). Taxing SSBs is one policy intervention that has potential to decrease SSB consumption (19, 23, 25-27), increase intake of more nutritious beverages (23, 25), decrease body weight (25), lower disease risk, and decrease premature mortality (19).

Canada does not have a dedicated SSB tax. Mexico (28, 29) and St. Helena (30) have recently introduced SSB taxes as a public health strategy to address obesity and diet-related chronic diseases. Other countries collect SSB taxes, but these taxes differ from those in Mexico (28, 29) and St. Helena (30) as they also apply to other types of food and beverages (29, 31). This evidence synthesis summarizes the findings from systematic reviews relevant to the impact of taxation or price changes of SSBs on beverage consumption and body weight.

METHODS

Review of Evidence. Published and unpublished studies and systematic reviews that examined the impact of SSB taxation or price changes on beverage consumption and body weight of adults and children were collected through searching 12 databases (Ovid Medline, Cochrane Library, PsycINFO via Ovid, CINAHL, EMBASE via Ovid, EconLit, ERIC via Ovid, Business Source Complete, Web of Science, Agricola, PAIS, PubMed) and from seven other sources (Yale Rudd Center for Food Policy & Obesity, Bridging the Gap (University of Illinois at Chicago), Systematic review references, National Bureau of Economics Research, USDA’s Economic Research Service, World Health Organization website, and the Principal Investigator). The search was limited to English or French publications. No publication date limit was applied. All systematic reviews relevant to SSB taxation or price changes, beverage consumption, and/or body weight published between 2011 and 2014 were selected for this review. Those that did not present findings for SSBs separately (i.e. they presented combined outcomes for a variety of foods and beverages) were excluded.

SYNTHESIS OF EVIDENCE

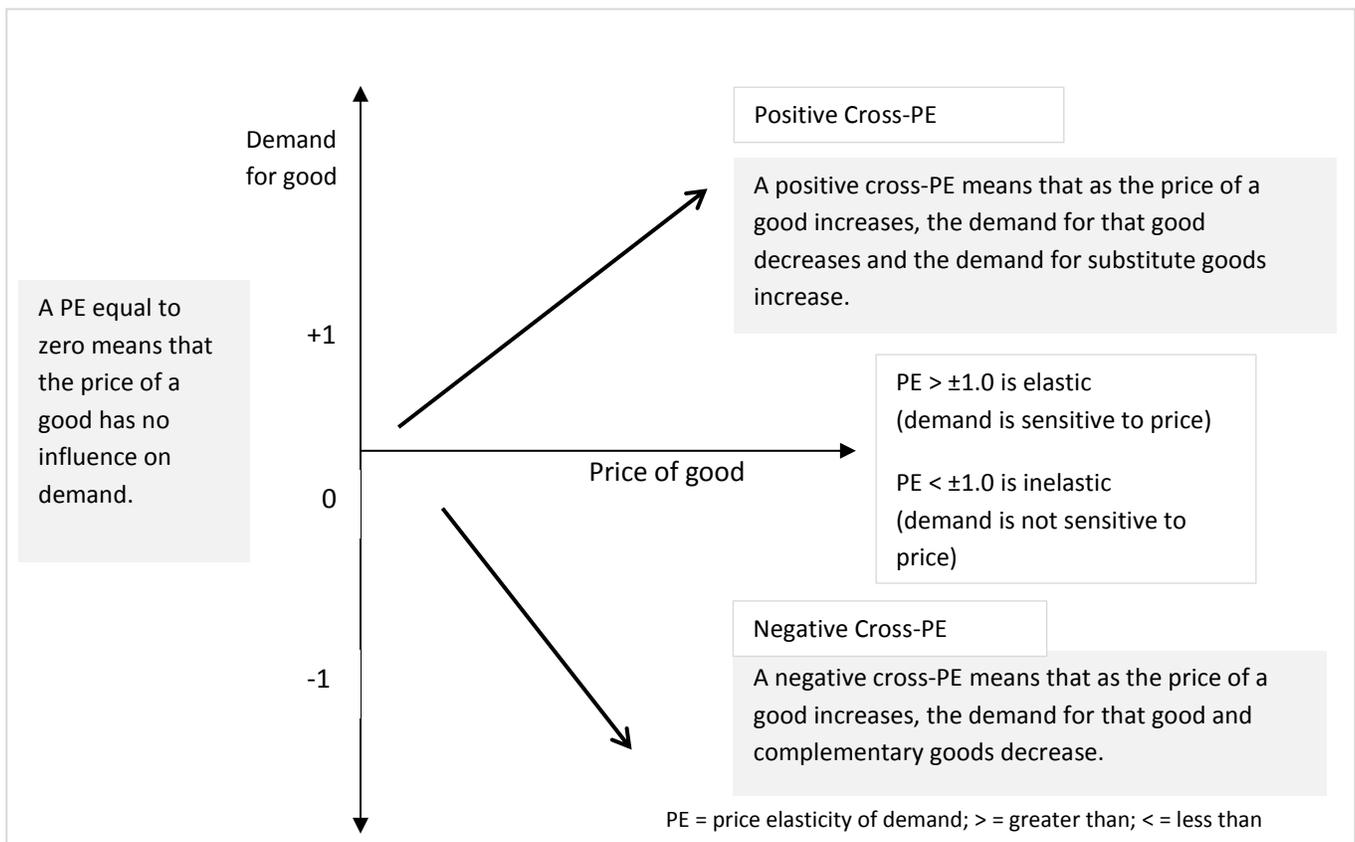
Characteristics of Systematic Reviews. Three systematic reviews met the inclusion criteria, including one meta-analysis (25). All reviews evaluated the effects of taxation and/or price changes of SSBs on SSB consumption and body weight (25-27). All reviews reported own-price elasticity of demand (own-PE) of SSBs (25-27), while only one reported cross-price elasticity of demand (cross-PE) (25). Own-PE is the “[change] in the demand of a good/food [eg. SSB] due to changes in its own price” (26). Cross-PE is “the change in the quantity demanded of one good [eg. other beverages] in response to a change in the price of another good [eg. SSB]” (25). See Figure 1 for an explanation of price elasticity of demand.

