SODA TAX IMPACT ON SOFT DRINKS CONSUMPTION : A SYSTEMATIC REVIEW

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ABSTRACT

Introduction: Many countries have introduced a tax on sugar-sweetened beverages hoping for controlling the soft drinks consumption to reduce the adverse health effects such as obesity and diabetes. This study aimed to review the impact of sugar-sweetened beverages taxation on soft drinks' consumption through increase in the price of the beverages after taxation. **Methodos**: A systematic search related to articles on soda tax impact on soft drink consumption was conducted by using PubMed, Cochrane, Ovid Medline, and Scopus databases. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis flow checklist was used as a guide to search for the eligible articles. **Results**: Overall, there were a total of fifteen eligible articles included in this systematic review. All studies showed that an increase in SSB prices will cause a reduction in its demand, which ranges from 1.16% to 40.93%. The highest soft drinks consumption reduction occurred among the population who had a high intake of soft drinks before the introduction of the soda tax implementation. This review showed that both specific excise taxes and ad valorem taxes implementation showed significant reduction in soda consumption. **Conclusion**: Therefore, it can be concluded that fiscal intervention such as a soda tax could improve population's behaviour towards unhealthy sugary beverage intake.

Keywords: Soft Drinks; Soda Tax; Consumption; Systematic Review

Introduction

The Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013–2020 stated that food and beverage taxation are proven tools that may improve access to healthy dietary choices, change people's behavior discourage the consumption of less healthy choices, and further improve health outcomes (World Health Organization, 2016).

Sugar-sweetened beverages (SSB) are defined as beverages containing added caloric sweeteners, like sucrose, high-fructose corn syrup, or fruit-juice concentrates including soda, fruit drinks, sports drinks, energy and vitamin water drinks, sweetened tea, and many more. Globally, SSB has become the major source of sugar in the diet, and its consumption is alarmingly increasing in most countries, especially among children and teenagers (World Health Organization, 2016). Soft drink consumption has been significantly linked to overweight, obesity, and diabetes worldwide, including in low- and middle-income countries (Basu et al., 2013). In the past few decades, many countries already implemented Soda Taxation to control the alarming rise in obesity prevalence like France, Brazil, United States (Claro et al., 2012; Han et al., 2013; Berardi et al., 2016).

Susceptible populations like those who come from low socio-economic status are expected to be the most price-responsive group that will benefit most as a result of food and beverage taxation (World Health Organization, 2016). This is supported by various studies which found that higher beverage prices as a result of soda tax implementation lead to a reduction in consumption (Andreyeva et al., 2010; Powell & Chriqui, 2011; Claro et al., 2012; Han et al., 2013).

Despite the broad implementation of soda taxation in numerous countries, conclusive scientific evidence regarding the most efficacious taxation method remains scarce. Aside from that, comparisons of the consumption patterns of populations worldwide after the implementation of the soda tax are limited. As it is proven that soda tax implementation can reduce its consumption, there is the need to compare different types of soda tax implementation which will bring different effects on soft drinks consumption. This systematic review is conducted to identify the effect on soft drink consumption patterns among populations after the implementation of the soda tax.

Methods

We conducted a systematic review of the literature to identify studies that reported on the soft drinks consumption following the change in the soft drinks price due to the soda tax implementation. Electronic databases namely PubMed, Cochrane, Ovid Medline, and Scopus were used to systematically search the studies that included terms related to soda tax implementation impact on soft drinks consumption from year 2008 to 2018. Keywords that were used for the search are as follows (using MeSH terms):

"soda" OR "cola" OR "carbonated drinks" OR "soft drinks"

AND

"tax" OR "price" OR "surcharge" OR "fiscal" OR "penalty"

AND

“consumption” OR “intake” OR “habit” OR “demand” OR “behaviors”

The preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) checklist was used as its guidelines to search for the eligible articles (Moher et al., 2009). Figure 1 shows the PRISMA checklist for this study. Records identified were assessed in terms of the relevance of the title with this systematic review scope to remove the irrelevant articles. The studies were included if they fulfilled the following criteria: (a) reported on the impact of a soda tax implementation on soda consumption, (b) full article, (c) published from year 2008 till 2018, and (d) must be a primary study. The exclusion criteria were: (a) systematic review study, meta-analysis, qualitative study, clinical trial, and commentary articles, (b) involved food tax, and (c) study done in another language than English. Then, accepted studies were assessed through the article abstract. Articles with relevant abstracts were included for further assessment which is formally assessed through its full text. Each eligible article extracted was reviewed independently by two reviewers. Relevant information was extracted from all included studies, including the impact of a soft drinks price change on beverage purchase and consumption.

