Effects of public policies in the prevention of cardiovascular diseases: a systematic review of global literature

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Abbreviations:

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Abstract

Objectives. Given the growing interest worldwide in applying public policies to improve human health, we undertook a systematic review of studies investigating whether public policies targeting unhealthy products could reduce cardiovascular diseases.

Study Design. Systematic review of literature.

Methods. We searched research studies published in 2000-2020 from major databases including MEDLINE and EMBASE. We followed PRISMA guidelines, and narratively synthesized the studies based on vote counting and direction of the intervention effect.

Results. Ninety-eight studies, mostly from high-income countries, met the inclusion criteria. Most studies were on public policies targeting sugar-sweetened beverages and tobacco, followed by alcohol, sugar, salt, and junk foods. Overall, many reported that several fiscal, regulatory, and educational policies generated beneficial effects of reducing the diseases. Those studies that reported no or limited effects highlighted several socio-demographic and health-risk characteristics, and design and implementation aspects of the policy interventions as factors limiting the policy effects; most of these are modifiable with appropriate policy interventions. For instance, lower magnitudes of tax, substitution with other unhealthy products, and firms' competitive response strategies, pre-existence of smoking bans, incremental enactment of smoking regulations, degree of enforcement, and various socio-cultural factors minimized the effects of the policies.

Conclusion. The literature supports a growing consensus on the beneficial effects of public policy for improving human health. Design and implementation of public policies must address various impeding factors and incorporate appropriate remedial measures. Further research is needed from low-and middle-income countries, and on whether and how multiple policy instruments work in tandem.

1. INTRODUCTION

Non-communicable diseases (NCDs) such as heart disease, stroke, diabetes, cancer and chronic respiratory diseases are the leading causes of premature death worldwide, representing more than 72% of all deaths and disabilities in 2016[1, 2]. Moreover, they create a huge economic burden for affected households, particularly in low- and middle-income countries (LMICs)[2]. NCDs are also identified as one of the major risk factors of Covid-19 pandemic; recent research and anecdotal evidence show that patients with NCDs are more susceptible to Covid-19, and patients with co-morbidities of NCDs experience more severe COVID-19 outcomes, including needing longer hospitalization and related-mortality[3-6]. A large and consistent body of evidence, including systematic reviews and meta-analyses, demonstrated that consumption of unhealthy products such as alcohol[7-9], sugar and sugar-sweetened beverages (SSBs)[10-15], tobacco[16-18], salt[19, 20] and junk foods[21] are major risk factors for cardiovascular diseases (CVDs) and their metabolic bio-markers, and most of these are modifiable with appropriate policy interventions. In parallel, numerous review studies have also demonstrated links between various public policy instruments and consumption of unhealthy products[22-27]. However, some primary studies have shown that, even though public policies helped to reduce consumption, the decline in consumption was not sufficient to reduce body mass index (BMI) and obesity[28, 29]. Obesity is a chronic metabolic disorder associated with CVDs mortality and morbidity[30].

Some previous systematic reviews have synthesized the effects of public policies related to unhealthy products on CVDs, but they have considered narrowly selected components of policy instruments and its effects on public health, including a selected range of CVDs outcomes[31-37]. Bringing these literatures together in a broader synthesis in the form of a large-scale review of whether a full spectrum of public policies, such as educational, fiscal, and regulatory policies, can produce a reduction in CVDs would form a more comprehensive evidence base for CVD prevention policymaking. In an attempt to fill this gap, we carried out a systematic review of research studies investigating whether public policies targeting unhealthy products could produce considerable changes in their consumption and subsequently translate into a decline in CVDs and their metabolic bio-markers. Specifically, conceptualizing public policies targeting unhealthy products as a CVD intervention, our focus was on identifying evidence of an intervention effect rather of measuring the size of the effect. Furthermore, we identified modifying factors that could influence the effects of those policies, especially in contexts where the policies had no or limited effects.

Public policy instruments

There is growing interest globally in applying several public policy instruments to reduce the consumption of unhealthy products, with the ultimate objective to reduce chronic diseases, especially the NCDs[38].

Several ‘educational/ informative’ policies consisting of awareness programs, health warnings on tobacco and alcohol, and food nutrition labeling have widely been used globally to reduce the consumption of unhealthy products[39, 40]. In 1965, the US mandated the health warnings on cigarette packs, and, thereafter, several countries required implementation of such picture-based warning labels. Similarly, countries and jurisdictions have employed food labelling policies with the aim to inform consumers about the amount of unhealthy components including sugar, fats, and sodium in the food products so to enable them to make healthier food choices.

However, recently, the attention has shifted to another set of public policy instruments: fiscal and regulatory policies. One of the strategies of the World Health Organization’s *Action Plan* on non-communicable diseases is “to use fiscal policies and marketing controls in full effect to influence demand for tobacco, alcohol, and foods high in saturated/trans fats, salt and sugar”[38]. Several countries, recently, started either adopting or proposing fiscal policies, especially in the form of increased tax on SSBs and junk foods. Similarly, interest is growing for implementing various regulatory policies including actions of marketing controls and restricting the availability/use of unhealthy products[41]. Especially after the year 2000, several countries introduced smoking bans on all public places[42-48], and few countries started limiting the availability SSBs and salty snacks in schools[28, 29, 49, 50].

Our systematic review aims to synthesize the impacts of these policies on CVDs reduction, with focus on the extent to which research studies reporting beneficial effects of public policy interventions. We investigate several sociodemographic and policy intervention-related factors, including design and implementation aspects of the policy interventions and limiting policy effects. We also consider the implications for how design and implementation of public policies must consider carefully and incorporate means to combat those impeding factors.

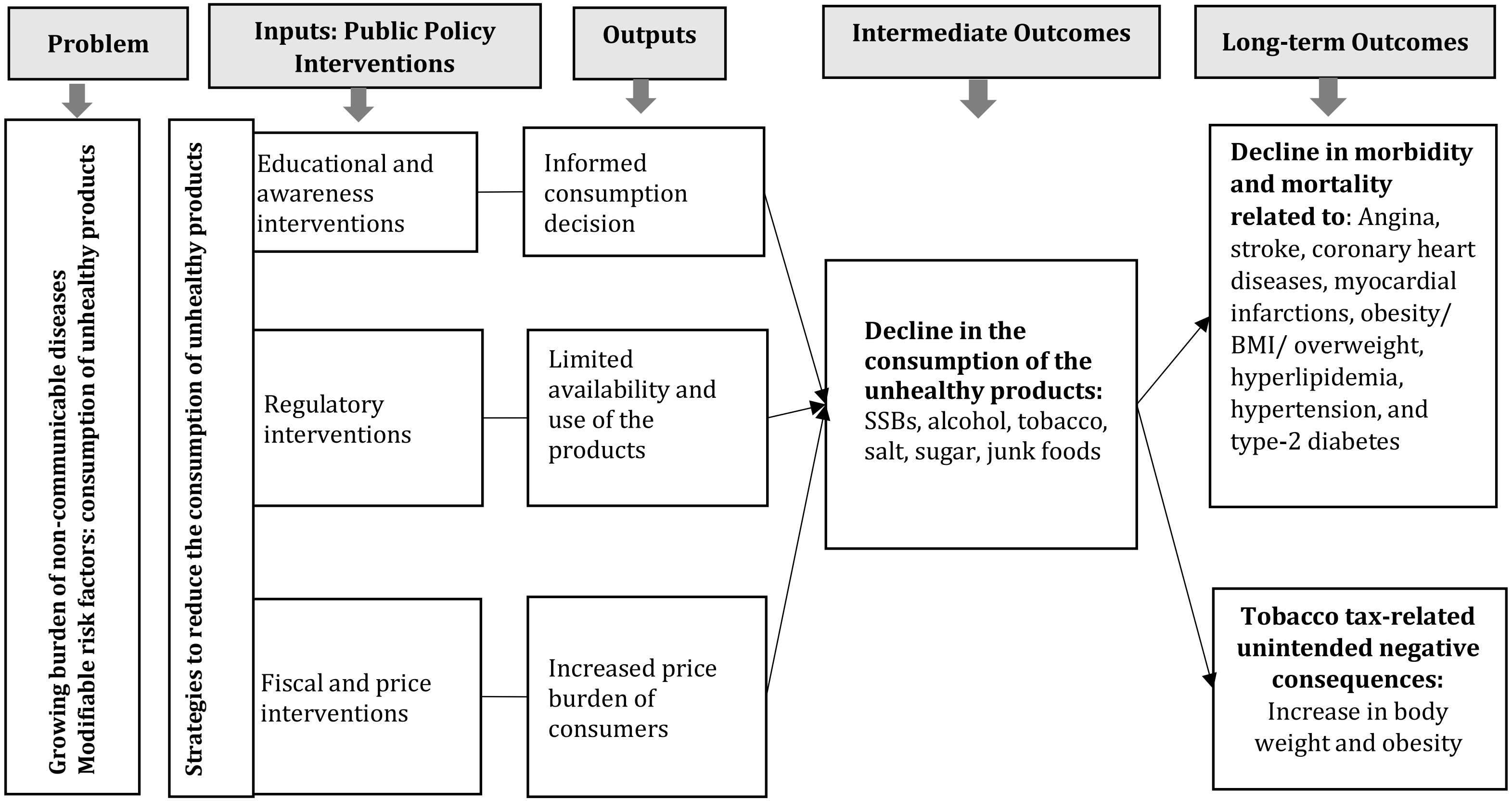
2. METHODS

We conducted a systematic literature search abiding the PRISMA guidelines, and carried out a narrative synthesis of the study findings[51].

2.1 Theoretical framework

Based on previous research, we framed a simple possible causal chain of how public policies could alter the consumption of unhealthy products, and its possible effects on changes in CVDs-related morbidity and mortality.

Figure 1. Causal chain of the effects of public policy on consumption of unhealthy products and health outcomes



Phase 1: Public Policies and Consumption

We categorized public policies under three broad groups, namely, educational, fiscal, and regulatory policies (Figure 1). These policy instruments aim to inform and incentivize people to adopt wise consumption decisions and thereby positively alter consumption behaviors[38, 41]. The educational interventions allow people the freedom of choice as consumers, but are intended to help them to develop better appreciations about the links between consumption choices and health consequences. The regulatory policies, at the more authoritarian end of the policy scale, restrict the availability/use of unhealthy products[41]. Falling somewhere between the extremes of educational and regulatory interventions, the fiscal/price policies are monetary nudges that seek to change consumption behavior towards healthier options by changing product prices to make unhealthy choices less affordable.

Phase 2: Consumption and Decline in CVDs

Subsequently, declines in consumption induced by public policy interventions are expected to reduce the incidence and prevalence of CVDs and its metabolic risk factors, and then a decline in the related mortality. For instance, the epidemiological pathways show that increased consumption of SSBs is more likely to produce low satiety levels, thus, increasing the risk of weight gain and the development of metabolic syndrome and type-2 diabetes, which in turn significantly increase the risk for CVDs[52]. Similarly, junk food with low nutrient density that provides calories primarily through fats and added sugars also would increase the risk of CVDs[30, 53]. As tobacco smoke contains high levels of carbon monoxide, an increase in tobacco consumption is associated with increased risks of heart attacks, hypertension, blood clots, strokes, hemorrhages, and other disorders of the cardiovascular system[54]. Tobacco consumption may also have indirect effects on CVDs risk, where breathing secondhand smoke can interfere with the normal functioning of the heart, blood, and vascular systems leading to increased risk of heart attack[55]. Similarly, excessive consumption of alcohol increases the risk of heart failure, stroke, peripheral arterial disease, and hypertension[56].

2.2 Inclusion and exclusion criteria

We considered all those public policies aiming to reduce the consumption of unhealthy products. Informed by the literature, we considered a wide range of unhealthy products including alcohol, SSBs, tobacco, salt, sugar and junk foods. We included studies that reported morbidity (incidence/prevalence/hospital admission rates) and/or mortality related to at least one of the following CVDs: angina, stroke, coronary heart diseases, myocardial infarctions (MI), obesity/BMI/overweight, hyperlipidemia, hypertension, and type-2 diabetes. Since there is extant literature including systematic reviews and meta-analysis already showing the positive effects of public policies in reducing the consumption of unhealthy products, we focused on a longer causal chain by considering whether the policies could produce considerable changes in consumption that can subsequently translate into declines in CVDs. Therefore, studies that reported only the effect of policies on changes in consumption, but not on CVDs were excluded. Studies published between 1st January 2000 and 30th June 2020 were included. No restriction was imposed on the study designs and country settings.

2.3 Search strategy

We identified the studies from major online databases including MEDLINE, EMBASE, Google Scholar, and other relevant websites including SSRN, NBER, OECD, WHOLIS, and a hand search of cross-references.

2.4 Data synthesis, and the assessment of risk of bias

Given the heterogeneity in both the study designs and the measures of intervention effect, we produced a narrative synthesis of the study findings. Following guidelines set out by Campbell et al.[51], our focus was on identifying "is there any evidence of an intervention effect?" rather of measuring "what is the average intervention effect?". We followed the approach of vote counting based on the direction of the measure of the intervention effect. Accordingly, the effect was grouped as beneficial effects versus no effects. Using a standard form recommended in the JBI Critical Appraisal Tools[57], we examined the components of each included primary study for risk of bias.