Study populations were described by two reviews (25, 27) and included children, adolescents, and adults. Price elasticities were aggregated across all age groups, but weight results were reported

separately for children and adults (25, 27). One review (26) did not describe the study populations examined.

Two reviews (25, 26) were judged to be of moderate quality using AMSTAR criteria (32), receiving five and six points out of a possible 11 (33). The third review was judged to be of low quality as it scored three points on the AMSTAR tool (33) (see Table 1 for AMSTAR rankings). A total of 29 primary research studies were included across the three reviews, with nine studies included in two or more reviews. Cross-sectional (25, 27), longitudinal (25, 27), and modelling (26, 27) studies were represented. The studies were conducted in the United States (25-27), Mexico (25), France (25), Norway (26), and Brazil (25). See Table 1 for additional details.

Figure 1: Explanation of Price Elasticity of Demand



IMPACT OF SSB TAXATION OR PRICE CHANGES ON BEVERAGE CONSUMPTION

Overall. The results of all three reviews (25-27) suggest that increasing the cost of SSBs, through price changes or taxation, reduces SSB consumption. As the price of SSB increases, consumption decreases in a linear manner (25, 26). See Table 2 for more information on review findings.

All SSBs. The mean overall own-PEs of SSBs (including regular carbonated soft drinks, fruit drinks, and sports drinks) were found to be -1.21 (statistical significance not reported) (27) and -1.30 (statistically significant) (25). This suggests that when the price of SSBs increases by 10%, consumption of SSBs decreases by 12-13%.

Soft Drinks. The mean own-PE of regular (non-diet) soft drinks was -1.25 (statistical significance not reported) (27). All soft drinks (regular and diet) were found to be inelastic with mean own-PEs between -1.0 and 1.0 (-0.86 (27) and -0.93 (26)). These findings suggest that the demand for regular and diet soft drinks was not sensitive to their price when regular and diet soft drinks are taxed together. However, taxing regular soft drinks without including diet soft drinks was associated with decreased consumption of regular soft drinks. By definition, diet beverages are not SSBs, but have been combined with regular soft drinks or other SSBs by some researchers because some existing taxes are applied to both regular and diet soft drinks.