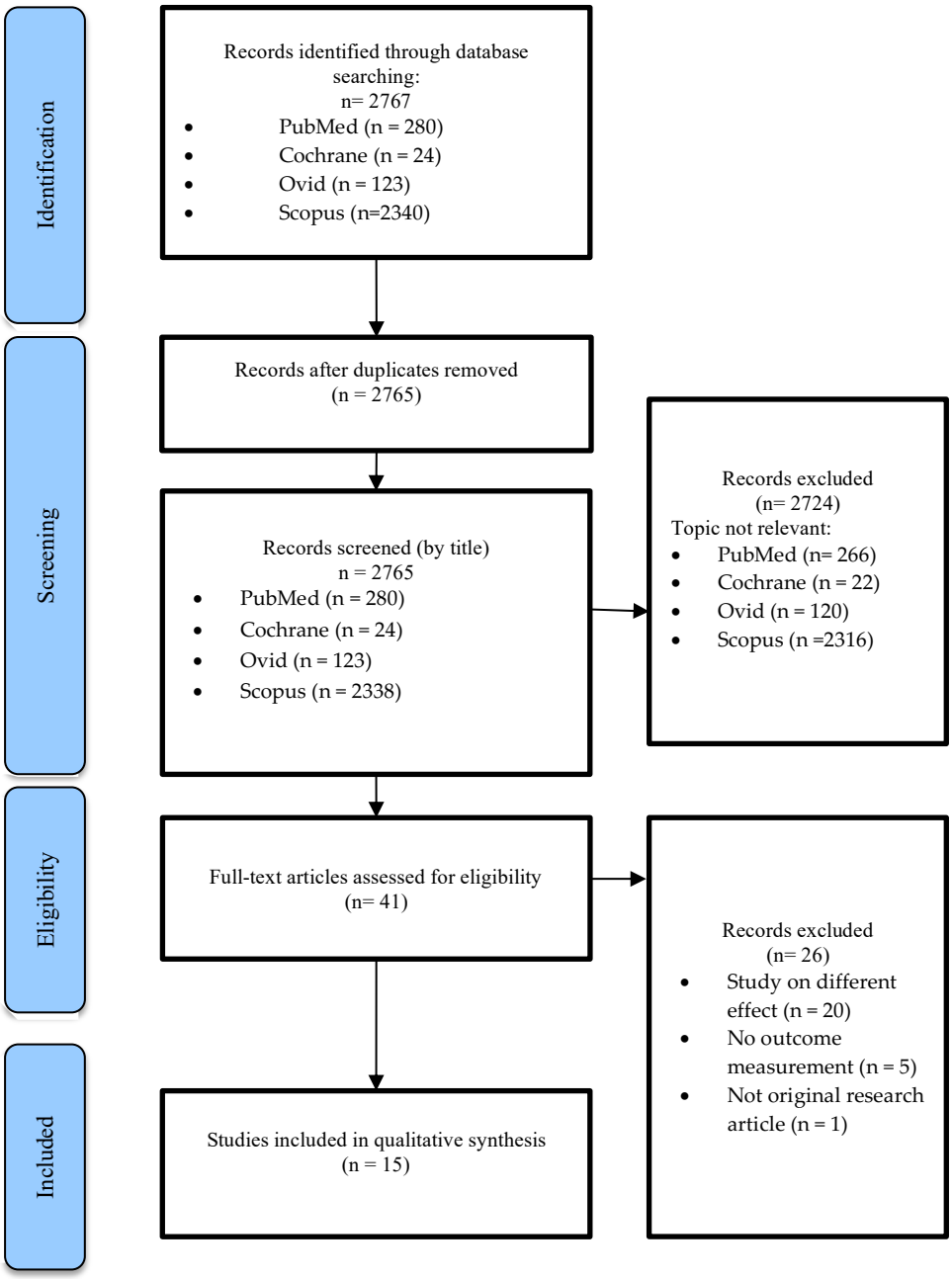

Figure 1. PRISMA Checklist Flowchart

Results

There are a total of 15 studies included, including the regions of Central America, South America, North America, Oceania, and the European Union. All studies are based on national surveys on SSB tax or hypothetical tax. According to the studies, the monthly consumption of SSB ranged from 4.24 to 66 liters per month per household. We found that the own price elasticities for SSB ranged from -0.06 to -3.95. On the other hand, the consumption changes due to tax varied based on the type of tax implemented. Seven studies involved specific excise tax, six studies involved ad valorem tax, and two studies compared the impact of both excise tax and ad valorem tax. The highest impact of the reduction in SSB consumption is seen upon implementation of a specific excise tax in Philadelphia with USD

0.015/ounce on sugar (regular) and sugar-substitute (diet) beverages and France Tax of €0.072/liter (USD 0.09/L), on regular and diet soft drinks and juice drinks with sweeteners (Refer Table 1).

Table 1: Characteristics of included studies.

No.	Author, year published	Data used, data collection, sample size	Expenditure / Consumption monthly	Price elasticities	SSB Tax/ Hypothetical SSB tax	Expenditure/ consumption change due to tax
1.	Chacon et al. 2018	Data source: 2014 Guatemala Living Conditions National Survey. Data collection: 2014 Sample size: 11,536 households	Expenditure: USD 3.54 Consumption: 4.6 liters	-1.39	Guatemala excise tax: 18 cents of Quetzal (GTQ) (USD 2.45) per liter on distribution of soft drinks	Decreased of soft drinks consumption by 9.9%
2.	Nakamura et al. 2018	Data source: Household-level grocery-purchasing data Data collection: 2011 to 2015 Sample size: 2,836 households living in cities of Chile	Expenditure: Chilean Peso 52.25 (USD 0.074) per 100ml Consumption: Overall: 7,349.5 ml High-tax soft drinks: 3,574.8 Low-tax soft drinks: 2,627.9 No-tax soft drinks: 379.1	−0.060	Chile ad valorem tax: 18% on SSB > 6.25g sugar/100 mL 10% on SSB <6.25g sugar/100mL	Decrease on the monthly purchased volume of high-tax soft drinks by 21.6%