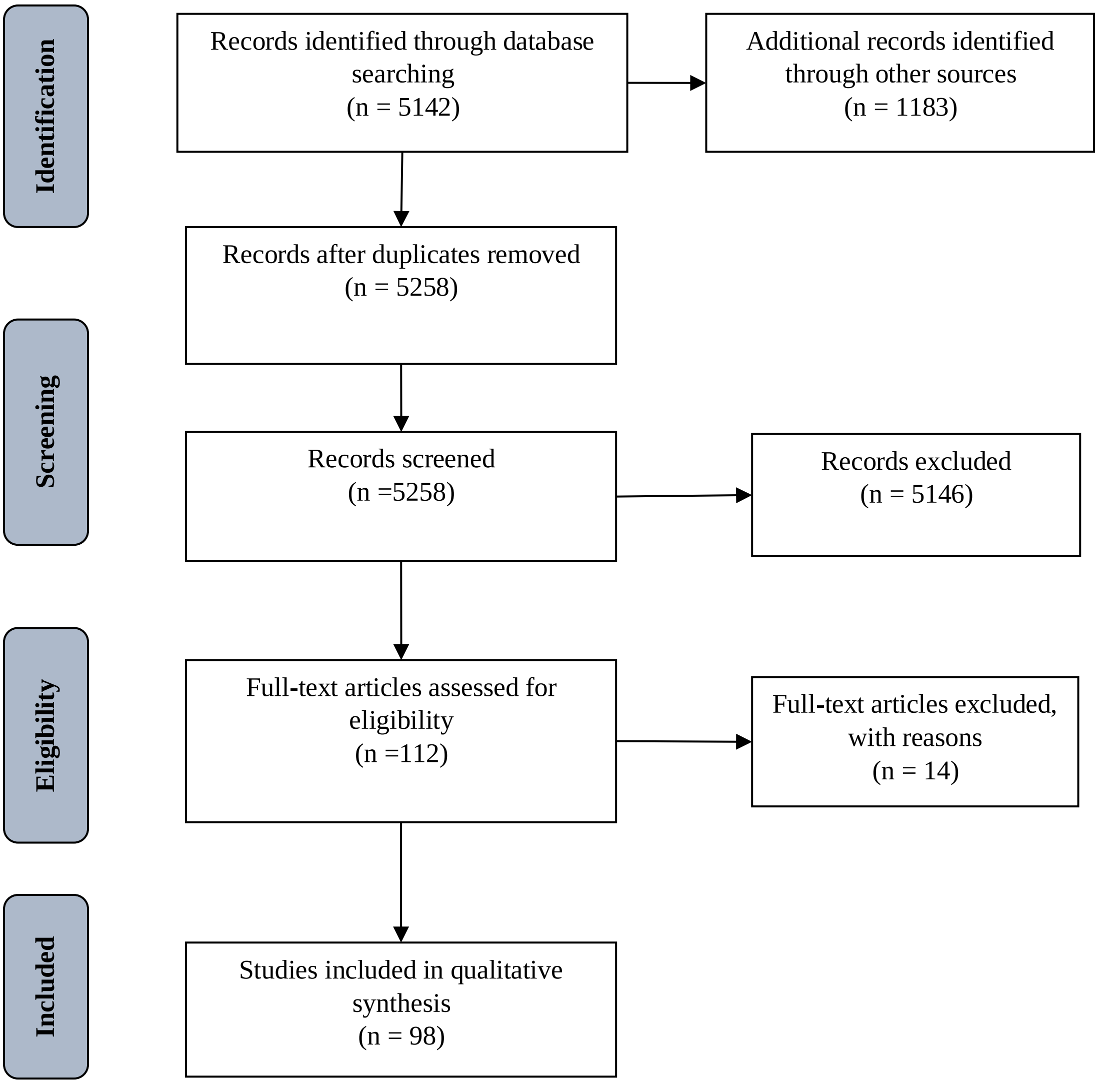
We present the results separately by geographical location, particularly by country. In part, this is because design and implementation of most of the public policies as strategies to fight against CVDs emerged from a small number of high-income countries. Moreover, some studies examine the impact of policies which are modifications of some existing policies overtime; for example, many countries in fact increased the tax over the existing tariffs by explicitly stating the welfare impacts in CVDs prevention. Presenting the findings separately by geographical location provides important contextual information to help readers relate the effects of various public policy to the socioeconomic and political contexts of those countries. Furthermore, as the growing interest in applying these policies in LMICs is a relatively recent phenomena, presenting findings this way informs policymakers, particularly from LMICs, of the need to adapt lessons across contexts.

3. RESULTS

3.1 Description of the studies

Ninety eight research studies met our inclusion-exclusion criteria (Figure 2). The most common study settings were high-income countries. The studies of fiscal policies (n=38) were mostly taxes on SSBs (n=29), with a relative few focusing on tobacco (n=4), alcohol (n=4) and junk foods (n=1) (Supplementary Table 1). The studies of regulatory policies (n=55), primarily involved smoking cessation in public places (n=50), and bans on SSBs (n=4) and junk foods (n=1) in school settings (Supplementary Table 2). The studies of educational policies were mostly awareness programs such as nutrition labelling requirements to reduce the consumption of unhealthy foods (n=4) (Supplementary Table 3).

Figure 2. PRISMA flow diagram for identifying studies for inclusion



3.2 Effects of fiscal policies

3.2.1 SSBs-related fiscal policies

Several studies of fiscal policies, mostly simulation studies predicting the effects of proposed tax increase, demonstrated beneficial effects of reductions in CVDs and their bio-markers in the US: imposing a $0.01/ounce SSBs excise tax are expected to reduce diabetes, coronary heart events, strokes, and related premature deaths[58], BMI[59] and obesity[60]; a proposed 20% increase in SSBs tax would reduce BMI[61], weight[62, 63] and overweight and obesity among adults and children[64], and reductions in stroke-related deaths, and a somewhat lesser extent, due to diabetes and coronary heart disease[65].

Similarly, several fiscal policy studies showed beneficial impacts in other country settings. Findings indicated beneficial effects of a proposed 20% SSBs tax in the metabolic risk factors of CVDs in the UK[66], Australia[67], Germany[68], South Africa[69-71] and India[72]. A 10% SSBs tax was found to reduce obesity rates in Ireland[73]. In Mexico, 10% SSBs tax was predicted to reduce the incidence of diabetes, strokes, and MI[74] and a 1-peso-per-liter tax increase was predicted to prevent diabetes[75].

However, a few studies reported no or limited effects of tax on CVDs. In the US, following very similar study approaches, two simulation studies estimated that a calorie-based increase in SSBs tax would result in significant weight-loss but non-significant decreases in obesity prevalence[76, 77].

In contrast to the mostly beneficial findings from the simulation studies reported above, a few empirically tested studies of actual policy intervention found very limited effects. In the US, studying the effects in states with and without an SSBs tax, studies found either no or very small effects of a SSBs tax on BMI and obesity[29, 78, 79], and beneficial effects among only those who are already overweight, especially among children from low-income families[80]. As one of the major potential factors limiting the effects, studies highlighted that the small magnitude of tax would not produce any meaningful difference in consumption behavior[29, 78, 80]. In addition, the type of tax also matters: excise tax was more effective as compared to sales tax because the latter is not incorporated into the shelf price[64], making the higher costs due to excise tax less visible to consumers[80]. Moreover, the availability of close substitutes, the associated cross-price elasticity, and the subsequent substitution with other high-caloric products also might limit the policy effects[29, 79]. Furthermore, firms' competitive marketing strategies of fully or partially absorbing the tax burden can dampen the impact of tax increases[64].

3.2.2 Tobacco-related fiscal policies

Studies of tobacco-related fiscal policies (n=4) assessed the direct and indirect effects of increasing cigarettes taxes[81-84]. A US-based study investigating the direct effect of increasing the cigarette excise tax found no clear effect on the morbidity rate for heart attacks and strokes (Supplementary Table 1)[84]. In contrast, reporting the unintended consequence of tobacco tax, studies found that the cigarette tax increased BMI among adults[81], and among the children of smoking mothers in the US[82], and obesity in Canada[83]. These studies highlighted the epidemiological relationship between a decline in smoking and the risk of obesity, as well the income effect of increased cigarette prices on households, as the major factors causing increase in obesity overall, and thus, limiting the effects of tobacco-related tax policies.

3.2.3. Alcohol-related fiscal policies

Of the studies on alcohol-related fiscal interventions (n=4), a proposed increase in excise tax in European Union countries was predicted to postpone considerable deaths and reduce prevalence of diabetes and strokes[85]. In the US, increased alcohol taxes were associated with reductions in alcohol-related disease mortality in Alaska[86], Florida[87] and New York[88].

3.2.4. Other unhealthy product-related fiscal policies

In Australia, a population-level intervention of a 10% ‘junk-food' tax was associated with a reduction of mean weight[89].

3.3 Effects of Regulatory policies

3.3.1 SSBs-related regulatory policies

Studies of the SSBs-related regulatory policies (n=4) focused on limiting access to SSBs in school settings in the US and Canada. Reducing the availability of SSBs was associated with reduction in their consumption, and thereby with reduced obesity[49, 50]. In contrast, while a decrease in SSBs consumption due to a regulatory intervention in school settings in the US, this did not translate into a decrease in obesity[28]. Another study found only moderate beneficial effects on the consumption of SSBs, which ultimately had no effect on BMI and obesity[29]. The potential reasons for such limited effects is that i) students substitute food that can be bought from outside their school, and ii) the food with the same energy content available in school[28, 29, 49].

3.3.2. Tobacco-related regulatory policies

Of the studies of regulatory policies of smoking restrictions in public and workplaces (n=56), studies showed considerable beneficial effects (n=34), limited beneficial effects (n=18), and no effects (n=4).

In the US, many studies reported beneficial effects of declines in hospital admission for various CVDs[48, 90-99] and CVDs-related morbidities and mortalities[100-103]. However, many studies showed mixed effects and/or no or small effect sizes of smoking bans. In the US, only a modest beneficial effect in the form of a small decrease in AMI hospital admission rates in the Medicare recipients[104], and in some states had little or no immediate measurable effect on

AMI mortality[105]. Another study found no effect on short-term declines in mortality or hospital admissions for myocardial infarction (MI), with considerable heterogeneity in effect between the regions[106]. In New York, fewer hospital admissions for AMI, but no reduction in the number of hospital admissions for stroke was found[48].

Several studies of tobacco-related regulatory policies conducted in European countries mostly showed beneficial effects. In Italy, a smoking ban in public places was associated with a reduction in acute coronary events[107, 108], decline in hospital admissions for AMI aged under 60[109] and decline in acute coronary events among persons aged less than 70 years[42], but only modest beneficial effects in the short-term was found while adjusting for different model specifications[110].

In Spain, studies found a reduction in the AMI hospitalization rate due to the implementation of the 2006 anti-smoking law[111], and a reduction in AMI mortality due to its extension of the law to more public places[112]. Another study found mixed-effects, with no significant changes in hospital admission rates for any CVDs in the city of Madrid but significant changes in Barcelona[44]. Another study in Spain demonstrated that hospitalizations due to CVDs significantly decreased in the population aged ≥ 65 years immediately after the implementation but not among patients ≥18 years of age[113], however, with wide heterogeneity in effects in different provinces. The source of this heterogeneity may be related to differences in implementation[44, 113].

In Switzerland, studies reported decreases in the incidence of AMI[114, 115] and ischemic heart disease (IHD) hospitalizations[116] and ST-Elevation Myocardial Infarction (STEMI) hospitalizations[117]. Another study demonstrated a decrease in the hospitalization rate for acute coronary syndrome (ACS) but not for ischemic stroke[118].

In Denmark, a study reported significant reductions in AMI-related hospital admissions one-year and two-years after the ban[45]. However, they also found a reduction in the year before the ban. They explain this finding as resulting from: i) the incremental enactment of smoking bans prior to the nationwide ban of 2007 alongside the implementation of a nation-wide ban on industrially produced trans-fatty acids in food in 2004, ii) uneven/partial enforcement of the smoking ban of 2007, including several exceptions to the ban that were made, and iii) cultural norms around socializing, as most social events are in private homes, whereas the Danish smoking ban prohibits smoking only in public areas[45].

In Belgium, a stepwise introduction of smoking ban was associated with immediate rather than gradual decrease in AMI mortality[43]. In Germany, studies reported decrease in hospital admissions for STEMI[119], and for both AMI and angina pectoris[120].

In the UK, the beneficial effects was reported in terms of decrease in hospital admissions for ACS[121] and emergency admissions for MI[122]. In Ireland, the smoking ban was associated with a reduction in IHD, and stroke-related mortality among people aged ≥ 65 years[123], and with an early significant decrease in hospital admissions for ACS[124]. Reduction in AMI admissions was found in New Zealand[125], Uruguay [126] and Canada[47, 127, 128]. Another study in Canada that demonstrated a small effect size in the decline in hospital admission rates for CVDs[129] pointed out the stepwise enactment of anti-smoking legislation and lower rates of current smoking levels accounted as possible reasons. A decline in CVD-related morbidity was found in Russia[130]. Beneficial effects of smoking ban for ACS was found in Argentina[131] and France[132].

3.3.3 Effects of alcohol-related regulatory policies

No studies on alcohol-related regulatory policies were found in our review.

3.3.4. Other unhealthy products-related regulatory policies

A study in the US found that limiting the availability of salty snacks in schools was associated with decrease obesity[50].

3.4 Educational policies

A study of educational program of discouraging SSB consumption in school settings in Brazil resulted in a decline in the consumption but a non-significant overall reduction in BMI, except among those students who were overweight at baseline[133] (Supplementary Table 3). In the US, one study of nutrition and caloric labels more broadly showed that such labels had no effect at the population level[134], and another study showed that reading nutrition information does not affect BMI[135]. One study in South Korea showed that pictorial warning labels on cigarettes were associated beneficial effects of reductions in diabetes and IHD cases[136]. We found no studies of alcohol-related educational policies.

3.5 Effects of combined implementation of policies

Only a few studies (n=4) reported the effects of the two or three interventions, either when jointly implemented or when implemented as separate policies but across overlapping time periods (Supplementary Table 4). These studies predicted considerable beneficial effects of the combination of tobacco-related fiscal and regulatory policies in CVDs prevention in India[137], Russia[130], China[138] and Panama[139].

3.6 Role of funding source

We found most of the studies were funded by either government agencies or philanthropic organizations or multilateral international agencies. Fourteen studies did not disclose their funding source. We found only one study directly funded by industry, and it showed that the smoking ban in public places had little or no immediate measurable effect on AMI mortality.

4. DISCUSSION

Overall, our study showed an increasing consensus in the literature about the beneficial effects of public policies for reducing CVDs. The few studies which reported no or limited effects highlighted many potential factors limiting the magnitude of policy effects. These include intervention-related factors, such as design and implementation aspects of the policy interventions, and various sociodemographic and health risk characteristics of the target population groups.