Fruit and Sports Drinks. The impact of increasing the price of regular fruit and sports drinks is also substantial with mean own-PEs of -1.41 and -2.44, respectively (statistical significance not reported) (27).

Sweetened Teas, Water and Energy Drinks. Although own-PEs for regular ready-to-drink teas, flavoured water, and energy drinks were not calculated, when these beverages were taxed, their consumption declined (26).

Other Beverages (Juice, Milk, Diet Beverages). Only one review (25) assessed the relationship between the cost of SSBs and consumption of other beverages. The cross-PEs of SSBs with fruit juice and whole milk were +0.39 (statistically significant) and +0.13 (not statistically significant), respectively, suggesting that when the price of SSBs increases, consumers may substitute SSBs with juice and possibly milk (25). In contrast, as the price of SSBs increased, fewer diet drinks were consumed (cross-PE=-0.423) (statistically significant) (25). This suggests that diet drinks are complementary to SSBs (25); as the price of SSBs increases, consumers drink fewer diet beverages. However, the cross-PEs for fruit juice, milk and diet beverages were all less than the absolute value of 1.0, suggesting that the demand for these products are relatively inelastic (not very sensitive to price changes in SSBs).

IMPACT OF SSB TAXATION OR PRICE CHANGES ON BODY WEIGHT

Overall. All three reviews evaluated the impact of SSB and/or soft drink taxes or price changes on body weight. It is possible that some of the taxes that were evaluated were also applied to diet beverages, but the reviews did not make this clear. Overall, the reviews found that as the cost of soft drinks or SSBs

increased, there was a tendency for population-level body weight to decline (25, 27). The evidence was limited and not consistent, however, as some studies found no impact on body weight (26, 27), while a small number actually reported small increases in body weight (25, 26).

LIMITATIONS OF REVIEWS

The magnitude, type, and scope of the taxes evaluated by the studies included in these reviews limit their findings (27). First, some studies evaluated existing SSB taxes and existing tax rates may be too low to produce measurable changes in population-level body weight (27). Second, some of these taxes were only applied to soft drinks, including diet varieties and excluded other SSBs (e.g. fruit drinks, sports drinks, energy drinks). This taxation model may minimize the impact of taxation on SSB consumption and body weight (27).

Similarly, the effectiveness of taxation may be limited when taxes are only applied within specific settings, such as grocery stores or vending machines, because consumers may be able to purchase these products at a lower price elsewhere (25). Moreover, a sales tax that is added at the point-of-purchase may be less likely to influence purchasing behaviour, as purchasing decisions are often made at the shelf rather than at the cash register (27). An excise tax, in which SSBs are taxed at the manufacturer or merchant-level, may be more effective as it is more likely to be incorporated into the shelf price (27). As only cross-sectional, longitudinal, and modelling studies were included in the reviews, the findings can only suggest that taxing or changing the price of SSBs is correlated with changes in beverage consumption and body weight. No randomized controlled trials (RCTs) were included in these reviews, therefore no conclusions regarding a cause and effect relationship between these variables can be made. One systematic review was of poor quality, as per its AMSTAR ranking, which decreases the validity of conclusions made from this evidence synthesis. Finally, the findings from these reviews are limited by the small number of studies available that have examined associations between SSB taxation and/or price changes with beverage consumption and body weight.

CONCLUSIONS

Findings from these reviews suggest that taxing or raising the price of SSBs may reduce SSB consumption (25-27). Greater amounts of juice or milk and lower amounts of diet soft drinks may be consumed with a SSB tax or price increase (25). However, the demand for these goods do not seem to be highly sensitive to the price of SSBs. Limited evidence suggests SSB taxation has the potential to improve population-level body weight; however impact will likely depend on the magnitude and type of tax that is applied.