3.	Zhong et al. 2018	Data source: Drexel University Beverage Choice Research Study Data collection: During no-tax period (Dec 6–31, 2016) During tax period (Jan 15 – Feb 31, 2017 Sample size: Total 1,777 respondents: 899 respondents in Philadelphia, Pennsylvania, and 878 respondents in three nearby	Expenditure: NA Consumption: Pre-tax: 89 oz Post-tax: 80 oz	-1.5 to -1.9	Philadelphia tax: USD 0.015/ounce on sugar (regular) and sugar-substitute (diet) beverages	Odds of daily consumption of regular soda was 40% lower (OR=0.6, 95% CI=0.37, 0.97)

		comparison cities				
4.	Guerrero-López et al. 2017	Data source: VII Family Budget Survey (FBS) Data collection: Nov 2011 – Oct 2012 Sample size: 10,527 households	Expenditure: NA Consumption: NA	-1.37	Increase 5% rate of taxes	Decrease ~ 6.85% in the consumption of soft drinks
5.	Paraje 2016	Data source: National Urban and Rural Household Income and Expenditures Survey (ENIGHUR). Data collection: 2011 – 2012 Sample size: 39,617 (1,383 were eliminated from the analysis)	Expenditure: USD 780.1 in 2011 Consumption: 10.7 liters per household	-1.192	SSB tax increase of 10%	Reduce the consumption substantially more than 12%
6.	Colchero et al. 2015	Data source: Mexican National Institute of Statistics and Geography (MNHIES). Data collection: Done very 2 years (2006, 2008 & 2010). Sample size: 73,311 households (19,512 in 2006, 27,994 in 2008 & 25,805 in 2010)	Expenditure: USD 0.60 / liters Consumption: 5.5 liters / weeks / household (66 liters / month/ household)	-1.06 to -1.16	Exact hypothetical tax not mentioned, assumed 10% increase in SSB price	Decreased quantity consumption of soft drinks by 10.6% and 11.6% for SSB
7.	Etile & Sharma 2015	Data source: 2010 ACNielsen Homescan Panel Data Data collection: 52 weeks Sample size: 16,728 observation for 1394 households	Expenditure: AUD 48.94 (USD 49.79) on non-alcoholic beverages AUD 76.15 (USD 77.47) for all SSB Consumption: 7.57 liters/ cap/ month (~250ml/ cap/ day)	Range between -2.3 to -0.2	Increase excise tax by 20% Increase ad valorem tax	Reduction -0.6 liters/ cap/ month at simulated median and -1.4 l/ cap/ month at simulated 75th centile. Reduction -0.6 l/ cap / month at simulated median and -1.0 l/cap/