For instance, a substantial increase in the tax is required to produce significant effects[78]. Furthermore, after the imposition of a tax, as some studies highlighted, consumers may substitute the consumption of other high-calorie drinks (milk, fruit juice, other sugary, high calorie foods, etc.) for SSBs, which would offset the calorie decline[29, 79]. This finding implies that taxing SSBs with the aim to reduce caloric intake must also tax potential substitutes as well. However, these are sometimes nutritionally controversial propositions, as substitutes such as milk are rich sources of calcium and vitamins. Our review also indicated that firms' competitive marketing strategies--especially manufacturers' and retailers' responses--can dampen the impact of tax increases. In particular, manufacturers and retailers may fully or partially absorb the tax burden, meaning prices overall will not increase for the consumer despite higher taxes[64]. Whether firms respond by fighting the policy measure or promoting diet drinks as an alternative also matters; such responses can dampen efficacy of fiscal policies, and thus warrant appropriate policy considerations[66]. Policymakers may also incorporate several intervention-related factors as well as sociocultural factors in the implementations of the public policies[42, 45, 48, 103, 118, 123, 129]. New public policy instruments may be efficaciously applied to complement pre-existing policy interventions for stronger beneficial effects. The degree of enforcement of the policy interventions also influences the impact of the policies: for example, citing that the enforcement of the smoking ban in prison provides a case of full enforcement, one study has shown that full enforcement as compared to the partial enforcement of the smoking ban in public places has yielded better results[103].

The unintended consequences of a tax on tobacco and the relevance of fiscal policy on tobacco is another area of policy concern. Our review found only one study on the direct effect of cigarette taxes on CVDs (reporting limited beneficial effects in reducing CVDs) whereas 4 studies had demonstrated that taxes on cigarettes were associated with the unintended effect of increasing obesity. We suggest that this may not be considered a case against using taxes on tobacco; rather, it may simply reflect the small number of studies on assessing the direct effect. There are many studies showing that cigarette consumption is sensitive to prices[140, 141], and a tax increase of high magnitude is expected to generate some direct benefit of reduction in CVDs, especially AMI and IHDs. Further research on this topic, particularly testing what confounding factors may affect the final outcomes of CVDs, is needed.

We could find only a few studies of education interventions. These insights should not undermine the relevance of educational policies in the CVDs prevention. Some studies of educational interventions prior to our study inclusion period had shown beneficial effects. Analysis of public policy instruments has been evolving as a field: where the educational policies were an early pioneer, fiscal and regulatory policies have been of more recent interest, it is therefore possible that recent studies may be skewed towards fiscal and regulatory policies. Given that education policies such as nutrition labelling, tobacco labelling, and warning against the health consequences of alcohol and tobacco products in the media still in wide use for reducing the excess consumption of unhealthy products, it may be that the educational policies are effectively serving as baseline interventions, and fiscal and regulatory policies have served as supplementary policies, producing better cumulative results.

4.2 Limitations of the study

Our review study has several limitations. First, we have included only those public policies targeting unhealthy products affecting CVDs, and excluded the public policies targeting other risk factors of CVDs (for example, physical activity). Second, as industry funded studies are highly vulnerable to bias, we tried to identify the sources of study funding from the funding disclosure of each study. However, it is possible that the tobacco, alcohol and food multinationals may use a variety of opaque routes to fund biased science. Our analysis may not have detected such purposeful obfuscation.

4.3 Suggestions for future research

First, further research is needed on whether and how multiple policy instruments work in tandem, as most of the included studies assessed the effects of stand-alone policies, be it fiscal, regulatory, or educational. Second, future research may examine whether and how specific public policy instruments generate beneficial externalities: when, for instance, a government announces an increase in tax on SSBs and tobacco with an explicitly stated objective of preventing CVDs, it creates awareness of the health impacts of these products. As highlighted by one example, the generation of substantial media attention on the Danish regulatory smoking policy might have produced such externalities[45]. Third, more research is needed on actual policy interventions- we found several studies of SSBs-related fiscal policies were mostly modelling studies of increased taxes. Finally, more research is needed in low- and middle-income countries.

4.4 Policy Implications

Reflecting on our review findings, we call for applying various public policy instruments in the fight against the CVDs. Our review has identified several factors that impede the effect of these policies. However, importantly, most of these factors are modifiable, and so can be addressed with appropriate policy modifications.

To amplify policy effects, we suggest setting a high amount/rate of tax as a substantial increase in the tax found to be required to produce significant effects[78]. Furthermore, policymakers need to choose the appropriate type of tax as the type of tax also matters: Excise tax was found to be more effective as compared to sales tax because the latter is not incorporated into the shelf price[64, 80]. We have also found evidence of firms' competitive marketing strategies in dampening policy effects[64, 66], which highlights the need for incorporating the potential counter response strategies while designing and implementing the public policy instruments. Our findings also call for policymakers to incorporate intervention-related factors as well as sociocultural factors in the implementations of the public policies[42, 45, 48, 103, 118, 123, 129].

5. CONCLUDING REMARKS

The literature supports a growing consensus on the beneficial effects of public policy targeted on unhealthy products for CVDs reduction. However, several sociodemographic and health risk characteristics and intervention-related factors, including design and implementation aspects of the policy interventions, can limit policy effects. Our study emphasize the importance of carefully considering the design and implementation of public policies and incorporating appropriate measures to combat those impeding factors.

References

1. GBD Causes of Death Collaborators. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the Global Burden of Disease Study 2016. The Lancet. 2017; 390:1151-210.
2. World Health Organization. World Health Organization. (2021). Fact Sheet: Noncommunicable Diseases. Retrieved from https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases. 2021.
3. Nikoloski Z, Alqunaibet AM, Alfawaz RA, Almudarra SS, Herbst CH, El-Saharty S, et al. Covid-19 and non-communicable diseases: evidence from a systematic literature review. BMC Public Health. 2021; 21:1068.
4. Chen Y, Gong X, Wang L, Guo J. Effects of hypertension, diabetes and coronary heart disease on COVID-19 diseases severity: a systematic review and meta-analysis. medRxiv. 2020:2020.03.25.20043133.
5. de Almeida-Pititto B, Dualib PM, Zajdenverg L, Dantas JR, de Souza FD, Rodacki M, et al. Severity and mortality of COVID 19 in patients with diabetes, hypertension and cardiovascular disease: a meta-analysis. Diabetology & Metabolic Syndrome. 2020; 12:75.
6. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting Characteristics, Comorbidities, and Outcomes Among 5700 Patients Hospitalized With COVID-19 in the New York City Area. JAMA. 2020; 323:2052-9.
7. Reynolds K, Lewis B, Nolen JD, Kinney GL, Sathya B, He J. Alcohol consumption and risk of stroke: a meta-analysis. Jama. 2003; 289:579-88.
8. Briasoulis A, Agarwal V, Messerli FH. Alcohol consumption and the risk of hypertension in men and women: a systematic review and meta-analysis. J Clin Hypertens (Greenwich). 2012; 14:792-8.
9. Zheng YL, Lian F, Shi Q, Zhang C, Chen YW, Zhou YH, et al. Alcohol intake and associated risk of major cardiovascular outcomes in women compared with men: a systematic review and meta-analysis of prospective observational studies. BMC Public Health. 2015; 15:773.
10. Malik VS, Popkin BM, Bray GA, Despres JP, Willett WC, Hu FB. Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. Diabetes Care. 2010; 33:2477-83.
11. Malik VS, Pan A, Willett WC, Hu FB. Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. Am J Clin Nutr. 2013; 98:1084-102.
12. Vartanian LR, Schwartz MB, Brownell KD. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. Am J Public Health. 2007; 97:667-75.
13. Woodward-Lopez G, Kao J, Ritchie L. To what extent have sweetened beverages contributed to the obesity epidemic? Public Health Nutr. 2010; 14:499-509.
14. Greenwood DC, Threapleton DE, Evans CE, Cleghorn CL, Nykjaer C, Woodhead C, et al. Association between sugar-sweetened and artificially sweetened soft drinks and type 2 diabetes: systematic review and dose-response meta-analysis of prospective studies. Br J Nutr. 2014; 112:725-34.

15. Te Morenga L, Mallard S, Mann J. Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies. BMJ. 2012; 346:e7492.
16. Sun K, Liu J, Ning G. Active smoking and risk of metabolic syndrome: a meta-analysis of prospective studies. PLoS One. 2010; 7:e47791.
17. Willi C, Bodenmann P, Ghali WA, Faris PD, Cornuz J. Active smoking and the risk of type 2 diabetes: a systematic review and meta-analysis. Jama. 2007; 298:2654-64.
18. Meyers DG, Neuberger JS, He J. Cardiovascular effect of bans on smoking in public places: a systematic review and meta-analysis. J Am Coll Cardiol. 2009; 54:1249-55.
19. He FJ, Li J, Macgregor GA. Effect of longer term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomised trials. Bmj. 2013; 346:f1325.
20. Siervo M, Lara J, Chowdhury S, Ashor A, Oggioni C, Mathers JC. Effects of the Dietary Approach to Stop Hypertension (DASH) diet on cardiovascular risk factors: a systematic review and meta-analysis. Br J Nutr. 2015; 113:1-15.
21. Stanley WC, Shah KB, Essop MF. Does junk food lead to heart failure? Importance of dietary macronutrient composition in hypertension. Hypertension. 2009; 54:1209-10.
22. Campos S, Doxey J, Hammond D. Nutrition labels on pre-packaged foods: a systematic review. Public Health Nutr. 2011; 14:1496-506.
23. Cornelsen L, Green R, Turner R, Dangour AD, Shankar B, Mazzocchi M, et al. What happens to patterns of food consumption when food prices change? Evidence from a systematic review and meta-analysis of food price elasticities globally. Health Econ. 2014.
24. Eyles H, Ni Mhurchu C, Nghiem N, Blakely T. Food pricing strategies, population diets, and non-communicable disease: a systematic review of simulation studies. PLoS Med. 2012; 9:e1001353.
25. Andreyeva T, Long MW, Brownell KD. The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. Am J Public Health. 2010; 100:216-22.
26. Gibson S. Sugar-sweetened soft drinks and obesity: a systematic review of the evidence from observational studies and interventions. Nutr Res Rev. 2008; 21:134-47.
27. Noar SM, Francis DB, Bridges C, Sontag JM, Ribisl KM, Brewer NT. The impact of strengthening cigarette pack warnings: Systematic review of longitudinal observational studies. Soc Sci Med. 2016.
28. Bauhoff S. The effect of school district nutrition policies on dietary intake and overweight: a synthetic control approach. Econ Hum Biol. 2014; 12:45-55.
29. Fletcher JM, Frisvold D, Tefft N. Taxing soft drinks and restricting access to vending machines to curb child obesity. Health Aff (Millwood). 2010; 29:1059-66.
30. Poirier P, Giles TD, Bray GA, Hong Y, Stern JS, Pi-Sunyer FX, et al. Obesity and cardiovascular disease: pathophysiology, evaluation, and effect of weight loss: an update of the 1997 American Heart Association Scientific Statement on Obesity and Heart Disease from the Obesity Committee of the Council on Nutrition, Physical Activity, and Metabolism. Circulation. 2006; 113:898-918.
31. Lightwood JM, Glantz SA. CLINICAL PERSPECTIVE. Circulation. 2009; 120:1373-9.
32. Meyers DG, Neuberger JS, He J. Cardiovascular effect of bans on smoking in public places: a systematic review and meta-analysis. Journal of the American College of Cardiology. 2009; 54:1249-55.
33. Mackay DF, Irfan M, Haw S, Pell J. Meta-analysis of the effect of comprehensive smoke-free legislation on acute coronary events. Heart. 2010; 96:1525-30.

34. Tan CE, Glantz SA. Association between smoke-free legislation and hospitalizations for cardiac, cerebrovascular, and respiratory diseases: a meta-analysis. Circulation. 2012; 126:2177-83.
35. Powell LM, Chriqui JF, Khan T, Wada R, Chaloupka FJ. Assessing the potential effectiveness of food and beverage taxes and subsidies for improving public health: a systematic review of prices, demand and body weight outcomes. Obes Rev. 2013; 14:110-28.
36. Maniadakis N, Kapaki V, Damianidi L, Kourlaba G. A systematic review of the effectiveness of taxes on nonalcoholic beverages and high-in-fat foods as a means to prevent obesity trends. Clinicoecon Outcomes Res. 2013; 5:519-43.
37. Wagenaar AC, Tobler AL, Komro KA. Effects of alcohol tax and price policies on morbidity and mortality: a systematic review. American journal of public health. 2010; 100:2270-8.
38. World Health Organization. Global action plan for the prevention and control of noncommunicable diseases 2013-2020. 2013.
39. Wolfenden L, Goldman S, Stacey FG, Grady A, Kingsland M, Williams CM, et al. Strategies to improve the implementation of workplace-based policies or practices targeting tobacco, alcohol, diet, physical activity and obesity. Cochrane Database Syst Rev. 2018; 11:Cd012439.
40. Hyseni L, Atkinson M, Bromley H, Orton L, Lloyd-Williams F, McGill R, et al. The effects of policy actions to improve population dietary patterns and prevent diet-related non-communicable diseases: scoping review. Eur J Clin Nutr. 2017; 71:694-711.
41. Thaler RH, Sunstein CR. Nudge: Improving decisions about health, wealth, and happiness: New Haven: Yale University Press; 2008.
42. Barone-Adesi F, Gasparrini A, Vizzini L, Merletti F, Richiardi L. Effects of Italian smoking regulation on rates of hospital admission for acute coronary events: a country-wide study. PLoS One. 2011; 6:e17419.
43. Cox B, Vangronsveld J, Nawrot TS. Impact of stepwise introduction of smoke-free legislation on population rates of acute myocardial infarction deaths in Flanders, Belgium. Heart. 2014; 100:1430-5.
44. Galan I, Simon L, Flores V, Ortiz C, Fernandez-Cuenca R, Linares C, et al. Assessing the effects of the Spanish partial smoking ban on cardiovascular and respiratory diseases: methodological issues. BMJ Open. 2015; 5:e008892.
45. Christensen TM, Moller L, Jorgensen T, Pisinger C. The impact of the Danish smoking ban on hospital admissions for acute myocardial infarction. Eur J Prev Cardiol. 2014; 21:65-73.
46. Kvasnicka M, Siedler T, Ziebarth NR. The health effects of smoking bans: Evidence from G erman hospitalization data. Health economics. 2018; 27:1738-53.
47. Gaudreau K, Sanford CJ, Cheverie C, McClure C. The effect of a smoking ban on hospitalization rates for cardiovascular and respiratory conditions in Prince Edward Island, Canada. PLoS One. 2013; 8:e56102.
48. Juster HR, Loomis BR, Hinman TM, Farrelly MC, Hyland A, Bauer UE, et al. Declines in hospital admissions for acute myocardial infarction in New York state after implementation of a comprehensive smoking ban. Am J Public Health. 2007; 97:2035-9.
49. Masse LC, de Niet-Fitzgerald JE, Watts AW, Naylor PJ, Saewyc EM. Associations between the school food environment, student consumption and body mass index of Canadian adolescents. Int J Behav Nutr Phys Act. 2014; 11:29.
50. Seo D-C, Lee CG. Association of School Nutrition Policy and Parental Control With Childhood Overweight. Journal of School Health. 2012; 82:285-93.

51. Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. BMJ. 2020; 368:l6890.
52. Bhupathiraju SN, Hu FB. Epidemiology of obesity and diabetes and their cardiovascular complications. Circulation research. 2016; 118:1723-35.
53. Kubik MY, Wall M, Shen L, Nanney MS, Nelson TF, Laska MN, et al. State but not district nutrition policies are associated with less junk food in vending machines and school stores in US public schools. J Am Diet Assoc. 2010; 110:1043-8.
54. U.S Department of Health, Staff HS, Prevention NCfCD, Smoking HPOo, Control CfD, Prevention. How tobacco smoke causes disease: the biology and behavioral basis for smoking-attributable disease: a report of the Surgeon General: US Government Printing Office; 2010.
55. Health UDo, Services H. The health consequences of involuntary exposure to tobacco smoke: a report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease …; 2006.
56. Piano MR. Alcohol's Effects on the Cardiovascular System. Alcohol Res. 2017; 38:219-41.
57. Joanna Briggs Institute. Critical Appraisal Tools- JBI Reviewer's Manual. . 2020 [cited 2020 01-02-2020]; Available from: https://joannabriggs.org/ebp/critical_appraisal_tools.
58. Wang YC, Coxson P, Shen YM, Goldman L, Bibbins-Domingo K. A penny-per-ounce tax on sugar-sweetened beverages would cut health and cost burdens of diabetes. Health Aff (Millwood). 2012; 31:199-207.
59. Long MW, Gortmaker SL, Ward ZJ, Resch SC, Moodie ML, Sacks G, et al. Cost effectiveness of a sugar-sweetened beverage excise tax in the US. American journal of preventive medicine. 2015; 49:112-23.
60. Kristensen AH, Flottemesch TJ, Maciosek MV, Jenson J, Barclay G, Ashe M, et al. Reducing childhood obesity through US federal policy: a microsimulation analysis. American journal of preventive medicine. 2014; 47:604-12.
61. Dharmasena S, Capps O, Jr. Intended and unintended consequences of a proposed national tax on sugar-sweetened beverages to combat the U.S. obesity problem. Health Econ. 2012; 21:669-94.
62. Lin B-H, Smith TA, Lee J-Y, Hall KD. Measuring weight outcomes for obesity intervention strategies: the case of a sugar-sweetened beverage tax. Economics & Human Biology. 2011; 9:329-41.
63. Schroeter C, Lusk J, Tyner W. Determining the impact of food price and income changes on body weight. Journal of health economics. 2008; 27:45-68.
64. Smith TA, Lin B-H, Lee J-Y. Taxing caloric sweetened beverages: potential effects on beverage consumption, calorie intake, and obesity. USDA-ERS Economic Research Report. 2010.
65. Penalvo JL, Cudhea F, Micha R, Rehm CD, Afshin A, Whitsel L, et al. The potential impact of food taxes and subsidies on cardiovascular disease and diabetes burden and disparities in the United States. BMC Med. 2017; 15:208.
66. Briggs AD, Mytton OT, Kehlbacher A, Tiffin R, Rayner M, Scarborough P. Overall and income specific effect on prevalence of overweight and obesity of 20% sugar sweetened drink tax in UK: econometric and comparative risk assessment modelling study. BMJ. 2013; 347:f6189.
67. Veerman JL, Sacks G, Antonopoulos N, Martin J. The Impact of a Tax on Sugar-Sweetened Beverages on Health and Health Care Costs: A Modelling Study. PLoS One. 2016; 11:e0151460.

68. Schwendicke F, Stolpe M. Taxing sugar-sweetened beverages: impact on overweight and obesity in Germany. BMC Public Health. 2017; 17:88.
69. Manyema M, Veerman LJ, Chola L, Tugendhaft A, Sartorius B, Labadarios D, et al. The potential impact of a 20% tax on sugar-sweetened beverages on obesity in South African adults: a mathematical model. PLoS One. 2014; 9:e105287.
70. Manyema M, Veerman LJ, Tugendhaft A, Labadarios D, Hofman KJ. Modelling the potential impact of a sugar-sweetened beverage tax on stroke mortality, costs and health-adjusted life years in South Africa. BMC Public Health. 2016; 16:405.
71. Manyema M, Veerman JL, Chola L, Tugendhaft A, Labadarios D, Hofman K. Decreasing the Burden of Type 2 Diabetes in South Africa: The Impact of Taxing Sugar-Sweetened Beverages. PLoS One. 2015; 10:e0143050.
72. Basu S, Vellakkal S, Agrawal S, Stuckler D, Popkin B, Ebrahim S. Averting obesity and type 2 diabetes in India through sugar-sweetened beverage taxation: an economic-epidemiologic modeling study. PLoS Med. 2014; 11:e1001582.
73. Briggs AD, Mytton OT, Madden D, O'Shea D, Rayner M, Scarborough P. The potential impact on obesity of a 10% tax on sugar-sweetened beverages in Ireland, an effect assessment modelling study. BMC Public Health. 2013; 13:860.
74. Sanchez-Romero LM, Penko J, Coxson PG, Fernandez A, Mason A, Moran AE, et al. Projected Impact of Mexico's Sugar-Sweetened Beverage Tax Policy on Diabetes and Cardiovascular Disease: A Modeling Study. PLoS Med. 2016; 13:e1002158.
75. Barrientos-Gutierrez T, Zepeda-Tello R, Rodrigues ER, Colchero MA, Rojas-Martinez R, Lazcano-Ponce E, et al. Expected population weight and diabetes impact of the 1-peso-per-litre tax to sugar sweetened beverages in Mexico. PLoS One. 2017; 12:e0176336.
76. Ruff RR, Zhen C. Estimating the effects of a calorie-based sugar-sweetened beverage tax on weight and obesity in New York City adults using dynamic loss models. Annals of epidemiology. 2015; 25:350-7.
77. Gortmaker SL, Long MW, Resch SC, Ward ZJ, Cradock AL, Barrett JL, et al. Cost effectiveness of childhood obesity interventions: evidence and methods for CHOICES. American journal of preventive medicine. 2015; 49:102-11.
78. Powell LM, Chriqui J, Chaloupka FJ. Associations between state-level soda taxes and adolescent body mass index. J Adolesc Health. 2009; 45:S57-63.
79. Fletcher JM, Frisvold DE, Tefft N. The effects of soft drink taxes on child and adolescent consumption and weight outcomes. Journal of Public Economics. 2010; 94:967-74.
80. Sturm R, Powell LM, Chriqui JF, Chaloupka FJ. Soda taxes, soft drink consumption, and children's body mass index. Health Aff (Millwood). 2010; 29:1052-8.
81. Baum CL. The effects of cigarette costs on BMI and obesity. Health Econ. 2009; 18:3-19.
82. Mellor JM. Do cigarette taxes affect children's body mass index? The effect of household environment on health. Health Econ. 2011; 20:417-31.
83. Sen A, Entezarkheir M, Wilson A. Obesity, smoking, and cigarette taxes: evidence from the Canadian Community Health Surveys. Health Policy. 2010; 97:180-6.
84. Liu E, Rivers PA, Sarvela PD. Does increasing cigarette excise tax improve people's health? The cases of heart attacks and stroke. J Health Care Finance. 2008; 34:91-109.
85. Lhachimi SK, Cole KJ, Nusselder WJ, Smit HA, Baili P, Bennett K, et al. Health impacts of increasing alcohol prices in the European Union: a dynamic projection. Prev Med. 2012; 55:237-43.
86. Wagenaar AC, Maldonado-Molina MM, Wagenaar BH. Effects of alcohol tax increases on alcohol-related disease mortality in Alaska: time-series analyses from 1976 to 2004. American journal of public health. 2009; 99:1464-70.

87. Maldonado-Molina MM, Wagenaar AC. Effects of alcohol taxes on alcohol-related mortality in Florida: time-series analyses from 1969 to 2004. Alcohol Clin Exp Res. 2010; 34:1915-21.
88. Delcher C, Maldonado-Molina MM, Wagenaar AC. Effects of alcohol taxes on alcohol-related disease mortality in New York State from 1969 to 2006. Addict Behav. 2012; 37:783-9.
89. Sacks G, Veerman JL, Moodie M, Swinburn B. 'Traffic-light' nutrition labelling and 'junk-food' tax: a modelled comparison of cost-effectiveness for obesity prevention. Int J Obes (Lond). 2011; 35:1001-9.
90. Weaver AM, Wang Y, Rupp K, Watson DP. Effects of smoke-free air law on acute myocardial infarction hospitalization in Indianapolis and Marion County, Indiana. BMC Public Health. 2018; 18:232.
91. Hurt RD, Weston SA, Ebbert JO, McNallan SM, Croghan IT, Schroeder DR, et al. Myocardial infarction and sudden cardiac death in Olmsted County, Minnesota, before and after smoke-free workplace laws. Archives of internal medicine. 2012; 172:1635-41.
92. Dove MS, Dockery DW, Mittleman MA, Schwartz J, Sullivan EM, Keithly L, et al. The impact of Massachusetts' smoke-free workplace laws on acute myocardial infarction deaths. American journal of public health. 2010; 100:2206-12.
93. Hahn EJ, Rayens MK, Burkhart PV, Moser DK. Smoke-free laws, gender, and reduction in hospitalizations for acute myocardial infarction. Public Health Reports. 2011; 126:826-33.
94. Seo D-C, Torabi MR. Reduced admissions for acute myocardial infarction associated with a public smoking ban: matched controlled study. Journal of drug education. 2007; 37:217-26.
95. Bartecchi C, Alsever RN, Nevin-Woods C, Thomas WM, Estacio RO, Bartelson BB, et al. Reduction in the incidence of acute myocardial infarction associated with a citywide smoking ordinance. Circulation. 2006; 114:1490-6.
96. Moraros J, Bird Y, Chen S, Buckingham R, Meltzer RS, Prapasiri S, et al. The impact of the 2002 Delaware smoking ordinance on heart attack and asthma. International journal of environmental research and public health. 2010; 7:4169-78.
97. Gupta R, Anderson RH, Luo J, Ray A. Clean indoor air regulation and incidence of hospital admissions for acute coronary syndrome in Kanawha County, West Virginia. 2011.
98. Khuder SA, Milz S, Jordan T, Price J, Silvestri K, Butler P. The impact of a smoking ban on hospital admissions for coronary heart disease. Preventive medicine. 2007; 45:3-8.
99. Herman PM, Walsh ME. Hospital admissions for acute myocardial infarction, angina, stroke, and asthma after implementation of Arizona's comprehensive statewide smoking ban. American journal of public health. 2011; 101:491-6.
100. Mayne SL, Widome R, Carroll AJ, Schreiner PJ, Gordon-Larsen P, Jacobs Jr DR, et al. Longitudinal associations of smoke-free policies and incident cardiovascular disease: CARDIA study. Circulation. 2018; 138:557-66.
101. Sargent RP, Shepard RM, Glantz SA. Reduced incidence of admissions for myocardial infarction associated with public smoking ban: before and after study. Bmj. 2004; 328:977-80.
102. Ong MK, Glantz SA. Cardiovascular health and economic effects of smoke-free workplaces. Am J Med. 2004; 117:32-8.
103. Binswanger IA, Carson EA, Krueger PM, Mueller SR, Steiner JF, Sabol WJ. Prison tobacco control policies and deaths from smoking in United States prisons: population based retrospective analysis. Bmj. 2014; 349.