More research is needed to illustrate the link between taxation and price changes of SSBs, beverage

consumption and population body weight (25, 27). RCTs could provide stronger evidence on the relationship between taxation and beverage consumption or body weight. Additional longitudinal studies or RCTs with long follow-ups may provide more insight into the impact of SSB taxation on body weight, as this outcome changes more slowly over time. More research should be done on the effects of SSB taxation on consumption of beverages other than SSBs in order to assess unintended consequences of a SSB tax (26). All populations should be studied, but as youth consume the greatest amount of SSBs in Canada (23), they represent a particularly important focus for future research.

Table 1. Characteristics of reviews evaluating the impact of SSB taxation or price changes on beverage consumption and body weight

Author	Years	Study design	Number of studies included ¹	Types of studies included ¹	Number of studies that overlap with other included reviews	Location of studies	AMSTAR ranking (32)
Escobar et al. (2013) (25)	January 2000- January 2013	Meta-analysis of impact of SSB taxation or price changes on consumer demand for SSBs and other beverages Systematic review of impact of SSB taxation or price changes on body weight	n=12 (9 report impact on beverage consumption; 6 report impact on body weight) ²	Cross-sectional Longitudinal	n=8	United States (n=6) Mexico (n=1) Brazil (n=1) France (n=1)	5/11 [moderate quality (33)]
Eyles et al. (2012) (26)	January 1990- October 2011	Systematic review of impact of SSB taxation or price changes on consumer demand for SSBs and on body weight	n=12 (9 report impact on beverage consumption; 5 report impact on body weight) ²	Modelling ³	n=5	United States (n=11) Norway (n=1)	6/11 [moderate quality (33)]
Powell et al. (2012) (27)	January 2007- March 2012	Systematic review of impact of SSB taxation or price changes on consumer demand for SSBs and on body weight	n=18 (14 report impact on beverage consumption; 7 report impact on body weight) ²	Cross-sectional Longitudinal Modelling ³	n=9	United States (n=18)	3/11 [low quality (33)]

SSB = sugar sweetened beverage; AMSTAR = a measurement tool to assess systematic reviews

¹ Only includes studies relevant to SSBs

² Some studies reported on both beverage consumption and body weight

³ Modelling studies estimate consumer demand of goods (34) and relationships between one variable and one or more other variables (35), such as food cost and food intake/purchase or body weight.

Table 2. Overview of findings of reviews evaluating the impact of SSB taxation or price increases on beverage consumption and body weight

Author	Change in consumption of SSBs	Change in consumption of other beverages	Change in body weight	Conclusions
Escobar et al. (2013) (25)	↓SSB consumption (own-PE = -1.30)	↑ fruit juice consumption (cross-PE=+0.39) ↑whole milk consumption (cross-PE=+0.13)* ↓diet soft drink consumption (cross-PE=-0.42)	SSB taxation or price increases were associated with increases and decreases in body weight.	SSB taxation or price increases are associated with reduced SSB and diet soft drink consumption and increased consumption of fruit juice and possibly whole milk. The higher the price of, or greater the tax on SSBs, the greater the effect on beverage consumption. SSB taxation or price increases may have a modest effect on body weight.
Eyles et al. (2012) (26)	↓soft drink ¹ consumption (own-PE = -0.93) †	N/R	SSB and soft drink taxes were associated with increases in body weight.	As the price of SSB increases, consumption decreases in a linear manner. No conclusions related to SSB or soft drink taxes on body weight were made.
Powell et al. (2012) (27)	↓SSB consumption (own-PE = -1.21) † ↓regular soft drink consumption (own-PE = -1.25) † ↓ soft drink ¹ consumption (own-PE = -0.86) † ↓fruit drink consumption (own-PE = -1.41) † ↓sports drink consumption	N/R	In adults, soft drink taxes or price increases were associated with no or small significant reductions in body weight. In children, increases and decreases in body weight were observed with soft drink taxes or price increases.	SSB taxation or price increases may reduce SSB consumption. SSB taxation or price increases may have a minimal influence on body weight.

	(own-PE = -2.44) †			
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SSB = sugar sweetened beverage

Findings in bold were statistically significant; *not statistically significant; †statistical significance not reported

¹May include diet/artificially sweetened beverages

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