						month at simulated 75th centile.
8.	Tiffin et al. 2015	Data source: 2010 Living Costs and Food Survey: collected year 2010. KANTAR WorldPanel Data collection: 2010 (Living costs and food survey) 51-week period starting in August 2010 (KANTAR WorldPanel) Sample size: 5116 UK households (Living Costs and Food Survey) 24 495 UK households (KANTAR WorldPanel)	Expenditure: Regular soft drinks (weekly) High consumption: £34.36 (USD 53.27) Moderate consumption: £24.44 (USD 37.89) Low consumption: £8.33 (USD 12.91) Consumption: NA	Low consum-ption: -0.456 Moderate consum-ption: -0.759 High consum-ption: -1.271	France Tax: €0.072/liter (USD 0.09/L), on regular and diet soft drinks and juice drinks with sweeteners. Hypothetical tax rate of £0.02/liter (USD 0.03/L) Hypothetical tax of £0.06/ liter (0.09/L), on regular soft drinks and juice drinks with fruit content lower than 25% Hungary tax: 7 HUF/ liter (USD 0.03/L), on regular soft drinks and juice drinks with sweeteners	Reduce consumption of regular soft drinks: Low consumption: 9.09% Moderate consumption: 3.6% High consumption: 40.93% Reduce consumption of regular soft drinks: Low consumption: 3.03% Moderate consumption: 7.87% High consumption: 13.65% Reduce consumption of regular soft drinks: Low consumption: 3.49% Moderate consumption: 9.37% High consumption: 14.93% Reduce consumption of regular soft drinks: Low consumption: 1.16%

						Moderate consumption: 3.12% High consumption: 4.98%
9.	Colchero, M. A., et al. 2017	Data source: National Income and Expenditure Surveys: 2008, 2010, 2012, and 2014. Data collection: 2014 Sample size: 2008: 35,146 households 2010: 30,169 households 2012: 10,062 households 2014: 21,427 households	Expenditure: NA Consumption: 2012 (pre-tax): 4.56 ± 0.023 liters 2014 (post-tax): 4.24 ± 0.015 liters	NA	Mexico SSB tax: 1peso/L (USD 0.002/L)	Overall, 6.3% reduction in the purchases of SSBs (after tax) Low-income households had the greatest reductions in SSB purchases (210.3%) Reductions in SSB purchases were higher in urban areas (26.9%) than in rural areas (23.9%)
10.	Colchero, M. A., et al. 2016	Data source: January 2012 through December 2014 from Nielsen Mexico's Consumer Panel Services. Data collection: 2014. Sample size: 6253 households	Expenditure: NA Consumption: NA	NA	Mexico SSB tax 1peso/L (USD 0.002/L)	Overall, 6.3% reduction in the purchases of SSBs (after tax) Reduce consumption of regular soft drinks: a) Low SES: 17.4% b) Moderate SES: 5.5% c) High SES: 5.6%
11.	Silver, L. D., et al. 2017	Data source: Store price surveys from 26 Berkeley Stores Point-of-sale data on 15.5 million checkouts for beverage prices, sales, and store revenue of supermarkets	Expenditure: NA Consumption: Pre-tax: 121g/day Post-tax: 97 g/day	NA	Berkeley SSB tax: USD 0.01/oz on beverages with added caloric sweeteners	Reduction of 13.3% SSB intake