104. Barr CD, Diez DM, Wang Y, Dominici F, Samet JM. Comprehensive smoking bans and acute myocardial infarction among Medicare enrollees in 387 US counties: 1999-2008. Am J Epidemiol. 2012; 176:642-8.
105. Rodu B, Peiper N, Cole P. Acute myocardial infarction mortality before and after state-wide smoking bans. Journal of community health. 2012; 37:468-72.
106. Shetty KD, DeLeire T, White C, Bhattacharya J. Changes in US hospitalization and mortality rates following smoking bans. Journal of Policy Analysis and management. 2011; 30:6-28.
107. Cesaroni G, Forastiere F, Agabiti N, Valente P, Zuccaro P, Perucci CA. Effect of the Italian smoking ban on population rates of acute coronary events. Circulation. 2008; 117:1183.
108. Vasselli S, Papini P, Gaelone D, Spizzichino L, De EC, Gnavi R, et al. Reduction incidence of myocardial infarction associated with a national legislative ban on smoking. Minerva cardioangiologica. 2008; 56:197-203.
109. Barone-Adesi F, Vizzini L, Merletti F, Richiardi L. Short-term effects of Italian smoking regulation on rates of hospital admission for acute myocardial infarction. European heart journal. 2006; 27:2468-72.
110. Gasparrini A, Gorini G, Barchielli A. On the relationship between smoking bans and incidence of acute myocardial infarction. European journal of epidemiology. 2009; 24:597-602.
111. Villalbí JR, Castillo A, Cleries M, Saltó E, Sánchez E, Martínez R, et al. Acute myocardial infarction hospitalization statistics: apparent decline accompanying an increase in smoke-free areas. Revista Española de Cardiología (English Edition). 2009; 62:812-5.
112. Villalbí JR, Sánchez E, Benet J, Cabezas C, Castillo A, Guarga A, et al. The extension of smoke-free areas and acute myocardial infarction mortality: before and after study. BMJ open. 2011; 1:e000067.
113. Galán I, Simón L, Boldo E, Ortiz C, Medrano MJ, Fernández-Cuenca R, et al. Impact of 2 Successive Smoking Bans on Hospital Admissions for Cardiovascular Diseases in Spain. Revista Española de Cardiología (English Edition). 2018; 71:726-34.
114. Bonetti PO, Trachsel LD, Kuhn MU, Schulzki T, Erne P, Radovanovic D, et al. Incidence of acute myocardial infarction after implementation of a public smoking ban in Graubünden, Switzerland: Two year follow-up. Swiss medical weekly. 2011; 141:w13206.
115. Trachsel LD, Kuhn MU, Reinhart WH, Schulzki T, Bonetti PO. Reduced incidence of acute myocardial infarction in the first year after implementation of a public smoking ban in Graubuenden, Switzerland: Verlag nicht ermittelbar; 2011.
116. Vicedo-Cabrera AM, Roosli M, Radovanovic D, Grize L, Witassek F, Schindler C, et al. Cardiorespiratory hospitalisation and mortality reductions after smoking bans in Switzerland. Swiss Med Wkly. 2017; 146:w14381.
117. Di Valentino M, Muzzarelli S, Limoni C, Porretta AP, Rigoli A, Barazzoni F, et al. Reduction of ST-elevation myocardial infarction in Canton Ticino (Switzerland) after smoking bans in enclosed public places—No Smoke Pub Study. The European Journal of Public Health. 2015; 25:195-9.
118. Humair JP, Garin N, Gerstel E, Carballo S, Carballo D, Keller PF, et al. Acute respiratory and cardiovascular admissions after a public smoking ban in Geneva, Switzerland. PLoS One. 2014; 9:e90417.
119. Schmucker J, Wienbergen H, Seide S, Fiehn E, Fach A, Würmann-Busch B, et al. Smoking ban in public areas is associated with a reduced incidence of hospital admissions due to ST-elevation myocardial infarctions in non-smokers. Results from the Bremen STEMI Registry. European journal of preventive cardiology. 2014; 21:1180-6.

120. Sargent JD, Demidenko E, Malenka DJ, Li Z, Gohlke H, Hanewinkel R. Smoking restrictions and hospitalization for acute coronary events in Germany. Clinical research in cardiology. 2012; 101:227-35.
121. Pell JP, Haw S, Cobbe S, Newby DE, Pell AC, Fischbacher C, et al. Smoke-free legislation and hospitalizations for acute coronary syndrome. New England Journal of Medicine. 2008; 359:482-91.
122. Sims M, Maxwell R, Bauld L, Gilmore A. Short term impact of smoke-free legislation in England: retrospective analysis of hospital admissions for myocardial infarction. Bmj. 2010; 340:c2161.
123. Stallings-Smith S, Zeka A, Goodman P, Kabir Z, Clancy L. Reductions in cardiovascular, cerebrovascular, and respiratory mortality following the national irish smoking ban: interrupted time-series analysis. PLoS One. 2013; 8:e62063.
124. Cronin EM, Kearney PM, Kearney PP, Sullivan P, Perry IJ, Group CHAIRW. Impact of a national smoking ban on hospital admission for acute coronary syndromes: a longitudinal study. Clinical cardiology. 2012; 35:205-9.
125. Barnett R, Pearce J, Moon G, Elliott J, Barnett P. Assessing the effects of the introduction of the New Zealand Smokefree Environment Act 2003 on acute myocardial infarction hospital admissions in Christchurch, New Zealand. Australian and New Zealand journal of public health. 2009; 33:515-20.
126. Sebrié EM, Sandoya E, Hyland A, Bianco E, Glantz SA, Cummings KM. Hospital admissions for acute myocardial infarction before and after implementation of a comprehensive smoke-free policy in Uruguay. Tobacco control. 2013; 22:e16-e20.
127. Bruintjes G, Bartelson BB, Hurst P, Levinson AH, Hokanson JE, Krantz MJ. Reduction in acute myocardial infarction hospitalization after implementation of a smoking ordinance. The American journal of medicine. 2011; 124:647-54.
128. Lemstra M, Neudorf C, Opondo J. Implications of a public smoking ban. Canadian Journal of Public Health. 2008; 99:62-5.
129. Naiman A, Glazier RH, Moineddin R. Association of anti-smoking legislation with rates of hospital admission for cardiovascular and respiratory conditions. CMAJ. 2010; 182:761-7.
130. Gambaryan M, Reeves A, Deev A, Popovich M, Drapkina O, Snell A, et al. Effects of tobacco control policy on cardiovascular morbidity and mortality in Russia. European journal of public health. 2018; 28:14-6.
131. Ferrante D, Linetzky B, Virgolini M, Schoj V, Apelberg B. Reduction in hospital admissions for acute coronary syndrome after the successful implementation of 100% smoke-free legislation in Argentina: a comparison with partial smoking restrictions. Tobacco control. 2012; 21:402-6.
132. Séguret F, Ferreira C, Cambou JP, Carrière I, Thomas D. Changes in hospitalization rates for acute coronary syndrome after a two-phase comprehensive smoking ban. Eur J Prev Cardiol. 2014; 21:1575-82.
133. Sichieri R, Paula Trotte A, de Souza RA, Veiga GV. School randomised trial on prevention of excessive weight gain by discouraging students from drinking sodas. Public Health Nutr. 2009; 12:197-202.
134. Variyam JN, Cawley J. Nutrition labels and obesity: National Bureau of Economic Research2006.
135. Drichoutis AC, Nayga Jr RM, Lazaridis P. Can nutritional label use influence body weight outcomes? Kyklos. 2009; 62:500-25.
136. Kang E. Assessing Health Impacts of Pictorial Health Warning Labels on Cigarette Packs in Korea Using DYNAMO-HIA. J Prev Med Public Health. 2017; 50:251-61.

137. Basu S, Glantz S, Bitton A, Millett C. The effect of tobacco control measures during a period of rising cardiovascular disease risk in India: a mathematical model of myocardial infarction and stroke. PLoS Med. 2013; 10:e1001480.
138. Jia P, Li M, Xue H, Lu L, Xu F, Wang Y. School environment and policies, child eating behavior and overweight/obesity in urban China: the childhood obesity study in China megacities. Int J Obes (Lond). 2017; 41:813-9.
139. Jan C, Lee M, Roa R, Herrera V, Politis M, Motta J. The association of tobacco control policies and the risk of acute myocardial infarction using hospital admissions data. PloS one. 2014; 9:e88784-e.
140. Gallet CA, List JA. Cigarette demand: a meta-analysis of elasticities. Health Economics. 2003; 12:821-35.
141. Chaloupka FJ, Yurekli A, Fong GT. Tobacco taxes as a tobacco control strategy. Tobacco Control. 2012; 21:172.

Appendix Table A. Search strategy

A-1.Data base: PubMed

("public polic*"[tiab] OR "social polic*"[Title/Abstract] OR "economic polic*"[Title/Abstract] OR "fiscal polic*"[Title/Abstract] OR "price polic*"[Title/Abstract] OR "excise duty*"[Title/Abstract] OR "tax"[Title/Abstract] OR "taxes"[Title/Abstract] OR "taxation"[Title/Abstract] OR "subsid*"[Title/Abstract] OR "regulatory polic*"[Title/Abstract] OR "legal polic*"[Title/Abstract] OR "restriction*"[Title/Abstract] OR "ban"[Title/Abstract] OR "label*"[Title/Abstract] OR "packag*"[Title/Abstract] OR "cessation"[Title/Abstract] OR "school polic*"[Title/Abstract] OR "education*"[Title/Abstract] OR "awareness"[Title/Abstract] OR "nutrition polic*"[Title/Abstract] OR "nutrition program*"[Title/Abstract] OR "pictorial warning label*"[Title/Abstract]) AND ("sugar sweetened beverage*"[Title/Abstract] OR "beverage*"[Title/Abstract] OR "soft drink*"[Title/Abstract] OR "tobacco"[Title/Abstract] OR "smoking"[Title/Abstract] OR "alcohol"[Title/Abstract] OR "dietary sugar"[Title/Abstract] OR "sugar"[Title/Abstract] OR "salt"[Title/Abstract] OR "junk food"[Title/Abstract] OR "fat food"[Title/Abstract] OR "unhealthy food"[Title/Abstract] OR "sugary food"[Title/Abstract] OR "salty food"[Title/Abstract] OR "trans fats"[Title/Abstract]) AND ("Cardiovascular diseas*"[Title/Abstract] OR "coronary heart diseas*"[Title/Abstract] OR "obesity"[Title/Abstract] OR "diabetes"[Title/Abstract] OR "overweight"[Title/Abstract] OR "Body Mass Index"[Title/Abstract] OR "hypertension"[Title/Abstract] OR "hyperlipidemia"[Title/Abstract] OR "Stroke"[Title/Abstract] OR "Ischemic stroke"[Title/Abstract] OR "Acute myocardial"[Title/Abstract] OR "infarction"[Title/Abstract] OR "Angina"[Title/Abstract] OR "Acute coronary syndrome"[Title/Abstract])

A-2. Database: MEDLINE (Ovid)

	Searches
1	(taxes[Title/Abstract]) OR taxes[Text Word]
2	(taxation[Title/Abstract]) OR taxation[Text Word]
3	(excise dut*[Title/Abstract]) OR excise dut*[Text Word]
4	(fiscal*[Title/Abstract]) OR fiscal*[Text Word]
5	(economic polic*[Title/Abstract]) OR economic polic*[Text Word]
6	(regulatory polic*[Title/Abstract]) OR regulatory polic*[Text Word]
7	(subsidy[Title/Abstract]) OR subsidy[Text Word]
8	(subsidies[Title/Abstract]) OR subsidies[Text Word]
9	(legal polic*[Title/Abstract]) OR legal polic*[Text Word]
10	(labelling[Title/Abstract]) OR labelling[Text Word]
11	(labeling[Title/Abstract]) OR labeling[Text Word]
12	(packaging[Title/Abstract]) OR packaging[Text Word]

13	(school polic*[Title/Abstract]) OR school polic*[Text Word]
14	(educational polic*[Title/Abstract]) OR educational polic*[Text Word]
15	(nutrition polic*[Title/Abstract]) OR nutrition polic*[Text Word]
16	(food polic*[Title/Abstract]) OR food polic*[Text Word]
17	(marketing[Title/Abstract]) OR marketing[Text Word]
18	(smoking polic*[Title/Abstract]) OR smoking polic*[Title/Abstract]
19	(tobacco polic*[Title/Abstract]) OR tobacco polic*[Text Word]
20	(alcohol polic*[Title/Abstract]) OR alcohol polic*[Text Word]
21	(smoking ban*[Title/Abstract]) OR smoking ban*[Text Word]
22	(commitment contract[Title/Abstract]) OR commitment contract[Text Word]
23	(workplace polic*[Title/Abstract]) OR workplace polic*[Text Word]
24	(dietary sugar[Title/Abstract]) OR dietary sugar[Text Word]
25	(sugar sweetened beverage*[Title/Abstract]) OR sugar sweetened beverage*[Text Word]
26	(soft drink*[Title/Abstract]) OR soft drink*[Text Word]
27	(junk food*[Title/Abstract]) OR junk food *[Text Word]
28	(salty food*[Title/Abstract]) OR salty food *[Text Word]
29	(sugary food*[Title/Abstract]) OR sugary food *[Text Word]
30	(sugar tax*[Title/Abstract]) OR sugar tax*[Text Word]
31	(sugar polic*[Title/Abstract]) OR sugar polic*[Text Word]
32	(obesity[Title/Abstract]) OR obesity[Text Word]
33	(diabetes[Title/Abstract]) OR diabetes[Text Word]
34	(overweight[Title/Abstract]) OR overweight[Text Word]
35	(Body Mass Index[Title/Abstract]) OR Body Mass Index[Text Word]
36	(hypertension[Title/Abstract]) OR hypertension[Text Word]
37	(hyperlipidemia[Title/Abstract]) OR hyperlipidemia[Text Word]
38	(cardiovascular*[Title/Abstract]) OR cardiovascular*[Text Word]
39	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31
40	32 or 33 or 34 or 35 or 36 or 37 or 38
41	39 and 40

Appendix Table B. JBI's risk of bias check list for studies

1: Cross sectional study checklist

Study authors	1.Were the criteria for inclusion in the sample clearly defined?	2.Were the study subjects and the setting described in detail?	3.Was the exposure measured in a valid and reliable way?	4.Were objective, standard criteria used for measurement of the condition?	5.Were confounding factors identified?	6.Were strategies to deal with confounding factors stated?	7.Were the outcomes measured in a valid and reliable way?	8.Was appropriate statistical analysis used?
Barnett et. al (2008)	Yes	Yes	Yes	Yes	Yes	partially	Yes	Yes
Baron -Adesi et. al (2006)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Barone-Adesi et. al (2011)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Barr et. al (2012)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Barrientos-Gutierrez et al. (2017)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Bartecchi et. al (2006)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Basu et al (2014)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Binswanger et. al (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bonetti et. Al (2011)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Briggs et al (2013)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Briggs et al (2013)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Manyema et al (2014)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Bruintjes G et al. (2011)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Cesaroni et. al (2008)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Christensen et. al (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cox et. al (2014)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Cronin et. al (2012)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
D. Ferrante et. al (2011)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Dharmasena & Capps (2012)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Di Valentino et. al (2014)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Dove et. al (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fletcher et al (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fletcher et al (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fletcher et al (2010)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Finkelstein et al. (2010)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Finkelstein et al. (2013)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Galan et. al (2015)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Galan et. al (2018)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Gambaryan et. al (2018)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Gasparrini A et. al (2009)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Gaudreau et. al (2013)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Gortmaker et al. (2015)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Gupta R et. al (2011)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Hahn et. al (2011)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Herman and Walsh (2011)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Hurt et. al (2012)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Jan et. al (2014)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Juster, H.R., et. al (2007)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