		Dietary and shopping behavior surveys (telephone surveys) Data collection: 2016 Sample size: 957 adult Berkeley residents.				
12.	Caro, J. C., et al. 2018	Data source: Household food purchases (Jan 2013 to Dec 2015) from Kantar WorldPanel Chile. Data collection: July 2016 Sample size: 2,000 households	Expenditure: 1618 Chile pesos (USD 2.29) Consumption: 4586mL	-1.30 to -1.37	Chile tax: 18% tax for SSB containing > 6.25g sugar/100mL	Overall, reduction of 3.4% SSB intake Reduce consumption of regular soft drinks: a) Low SES: 1.6% b) High SES: 6.4%
13.	Jithitikulchai, T. and T. Andreyeva 2018	Data source: The Supplemental Nutrition Assistance Program (data of beverage purchases in 58 chain stores in Connecticut and Massachusetts). Data collection: Jan 2009–June 2011. Sample size:28,878 households.	Expenditure: USD 8.21 Consumption: 340.7oz	− 1.081	Hypothetical tax: USD 0.005/oz Hypothetical tax: USD 0.01/oz	Reduction in 11.6 cans of SSB monthly Reduction in 23.2 cans of SSB monthly
14.	Stacey, N., et al. 2017	Data source: sub-national price data and the Statistics South Africa Income and Expenditure Survey (IES) Data collection: 2010/2011 Sample size: 13364 urban residence.	Expenditure: 37.488 ZAR (USD 4.60) Consumption: NA	-1.18	South Africa 20% tax	Reduction 23.6% SSB consumption

15.	Bonnet, C. and V. Réquillart 2013	Data source: French representative consumer panel data by KANTAR Worldpanel. Data collection:2005 Sample size:19,000 households	Expenditure:NA Consumption: 35 L /yr	−2.13 to −3.95	Scenario 1: Uniform ad valorem tax Scenario 2: 0.14% tax per gram of sugar per liter Scenario 3: Excise tax of €0.09 per 100 g (USD 0.11 per 100 g) of sugar per liter.	Reduce SSB consumption by 3.7 L/person/yr Reduce SSB consumption by 3.7 L/person/yr Reduce SSB consumption by 6.0L/person/yr

We assessed the methodological quality of the articles using the Newcastle-Ottawa Quality Assessment Scale tool which has been adapted for observational studies. Overall, all the articles had good and fair quality. Twelve studies had good quality, three studies had fair quality and none of the articles had poor quality (Refer to Supplementary Materials: Table S1).

Discussion

Health taxes which are also called “sin-tax”, refer to the practice of earmarking excise and tax revenues from detrimental consumption of products that have a bad public health impact such as tobacco products, alcohol, and SSB (Thabrany et al., 2016; World Health Organization, 2019; Allcott et al., 2019). The tax imposed on SSB is mainly aimed at reducing SSB consumption by making it less affordable for the consumers to purchase it as the price increases (World Health Organization, 2019).

There are a few types of taxes that could be applied for SSB taxation, namely excise tax, sales tax, or value-added tax (Chriqui et al., 2013). Overall, based on the studies, both specific excise taxes and ad valorem taxes implementation showed a significant reduction in soft drinks consumption, according to the size of the tax. This means that the higher the tax, the higher the impact of it on reducing soft drinks consumption amongst the population. As the included studies in this review used different taxes and different ways to measure the impact of tax on soda consumption, therefore we cannot compare which type of tax had the biggest impact on reducing the consumption of soft drinks. However, based on literature, a study showed that specific excise tax has shown to have a bigger impact in terms of percentage of reduction in SSB consumption (Tiffin et al., 2015). Nevertheless, in a condition in which SSB tax would have a small fiscal burden for the population regardless of their level of SSB consumption prior to tax implementation, then the preferred tax will be an excise tax instead of an ad valorem tax (Etilé et al., 2015). A specific excise tax is applied specifically to the negative content of the SSB, so it would be in the form of an increase in shelf price if the manufacturer did not want to absorb the cost fully without compromising the price to consumers (Chriqui et al., 2013). Literature reveals that out of

many types of taxes, excise taxes are the most important as they change the cost burden to the consumers of the taxed products (World Health Organization, 2019).