Kang E (2017)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Kent BD et. al (2012)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Khuder S A et. al (2007)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Kristensen et al (2014)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Lemestra et. al (2008)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Lhachimi et al (2012)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Lin et al. (2011)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Liu et. al (2008)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Long et al. (2015)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
M. Sims et. al (2010)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Manyema et al. (2015)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Manyema et al. (2016)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Masse et al(2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mellor (2011)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Moraros et. al (2010)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Naiman et. al (2010)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Ong and Glantz (2004)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Pell et. al (2008)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Penalvo et al (2017)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Powell et al (2009)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rodu B et. al (2012)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
R.Lopez and K Fantuzzi (2012)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Ruff et al. (2015)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Sargent JD et. al (2012)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Sargent RP et. al (2004)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Schmucker et. al (2013	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Sebrié et. al (2013)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Seguret et. al (2013)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Sen A et. al (2010)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Seo & Lee (2012)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Sacks et al (2011)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Sanchez-R et al (2016)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Schroeter et. al. (2008)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Schwendicke et. al(2017)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Smith et al (2010)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Shetty K. D. et. al (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Stallings-Smith et. al (2013)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Strum et al (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tranche et. al (2008)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Vasselli S et. al (2008)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Veerman et al. (2016)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Villabi. J R et. al (2009)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Villalbı JR et. al (2011)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Weaver et. al (2018)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Wang et al (2012)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes

2: Cohort studies

Criteria	1	2	3	4	5	6	7	8	9	10	11
Study authors	Were the two groups similar and recruited from the same population?	Were the exposures measured similarly to assign people to both exposed and unexposed groups	Was the exposure measured in a valid and reliable way?	Were confounding factors identified?	Were strategies to deal with confounding factors stated?	Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Were the outcomes measured in a valid and reliable way?	Was the follow up time reported and sufficient to belong enough for outcomes to occur?	Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	Were strategies to address incomplete follow up utilized?	Was appropriate statistical analysis used?
Mayne et. al (2018)	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes

3: Quasi Experimental Study

Criteria	1	2	3	4	5	6	7	8	9
Study authors	Is it clear in the study what is the ‘cause’ and what is the ‘effect’ (i.e. there is no confusion about which variable comes first)?	Were the participants included in any comparisons similar?	Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Was there a control group	Were there multiple measurements of the outcome both pre and post the intervention/exposure ?	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Were the outcomes of participants included in any comparisons measured in the same way?	Were outcomes measured in a reliable way?	Was appropriate statistical analysis used?
Bauhoff (2014)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Baum (2009)	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Delcher et al. (2012)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Humair et. al (2014)	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Moraros et. al (2010)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maldonado & Wagenaar (2010)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Seo and Torabi (2007)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vicedo Cabrera et al (2016)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Wagenaar et al. (2009)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

4: Randomized control studies

Criteria	1	2	3	4	5	6	7	8	9	10	11	12
Study	Was true randomization used for assignment of participants to treatment groups?	Was allocation to treatment groups concealed?	Were treatment groups similar at the baseline?	Were participants blind to treatment assignment?	Were those delivering treatment blind to treatment assignment?	Were outcomes assessors blind to treatment assignment?	Were treatment groups treated identically other than the intervention of interest?	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Were participants analyzed in the groups to which they were randomized?	Were outcomes measured in the same way for treatment groups?	Were outcomes measured in a reliable way	Was appropriate statistical analysis used?
Sichieri et al (2009)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Supplementary Tables

Supplementary Table 1: Fiscal policy-related study characteristics and key findings

Authors and year	Country setting	Participants sampling universe	Description of the intervention	Nature of intervention: Proposal or actual	Outcomes	Study design	Measures of intervention effect	Study findings and conclusions
Studies of SSBs-related fiscal policies								
Barrientos et al. (2017)	Mexico	People of age 20+	1-peso-perlitre increase in SSBs tax	Proposal	BMI; Obesity; Diabetes	Simulation	Mean prevalence rate	By 2030, the tax would prevent 86 to 134 thousand cases of diabetes. The SSBs tax in Mexico is expected to produce sizable and sustained reductions in obesity and diabetes, and increasing the tax could produce larger benefits
Basu et al (2014)	India	General population	20% increase in SSBs excise tax	Proposal	Obesity; Type 2 diabetes	Economic-epidemiological simulation model	Mean prevalence	The tax would reduce overweight and obesity prevalence by 3.0% and type 2 diabetes incidence by 1.6% among various Indian subpopulations over the period 2014–2023. Sustained SSB taxation at a high tax rate could mitigate rising obesity and type 2 diabetes in India among urban and rural subpopulations
Briggs et al (2013)	United Kingdom	Adults aged 16 and over	20% increase in SSBs tax	Proposal	Overweight; Obesity	Simulation	Prevalence rate	The tax was estimated to reduce the number of obese adults by 1.3% and who are overweight by 0.9%. The predicted reductions in prevalence of obesity for income thirds 1 (lowest income), 2, and 3 (highest income) were 1.3%, 0.9%, and 2.1%. Taxation of SSBs is a promising population measure to target population obesity, particularly among younger adults
Briggs et al (2013)	Ireland	General population	10% increase in SSBs tax	Proposal	Obesity; Overweight	Observational	Prevalence rate	10% tax is predicted to reduce the percentage of the obese adult population BMI ≥30 kg/m2 by 1.3%, and BMI ≥ 25 kg/m2 by 0.7%. A tax on SSBs would have a small but meaningful effect on obesity. From a health prospective the tax will predominantly affect younger adults who are the main consumers of SSBs
Dharmasena & Capps (2012)	United States	General population	20% increase in SSBs tax	Proposal	Body weight	Observational	Marginal effects from regression models	The reduction in the body weight is estimated to be between 1.54 and 2.55 lb per year at maximum. The substitutionary nature of interrelationships among various types of non-alcoholic SSBs in assessing the effect of the tax need to be considered
Finkelstein et al. (2010)	United States	General Population	20% and 40% tax	Proposal	Body weight	Simulation	Multivariate regression models	The tax would result in annual weight losses to an average of 0.32 and 0.59 kg per person for a 20% and a 40% tax, respectively. Large taxes on SSBs have the potential to positively influence weight outcomes, especially for middle-income households
Finkelstein et al. (2013)	United States	General Population	20% SSB tax	Proposal	Body weight	Simulation	Regression models	SSB tax would result an average weight loss of 1.6 pounds during the first year of implementation and a cumulated weight loss of 2.9 pounds over 10 years. Government intervention to decrease consumption on SSBs and other foods with a large degree of added sugars and added fats may be justified on economic grounds
Fletcher et al (2010)	United States	School-aged children, 5th and 8th grade	SSB tax (2.1% net higher than other foods)	Actual	Obesity	Cross Sectional	Mean difference	No mean difference in the children's weight between the States with and without SSB tax. No evidence of SSB tax at reducing children's BMI and obesity. Imposing higher tax rates may increase their effectiveness on obesity
Fletcher et al (2010)	United States	Children and adolescents, aged 3 to 18	State-level soda Taxes (average tax rate varying between 1.5% and 2.3%)	Actual	BMI; Overweight; Obesity	Cross Sectional	Marginal effects from regression model	Soft drink taxes have no influence on BMI, overweight, obesity among children and adolescents. Soft drink taxation, as currently practiced in the United States, leads to only a moderate reduction in soft drink consumption by children and adolescents, as this reduction is completely offset by increases in consumption of other high calorie drinks

Fletcher et al (2010)	United States	Adults	State-level soda Taxes (Incremental tax rate 0.50 and total tax rate 0.86)	Actual	BMI; Overweight; Obesity	Cross Sectional	Marginal effects from regression model	A 1 percentage point increase in the state SSB tax rate leads to a decrease in BMI of 0.003 point (p<0.001) and a decrease in overweight 0.02 (p<0.001) percentage point, but no effect on obesity. SSBs taxes influence BMI, but that the impact is small in magnitude
Gortmaker et al (2015)	United States	General population and children	$0.01 per ounce increase in SSB excise tax	Proposal	BMI	Simulation	Mean difference	Per person BMI unit reduction is 0.08 in all age groups, and 0.16 in 2–19 years age group. SSB taxation can be a viable cost-effective intervention to treat obesity
Kristensen et al (2014)	United States	Children (6–12 years) and adolescents (13–18 years)	$0.01/ounce increase in SSB excise tax	Proposal	Obesity	Simulation	Mean difference	The SSB excise tax would reduce obesity by 2.4 percentage points among adolescents aged 13–18 years. For reducing the childhood obesity prevalence, a national level $0.01/ounce SSB excise tax is the best option
Lin et al. (2011)	United States	Children and adolescents (2-19 year) and adults (20 and older)	20% increase in SSBs tax	Proposal	Bodyweight	Simulation	Marginal effects from regression model	The reduction in body weight in one year predicted by the static model is 1.6 kg and the dynamic model is 0.97 kg. Exploring heterogeneous demand elasticities could be useful for evaluating alternative policy options
Long et al. (2015)	United States	General population	A $0.01/ ounce increase in SSB excise tax	Proposal	BMI	Simulation	Mean difference	A $0.01/ounce SSB excise tax would reduce mean BMI by 0.16 units among youth and 0.08 units among adults. In the short term, the proposed SSB tax policy would likely reduce excess weight among both youth and adults while increasing potential revenue for health promotion
Manyema et al (2014)	South Africa	Adults aged 15 years and above	20% increase in SSBs tax	Proposal	Obesity	Mathematical simulation model	Prevalence rate	A 20% tax is predicted to reduce obesity by 3.8% in men and 2.4% in women. As one component of a multi-faceted effort to prevent obesity, taxing SSBs could reduce the burden of obesity, particularly in young adults
Manyema et al. (2015)	South Africa	Adults aged 15 years and older	20% increase in SSBs tax	Proposal	Type 2 diabetes	Simulation	Mean prevalence and incidence rates	Over 20 years, a 20% SSB tax could reduce diabetes incident cases by 106 000 in women and by 54 000 in men. Fiscal policy on SSBs has the potential to mitigate the diabetes epidemic in South Africa
Manyema et al. (2016)	South Africa	Adults aged 15 years and older	20 % increase in SSBs tax	Proposal	Stroke	Simulation	Mean difference in incidence rate	SSB tax may avert approximately 72 000 deaths, 550 000 stroke-related health-adjusted life years. Fiscal policy has the potential to mitigate the growing burden of Stroke in South Africa and contribute to the achievement of the target set by the Department of Health to reduce relative premature mortality from non-communicable diseases by the year 2020
Penalvo et al (2017)	United States	People of age 25+	10 % and 30% increase in SSBs tax	Proposal	CVDs and diabetes deaths	Observational	Incidence rates from comparative risk assessment	Jointly altering prices of all seven dietary factors would prevent 23,174 cardiovascular disease and diabetes (CMD) deaths/ year. Modest taxes and subsidies for key dietary factors could meaningfully reduce cardiovascular disease and diabetes
Powell et al (2009)	United States	School-aged children, 8th, 10th, and 12th grade	State-level differences in SSB tax	Actual	BMI	Cross Sectional	Marginal effects from regression model	No significant association between state-level soda taxes and adolescent BMI. Only a weak economic and statistically significant effect between soda tax rates and BMI among teens at risk for overweight. Current state-level tax rates are not significantly associated with adolescent weight outcomes. It is likely that taxes would need to be raised substantially to detect significant associations between taxes and adolescent weight
Lopez and Fantuzzi (2012)	United States	General Population	10% SSB Tax	Proposal	Obesity	Simulation	Random coefficient logit model	The tax is estimated to reduce BMIs and obesity rates. Comprehensive program is needed rather than a stand-alone tax policy on SSBs to reduce obesity
Ruff et al. (2015)	United States	Adults	Calorie-based increase in SSB tax	Proposal	Bodyweight; Obesity	Simulation	Mean difference	Calorie reductions would result in a per-person weight loss of 0.46 kg in year 1 and 0.92 kg in year 10. Results showed consistent but no significant decreases in obesity prevalence. SSB taxes may be viable strategies to reduce obesity when combined with other interventions to maximize effects in the population

Sacks et al (2011)	Australia	Adult population	10% increase in junk food tax, including SSBs	Proposal	Obesity	Mathematical simulation model	Mean change	A 10% 'junk-food' tax including of SSBs was associated with a reduction of mean weight by 1.6 kg. Population-wide interventions such as taxes on unhealthy foods are likely to offer 'value for money' as obesity prevention measures
Sanchez-Romero et al(2016)	Mexico	Adults, aged 35-94 years	10 % increase in SSBs excise tax	Proposal	Diabetes; CHD; MI; Stroke	Simulation	Mean difference in incidence rate	The tax would result in about 189,300 fewer incident type 2 diabetes cases, 20,400 fewer incident strokes and MI, and 18,900 fewer deaths occurring from 2013 to 2022. While the long-term impact of Mexico's SSB tax is not yet known, these projections, based on observed consumption reductions, suggest that Mexico's SSB tax may substantially decrease morbidity and mortality from diabetes and CVD
Schroeter et. al. (2008)	United States	General Population	10% SSB tax	Proposal	Body weight	Simulation	Price weight elasticity.	10% tax would lead to a weight loss of 0.099% for an average man and 0.122% for an average woman. A tax on caloric soft drink will likely decrease body weights
Schwendicke et. al(2017)	Germany	Population aged 15-79 years	20% increase in SSBs sales tax	Proposal	Overweight; Obesity	Simulation	Mean difference in prevalence rate	The tax would decrease BMI, number of overweight individuals and obese individuals. An SSB tax could have significant impact on overweight and obesity, which could translate into substantial reductions of morbidity and mortality
Smith et al (2010)	United States	General population	20% increase in SSBs tax	Proposal	BMI; Overweight; Obesity	Simulation	Mean prevalence	The tax could reduce the overweight prevalence among adults (from 66.9 to 62.4%) and children (from 32.3 to 27.0%). The actual impacts of the tax would depend on many factors such as how the tax is reflected in consumer prices and the competitive strategies of manufacturers and food retailers
Sturm et al (2010)	United States	School-aged children, grade 5	SSBs tax, which is 3.5% points higher than other food tax	Actual	BMI	Cross Sectional	Marginal effects from regression model	Existing taxes on SSBs do not substantially affect obesity rates. To have a measurable effect on consumption and obesity, taxes need to be tied to consumption, and they need to be larger than the existing state variation in sales taxes
Veerman et al. (2016)	Australia	Adults aged 20 years and older	20% increase in SSBs tax	Proposal	Diabetes; Heart Diseases; Stroke	Simulation	Mean prevalence and incidence rates	The tax would reduce the number of new type-2 diabetes cases by approximately 800 per year. 25 years after the introduction of the tax, there would be 4,400 fewer prevalent cases of heart disease and 1,100 fewer persons living with the consequences of stroke. Governments should consider increasing the tax on sugared drinks to improve population health
Wan g et al (2012)	United States	Adults, aged 25–64	Penny-per-ounce increase in SSBs excise tax	Proposal	CHD; Diabetes; Strokes	Observational and simulation	Difference in incidence rate (from CHD Policy Model)	An increase in SSB tax would prevent 2.4 million diabetes person-years, 95,000 coronary heart events, 8,000 strokes, and 26,000 premature deaths. A modest tax on SSBs could reduce the adverse health burdens of obesity, diabetes, and CVDs
Studies of Tobacco-related fiscal policies								
Baum (2009)	United States	General population, aged 30 years	Cigarette tax over time (weighted mean of state cigarette tax of $0.618 per pack)	Actual	BMI; Obesity	Quasi-experimental	Average treatment effects from difference-in-differences model	The cigarette taxes have positive effects on BMI (0.355; p< 0.01) and obesity (0.106; p=0.062). The net benefit to society of increasing cigarette taxes may not be as large as previously thought
Liu et. al (2008)	United States	Population, aged 45 years and older	Cigarette excise tax	Actual	Heart and stroke morbidity	Cross Sectional	Marginal effects from regression model	No clear relationship between cigarette excise tax and morbidity rates of heart attack and stroke. Use of the cigarette excise tax may not be an effective means to prevent heart attack and stroke of the US population
Mellor (2011)	United States	Children	Cigarette tax ($0.50 / $0.52 per pack)	Actual	BMI	Cross Sectional	Marginal effects from regression model	Increase in cigarette taxes increase BMI in the children of smoking mothers, but do not increase the likelihood of obesity in children. Study findings are consistent with a causal mechanism in which higher cigarette costs reduce smoking and increase food expenditures and consumption in the household

Sen A et. al (2010)	Canada	General population	Provincial differences in cigarette tax in 2003 and 2005	Actual	Obesity	Cross Sectional	Marginal effects from regression model	A 10% increase in cigarette tax is significantly correlated with a 4–5% increase in the obese population. Health benefits from higher cigarette taxes and lower smoking might be partially offset by a corresponding increase in obesity levels
Studies of Alcohol-related fiscal policies								
Delcher et al. (2012)	United States	General population	Increase in alcohol tax	Actual	Alcohol-related mortalities including CVDs	Quasi-experimental (Interrupted time-series)	Structural parameters from ARIMA model	Alcohol-related disease mortality declined by 7.0% after a 1990 tax increase for spirits and beer. A spirits-only tax increase (in 1972) was not significantly associated with mortality. Small tax decreases on beer between 1996 and 2006 had no measurable effect on mortality. Doubling the beer tax from $0.11 to $0.22 per gallon, a return to New York State's 1990 levels, would decrease deaths by an estimated 250 deaths per year.
Lhachimi et al (2012)	European Union	General population	Increase in alcohol tax	Proposal	Stroke; IHD; Diabetes	Observational and dynamic modeling	Absolute difference to reference scenario of no increase in tax	A 20% increase alcohol prices would avert the cases of diabetes of 20,500 in men and 4,600 in women, and stroke of 14,600 in men and 71,000 in women. Increase in alcohol tax throughout the EU completely would lead to substantial gains in population health
Molina and Wagenaar (2010)	United States	General population	Increase in alcohol tax	Actual	Alcohol-related mortalities including CVDs	Quasi-experimental (Interrupted time-series)	Structural parameters from ARIMA, fixed effect and random effect models	The frequency of deaths caused by alcohol-related diseases (t=−2.73, p=.007) and the rate per population (t=−2.06, p=.04) declined significantly after the increase in alcohol taxes. The study findings underlines the role of tax policy as an effective tool for reducing deaths associated with alcohol use
Wagenaar et al. (2009)	United States	General population	Increase in alcohol tax	Actual	Alcohol-related mortalities including CVDs	Quasi-experimental (Interrupted time-series)	Structural parameters from ARIMA model	Immediately after the 1983 and 2002 alcohol tax increases in Alaska, the reductions in deaths caused by alcohol-related diseases were –29% (Cohen's d = –0.57) and –11% (Cohen's d = –0.52), respectively. Taxing alcoholic beverages is an effective public health strategy for reducing the burden of alcohol-related disease
Studies of other unhealthy products-related fiscal policies								
Sacks et al. (2011)	Australia	General population	10% increase in price of junk foods	Proposal	obesity	Simulation	Mean difference	Junk-food tax resulted in reduced mean weight: of 1.6 kg (95% UI: 1.5; 1.7)

Acronyms: BMI: body mass index; CVD: cardiovascular diseases; CHD: coronary heart diseases; SSBs: sugar sweetened beverages; MI; MI: myocardial infarctions

Supplementary Table 2: Regulatory policy-related study characteristics and key findings

Authors and year	**Country setting**	**Participants sampling universe**	**Description of the intervention**	**Nature of intervention: Proposal or actual**	**Outcomes**	**Study design**	**Measures of intervention effect**	**Study findings and conclusions**
Studies of SSBs-related regulatory policies								
Bauhoff (2014)	United States	School-aged children, grade 7 to 9	School nutrition policy of limiting soft drinks	Actual	Obesity	Quasi-experimental	Average treatment effects from pre-post difference-in-differences model	No significant decreases in obesity rates: 1.7 (β=-1.69, SE=1.57) for male and 1.2 (β=-1.18, SE=1.09) for female. The intervention was mostly ineffective at reducing the overweight or obesity, though it significantly decreased consumption of SSBs

Fletcher et al (2010)	United States	School-aged children, 5th and 8th grade	Restricting access to SSBs from vending machines	Actual	Obesity	Cross Sectional	Mean differences	No mean difference in the children's weight between the States with and without the policy of restricting access to vending machines on BMI score and obesity. No evidence of restricting access to vending machines at reducing children's obesity
Masse et al(2014)	Canada	Children (mean age 15 years, 48.1% females)	Limiting SSBs availability in school	Actual	Obesity	Cross Sectional	Odds ratio from mixed-effect regression model	Availability of SSBs at school were positively associated with student obesity (OR = 1.50) but not with overweight. Availability and consumption of SSBs, but not less healthful foods, at school were associated with higher adolescent obesity
Seo and Lee (2012)	United States	Public secondary schools students	Limiting the availability of soda pop in schools	Actual	Overweight	Cross Sectional	Odds ratio	Children who attended schools where soda pop (OR = 3.79) could be purchased were more likely to be obese. School nutrition policy is associated with the children's overweight status
Studies of Tobacco-related regulatory policies								
Barone - Adesi et. al (2006)	Italy	Patients admitted to hospital	In January 2005, a national smoking ban was implemented on all indoor public places, including cafe´s, bars, restaurants, and discos	Actual	Acute myocardial infarction (AMI)	Cross Sectional	Rate ratios	Among persons aged under 60, the number of admissions for AMI decreased significantly after the introduction of the ban. Smoking regulations may have important short-term effects on health
Barone-Adesi et. al (2011)	Italy	Patients admitted to hospital	In January 2005, a national smoking ban was implemented on all indoor public places, including cafe´s, bars, restaurants, and discos	Actual	Acute coronary events	Cross Sectional	Rates ratio using mixed-effect regression model	The smoking ban was associated with 4% reduction in hospital admissions for acute coronary events among persons aged less than 70 years (rate ratio: 0.96), but not among persons aged at least 70 years (rate ratio 1.00). Smoke-free policies can constitute a simple and inexpensive intervention for the prevention of cardiovascular diseases
Barnett et. al (2008)	New Zealand	Patients, aged 55-74 admitted to hospital	In December 2004, the Smoke Free Environments Act 2003 Act applied to all workplaces and special focus was given on bars and restaurants	Actual	AMI	Cross Sectional	Percentage change in incidence	A 5% reduction in AMI admissions in the post-ban period; the 55-74 age group recorded the greatest decrease in admissions (9%) and this figure rose to 13% among never smokers in this group. Study recognize that smoke free legislation has the potential to reduce costly acute hospital admissions, but further research is needed to evaluate the longer-term effects of such legislation
Barr et. al (2012)	United States	Patients hospital admission rate	Between January 2000 and December 2007, several US counties implemented simultaneous smoking bans in bars, restaurants, and workplaces	Actual	AMI	Cross Sectional	Changes in mean rate using Poisson regression model	The percentage decrease in AMI rates was only 5% when using a linear trend, which is smaller than estimates from previous studies in the general population. Though there was already substantial evidence that smoking bans can benefit the public health, no statistically significant evidence of a smoking ban-related decrease in AMI hospital admission rates in the Medicare population
Bartecchi et. al (2006)	United States	Patients admitted to hospital	In July 2003, Pueblo, Colo geographically isolated community from US introduced the ordinance prohibiting smoking inside the workplace and all buildings open to the public	Actual	AMI	Cross Sectional	Relative risk using Poisson regression model	A reduction in AMI hospitalizations among Pueblo city limit residents (RR: 0.73) the area where the ordinance applied, and no significant changes in AMI rates among residents outside the city limits. A significant decline in hospital admissions for AMI after the institution of a comprehensive smoke-free ordinance was found, which supports previous data from a smaller study
Binswanger et. al (2014)	United States	All state prisons in the United States	Since 1993, various prison tobacco control policies have been introduced, including prohibiting smoking cigarettes and/or all tobacco products, including smokeless tobacco	Actual	CVD deaths	Cross Sectional	Incidence rate by Poisson regression model	Prisons that implemented smoking bans had a 9% reduction in smoking related CVD deaths. Prison tobacco control policies are associated with reduced mortality in settings were the ban can be strictly enforced

Bonetti et. Al (2011)	Switzerland	Patients admitted to hospital	In March 2008, a smoking ban in public buildings, including cafés, bars, and restaurants, became effective in the Canton of Graubuenden	Actual	AMI	Cross Sectional	One-way ANOVA and χ^2 test	The number of patients with AMI in the second year after adoption of the smoking ban was similar to that in the first year of the ban and significantly lower than in each of the two years preceding the ban. Compared with the two years preceding the implementation of a smoking ban, the incidence of AMI remained significantly reduced in the second year of the ban in Graubünden, whereas no similar reduction was seen in a comparable area without smoke-free legislation
Bruintjes et al. (2011)	Canada	Patients admitted to hospital	In December 2003, Greeley City Council enacted smoking ban in restaurants, bars, bowling alleys, bingo halls, and smoking in outdoor public gathering places	Actual	AMI	Cross Sectional	Mean incidence using Poisson regression model	A smaller, non-significant decrease in in AMI admissions (RR 0.83), and was more pronounced among smokers (RR 0.44) than nonsmokers (RR 0.86). A smoking ordinance was associated with a decrease in AMI hospitalizations of a magnitude similar to previous reports but could not be distinguished from the adjacent geographic area
Cesaroni et. al (2008)	Italy	General population, aged 35 to 84 years	In January 2005, a national smoking ban was implemented on all indoor public places, including cafe´s, bars, restaurants, and discos	Actual	Acute coronary events	Cross Sectional	Rate ratio using Poisson regression analysis	Significant reduction in acute coronary events found among persons aged 35-64 years and 65- 74 year. No evidence was found of an effect among the very elderly. The size of the effect of reduction in acute coronary events was consistent with the pollution reduction observed in indoor public places and with the known health effects of passive smoking
Christensen et. al (2014)	Denmark	Patients admitted to hospital for AMI	In August 2007, a national smoking ban in the indoor public places were implemented, with exceptions were made for Pubs/ bars under 40 m^2 where no food is served, one-man offices, private schools, and psychiatric wards	Actual	AMI	Cross Sectional	Relative risk using Poisson regression model	Significant reductions in hospital admission for AMI were found one year after the ban (RR) =0.77, and two years after the ban (RR=0.77). However, the reduction was found one year before the ban too (RR=0.86). The results differ from most results found in similar studies throughout the world and may be explained by the incremental enactment of smoking bans in Denmark prior to the nationwide bans of 2007
Cox et. al (2014)	Belgium	People of age 30+	Smoking ban was introduced in two phases: smoking ban in workplace and public places in January 2006, and smoking ban in restaurant in January 2007	Actual	AMI mortality	Cross Sectional	Relative risk using Poisson regression model	The smoking ban at work was associated with a decrease in AMI mortality rates for women younger than 60 years of age compared with an effect of −13.1% for male counterparts. Smoking ban interventions are associated with reductions in the population rate of myocardial mortality
Cronin et. al (2012)	Ireland	Patients aged≥18 years admitted to hospital	In March 2004, smoking ban implemented at workplaces	Actual	ACS	Cross Sectional	Percentage change in incidence	A significant 12% reduction in ACS admissions in the year following implementation of the ban but no change in the following year; however, a further 13% reduction was observed in the second year. A national ban on smoking in public places was associated with an early significant decrease in hospital admissions for ACS, suggesting a rapid effect of banning smoking in public places on ACS
Ferrante et. al (2011)	Argentina	Patients admitted to hospital	In 2006, Santa Fe implemented a 100% smoke-free law and Buenos Aires implemented a partial law with designated smoking areas and exceptions	Actual	ACS	Cross Sectional	Marginal effects using linear regression model	An immediate and persistent decrease of 2.5 and 0.26 admissions per 100000 per month in ACS admissions was observed. A 100% smoke-free law was more effective than a partial restriction law in reducing ACS admissions, and an immediate effect was followed by a sustained decrease in ACS admissions
Di Valentino et. al (2014)	Switzerland	Patients admitted to hospital	Swiss Cantons, Ticino introduced smoking ban in public places in April 2007 and prohibited cigarette advertisement in May 2009. Basel City prohibited	Actual	ST-elevation MI (STEMI)	Cross Sectional	Mean Incidence	The mean incidence of STEMI admissions during the 3 pre-ban years was significantly higher than the incidence of admissions in each of the 3 post-ban years. Study demonstrated a long-term post-ban reduction in the incidence of STEMI admissions among the overall population