Due to the SSB tax implementation, the manufacturer will need to handle the effect of the tax on their production. Thus, usually, the pass-on rate of the tax to the consumers will be lesser, the same, or more than 100%. If the pass-on rate is considered equal to or more than 100%, it means that the consumer may need to pay more to purchase it, due to the price increase (Briggs et al., 2013). The price increase may cause the SSB to become unaffordable for some consumers, and they might think twice before purchasing it (World Health Organization, 2019). Thus, it affects SSB purchasing and leads to lower consumption of SSB among populations (Claro et al., 2012; Han et al., 2013).
Based on this review, all studies included showed negative price elasticity, ranging from – 0.06 to – 3.95, which indicates that SSB prices are inversely associated with consumption. Price elasticity for SSB is a percent change in consumption for every 1% change in SSB price, thus, it may show how price changes affect demand. It calculates the purchasing effect of a good when prices vary (Briggs et al., 2013; Veerman et al., 2016). Studies in this review show that the higher the SSB price, the lower the SSB demand in the population. These findings are in line with a meta-analysis on the obesity rate after SSB tax implementation, that showed negative price elasticity (Cabrera et al., 2013).

This systematic review revealed a decrease in SSB intake among those who had a high level of SSB consumption before the tax enactment. This review also showed that those from lower income populations, are affected by the SSB tax by the reduction in SSB consumption, in line with recent literature (Phulkerd et al., 2020). In response to the SSB price increase, as low-income households spend far more than higher-income households, their consumption reductions are seen to be much larger as compared to those with higher incomes (Allcott et al., 2019). Other populations affected due to the imposition of the SSB tax were the rural indigenous population, children and teenagers (Han et al., 2013; Falbe et al., 2016) older people and the jobless ones (Phulkerd et al., 2020).

Another positive consequence of the SSB tax is that higher SSB prices are connected with increased demand for non-taxed beverages such as plain water, whole milk, and fruit juices (Cabrera et al., 2013). Various views regarding the likelihood of specific results of executing the behaviour, as well as people's appraisals of those outcomes, impact people's attitudes (Yzer & Marco, 2017). In this context, how the consumer reacts in view of an increase in SSB tax depends on their beliefs, attitudes, and choices. The notion of hyper-rational choice attempts to describe the behaviour of someone who makes good decisions while also considering the benefit or loss to others. The concept of hyper-rationality can be applied to a variety of real-life scenarios and choices, such as personal preferences, or maximising gain or minimising loss (Askari et al., 2019). In the case of SSB tax, reducing the loss in terms of higher payment needed to purchase the SSB, the consumers tend to change their purchase to beverages with lower prices as compared to SSB, believing they save more money (minimize the loss). This condition shift can be supported if the government applies healthy food and beverage subsidization (World Health Organization, 2016; Chriqui et al., 2013). Hence, SSB tax implementation resulting in reduced SSB

intake, indirectly reduces non-communicable diseases which leads to a healthier population, saves lives, and reduces burdens for healthcare systems (World Health Organization, 2021).

Research showed that tax implementation is the most effective way to reduce SSB consumption as it can be implemented throughout all population levels, despite it can generate revenue. This revenue can be used for public health promotion to reduce the non-communicable diseases prevalence in the community and thus may reduce the healthcare costs in the future for treating preventable diseases (Andreyeva et al., 2011; Veerman et al., 2016). SSB tax can be considered a progressive tax rather than a regressive tax. A regressive tax is one that takes a bigger percentage of income from low-income earners than it does from high-income earners and affects low-income earners more severely than high-income ones. By looking at taxes and income, they can appear regressive. However, the health benefits and lower health-care expenses and burdens counteract this, resulting in a progressive net impact for SSB tax (World Health Organization, 2019; Allcot et al., 2019).

There are some limitations in this study that need to be addressed. First, most of the research in this study was a simulation study. As is widely understood, simulation studies use assumptions in order to forecast the impact of modeled situations. In reality, there will be uncertainties as the situation may alter as a result of variables such as changes in population behaviour. Other than that, due to the fact that the majority of the studies included in this review focused on specific regions, the generalizability of the results is restricted; therefore, it is prudent to apply caution when projecting the findings to other countries.

Conclusion

It is shown that both specific excise taxes and ad valorem taxes implementation showed a significant reduction in soda consumption. Therefore, it can be concluded that fiscal intervention such as a soda tax could improve the population's behaviour towards unhealthy sugary beverage intake. Future research is needed to explore the necessity of redesigning the soda tax to improve its efficiency. Additionally, it is important to tackle issues such as the regressive nature of the soda tax in order to ensure the effectiveness of its implementation across the population.

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Conflicts of Interest

The authors declare no conflicts of interest.

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