			cigarette advertisement in January 2005					
Dove et. al (2010)	United States	Patients, aged 35 years and older, admitted to hospital	In 2003, Boston, Cambridge, and Somerville, and in July 2004 Massachusetts implemented comprehensive smoking bans at all workplaces, restaurants, and bars	Actual	Acute Myocardial Infarction (AMI)	Cross Sectional	Marginal effect using Poisson regression models	The AMI mortality rate decreased by 7.4% after implementation of the state law; the effect of the state ban was modest (–1.6%) in the first 12 months after implementation but much larger after the first 12 months (–18.6%). The study finding add to the evidence suggesting that smoke-free air laws are associated with lower rates of AMI
Galan et. al (2015)	Spain	Adults, aged 20 years and older	In January 2006, smoking ban was introduced at workplace and partial ban on restaurants, bars and any establishment serving food and beverages	Actual	CVD	Cross Sectional	Marginal effects using additive Poisson with over dispersion	No significant changes in hospital admission rates was found in the city of Madrid, but there was decline in the rates by 10.2% for cerebrovascular diseases in the city of Barcelona. The substantial variability in effects between the two cities of Madrid and Barcelona lends strong support for a nationwide study to assess the overall effect of a smoking ban and identify the causes of the observed heterogeneity
Galan et. al (2018)	Spain	Patients admitted to hospital	In January 2006, smoking ban was introduced at workplace and partial ban on restaurants, bars and any establishment serving food and beverages	Actual	AMI, IHD, and CVD	Cross Sectional and simulation	Changes in the admission rates	After the comprehensive ban immediate changes were –2.3% for AMI, –2.6% for IHD, and –0.8 for CVD (P>.05), only to return to pre comprehensive ban values 1 year later. Hospital admissions due to AMI, IHD, or CVD showed significant decreases immediately after the implementation of the comprehensive ban, but these reductions disappeared at the 1-year evaluation
Gasparrini et. al (2009)	Italy	Patients admitted to hospital, aged 30-64 years	In January 2005, a national smoking ban was implemented on all indoor public places, including cafe´s, bars, restaurants, and discos	Actual	AMI	Cross Sectional	Relative risk using Poisson regression model	The estimate of the effect of the ban was highly sensitive to the model specification and to the effects of unaccounted factors. The model with linear time trend estimated a decrease of 5.4%, this effect completely disappeared once the linearity assumption was relaxed. Several arguments which are put forward to inspect the causal relation between smoking bans and AMI indicate that the plausible effects could be lower than the estimates reported so far
Gaudreau et. al (2013)	Canada	General population	In June 2003, Prince Edward Island (PEI) enacted a province-wide smoking ban in public places and workplaces.	Actual	Hospital admission rates due to AMI and Angina	Cross Sectional	Mean and trend from time-series model	Hospital admission rates per 100,000 person-months: i) reduced by 5.92 cases in AMI immediately after the smoking ban; ii) was reduced by 20.44 cases in angina for men in the 67 months after the smoking ban. A comprehensive smoking ban reduced the overall mean number of acute myocardial infarction admissions and the trend of angina hospital admissions
Gupta et. al (2011)	United States	Patients admitted to hospital	In May 1995, Kanawha County implemented modest smoking regulation of prohibiting smoking in all enclosed public places	Actual	ACS	Cross Sectional	Marginal effect using Poisson regression model	The incidence of hospital admissions consistently declined, and this change was most pronounced among nonsmokers, people without diabetes, and women, compared with their respective counterparts. In the presence of a smoking legislation, a consistent decline in incidence of hospital admissions for ACS can be demonstrated
Hahn et. al (2011)	United States	Patients admitted to hospital	In April 2004. Lexington-Fayette (Kentucky) Urban County Government implemented smoking ban in restaurants, bars, bowling alleys, bingo halls, convenience stores, laundry facilities, and other businesses open to the public	Actual	AMI	Cross Sectional	Marginal Effect using Poisson regression model	A 23% decline in AMIs among women but not among men. Given the study findings of the effect with gender differences, enacting smoke-free laws that cover all places of employment laws may extend protection against AMIs to female and male workers

Herman and Walsh (2011)	United States	Patients admitted to hospital	In May 2007, Arizona introduced comprehensive statewide smoking ban in all indoor areas of workplaces, restaurants, and bars	Actual	AMI; angina; stroke	Cross Sectional	Marginal effect using Poisson regression model	Statistically significant reductions in hospital admissions were seen for AMI, angina, and stroke in counties with no previous bans over what was seen in counties with previous bans. Arizona's statewide smoking ban decreased hospital admissions for AMI, stroke, and angina
Humair et. al (2014)	Switzerland	Patients, aged 16 and over, admitted to the hospital	Canton of Geneva implemented stepwise smoking ban: first ban in July 2008 including prohibition of smoking in public places and private premises accessible to public, and after temporary suspension, implementation of a permanent smoking ban in October 2009	Actual	Acute coronary syndrome (ACS); Ischemic stroke	Pre-post study design	Incidence rate ratios (IRR)	The smoking ban was associated with decreases in hospitalization rate for acute coronary syndromes (IRR = 0.90. Admissions for ischemic stroke did not significantly change. A legislative smoking ban was followed by a strong decrease in acute coronary syndrome
Hurt et. al (2012)	United States	Patients admitted to hospital and death registration	Olmsted County, Minnesota implemented smoke-free restaurant ordinance in 2002, and the ordinance covered all workplaces including bars In 2007	Actual	MI; Sudden cardiac death (SCD)	Cross Sectional	Marginal effect using Poisson regression model	The incidence of MI declined by 33% and the incidence of SCD declined by 17%.A substantial decline in the incidence of MI and SCD was observed after smoke-free laws were implemented, the magnitude of which is not explained by community co-interventions or changes in cardiovascular risk factors with the exception of smoking prevalence
Juster et. al (2007)	United States	Persons aged 35 years and older	In July 2003, New York implemented statewide comprehensive smoking ban in all workplaces including restaurants and bars	Actual	AMI; Stroke	Cross Sectional	Marginal effects using regression model	An 8% fewer hospital admissions for acute MI, but no reduction in the number of hospital admissions for stroke. Smoking ban has positive impact on reducing the hospital admission rates for AMI but not for stroke
Kent et. al (2012)	Ireland	Hospital admissions of patients aged 20 to 70 years	In March 2004, nationwide smoking ban in all workplaces and indoor public locations	Actual	ACS	Cross Sectional	Marginal effect using Poisson regression model	Admissions with ACS declined (adjusted RR, 0.82), but not stroke (adjusted RR, 0.93; P = .60). The implementation of a nationwide workplace smoking ban is associated with a decline in admissions with ACS among specific age groups
Khuder et. al (2007)	United States	Patients admitted to hospital	In March 2002, Bowling Green, Ohio introduced clean indoor air ordinance including smoking ban at workplaces and public places	Actual	Coronary Heart Disease	Cross Sectional	incidence rate using ARIMA model	A reduction of coronary heart disease by 39% after 1 year and by 47% after 3 years following the implementation of the ordinance. Clean indoor air ordinances lead to a reduction in hospital admissions for coronary heart disease
Kvasnicka et. al (2018)	Germany	General population	In 2007, smoking ban at federal government office buildings and public transport	Actual	CVDs	Panel data analysis	Marginal effect using fixed effect model.	Smoking bans in bars and restaurants have been effective in preventing hospital admissions (-2.1%) due to cardiovascular diseases. Sizable public health benefits can be achieved from such an anti-smoking policy even if the laws for exemptions and enforcement are imperfect
Lemestra et. al (2008)	Canada	Patients admitted to hospital	In July 2004, Saskatoon initiated a public smoking ban in outdoor public places	Actual	AMI	Cross Sectional	Incidence rate ratio	The age-standardized incidence rate of AMI fell from 176.1 (July 2000 to June, 2004) to 152.4 cases per 100,000 population (July 2004 to June 2005). Public smoking ban in Saskatoon, Canada, is associated with reduced incidence rates of acute MI
Sims et. al (2010)	United Kingdom	Patients admitted to hospital	In July 2007, England implemented smoke free legislation of prohibiting smoking in all enclosed workplaces and public places	Actual	MI	Cross Sectional	Percentage change using Poisson regression model	Small but significant reduction in the number of emergency admissions for myocardial infarction after the implementation of smoke-free legislation (−2.4%). The considerably smaller decline in admissions observed in England, probably reflects aspects of the study design and the relatively low levels of exposure to secondhand smoke before the legislation

Mayne et. al (2018)	United States	Adults age 18-30	100% smoke-free policies in bars, restaurants, and/or no hospitality workplaces in State, county, and local-level Implemented during 1990-2014	Actual	Incidence of CVDs	Cohort study	Hazard ratio using extended cox regression model	Participants living in an area with smoke-free policy had lower risk of incidence of CVDs compared to those in areas without smoke-free policies. 100% smoke-free policies are associated with lower risk of cardiovascular disease among middle-aged adults
Moraros et. al (2010)	United States	Patients, over the age of 18, admitted to hospital	In 2002, Delaware introduced smoking ban in workplace and indoor public places	Actual	AMI	Cross Sectional	Marginal effect using Poisson regression model	A 4.7% reduction in AMI admissions for Delaware residents where the ordinance applied, and over the same time period, there was negligible change in the incidence of AMI for non-Delaware residents. The comprehensive non-smoking ordinance effectively was associated with a statistically significant decrease in the incidence of AMI
Naiman et. al (2010)	Canada	Patients aged 45 years and older	In May 2006, comprehensive Toronto province wide smoking ban	Actual	AMI; Angina; Ischemic stroke	Cross Sectional	Marginal effects using time-series regression model	Hospital admissions related to CVDs decreased by 39%; largest declines were seen after the phase of the ban affecting restaurants came into effect, and included a 17% decrease in the crude rate of admission because of AMI. Legislated bans on smoking are associated with reduced rates of admission to hospital, reinforcing the value of such bans for public health
Ong and Glantz (2004)	United States	Indoor workers	Smoke-free of all workplaces	Proposal	MI; stroke	Observational and simulation	Incidence rates	Making all workplaces smoke free would prevent about 1500 MI and 350 strokes within 1 year, and 6250 MI and 1270 strokes after 7 years. Making all U.S. workplaces smoke free would result in considerable health benefits
Pell et. al (2008)	United Kingdom	Patients admitted to hospital	In March 2006, smoking ban in all enclosed public places in Scotland	Actual	ACS	Cross Sectional	Percentage change in incidence	The number of admissions for ACS decreased by 17%, with 14% reduction among smokers and a 19% reduction among former smokers, and a 21% reduction among non-smokers. The number of admissions for acute coronary syndrome decreased after the implementation of smoke-free legislation
Rodu et. al (2012)	United States	Mortality Rate	Between the period of 1995 and 2003, statewide smoking ordinance in six states, where each state has different prohibition, but mainly including indoor public places and workplace	Actual	AMI	Cross Sectional	Marginal effect using regression model	Target-year declines in AMI mortality in California (2.0%), Utah (7.7%) and Delaware (8.1%) were not significantly different from the expected declines (P = 0.16, 0.43 and 0.89, respectively). The implementation of the smoke-free ordinances in six US states had little or no immediate measurable effect on AMI mortality
Sargent et. al (2004)	United States	Patients admitted to hospital	In June 2002, Helena, prohibited smoking in public places and workplaces	Actual	MI	Cross Sectional	Marginal effect using Poisson regression model	During the six months the law was enforced the number of admissions fell significantly. Laws to enforce smoke-free workplaces and public places may be associated with an effect on morbidity from heart disease
Sargent et. al (2012)	Germany	Patients admitted to hospital	Between August 2007 and July 2008, German states prohibited smoking in public areas and hospitality sector	Actual	AMI	Cross Sectional	Marginal effect using linear regression model	Law implementation was associated with a 13.3% decline in angina pectoris and an 8.6% decline in AMI after 1-year. Strengthening the laws could further reduce morbidity and costs from acute coronary syndromes in Germany
Schmucker et. al (2013)	Germany	General population who sought hospital admissions	in January 2008, Bremen implemented anti-smoking laws including banned smoking from public areas	Actual	ST-elevation MI (STEMIs)	Cross Sectional	Mean difference in incidence	A 16% decrease of the number of STEMIs. In non-smokers, a significant reduction of STEMIs over time was found. A significant decline of hospital admissions due to STEMIs in non-smokers but not among smokers was observed after the smoking ban in public areas, and it may be due to the protection of non-smokers from passive smoking

Sebrié et. al (2013)	Uruguay	Patients, aged 20 years and above admitted to a hospital	in March 2006, national 100% smoke free legislation of smoking prohibition in workplace, public places, restaurants, and bars	Actual	AMI	Cross Sectional	Marginal effect using linear regression model	Hospital admissions for AMI fell by 22% in the post-ban period. The national smoke-free policy implemented in Uruguay in 2006 was associated with a significant reduction in hospital admissions for AMI
Seguret et. al (2013)	France	Patients admitted to hospital	Stepwise enactment of smoking ban: i) Comprehensive smoking ban in November 2006 for public places, ii) smoking ban decree was implemented in February 2007, and iii) smoking ban in bars, hotels, restaurants, discos, and casinos in January 2008	Actual	ACS	Cross Sectional	Marginal effect using Poisson regression model	Though the hospitalization rate decreased by 12.8% in all groups, but not in young women, the reductions linked to the ban remained not significant in all groups after adjusting for linear trend. This study did not demonstrate a significant effect of a two-phases smoking ban on ACS hospitalization rate
Seo and Torabi (2007)	United States	Patients admitted to hospital	In August, 2003, Monroe County, Indiana, enacted a public smoking ban in all restaurants, retail stores, and workplaces	Actual	AMI	Quasi experimental	Marginal effect using Poisson regression model	A significant drop of 12 admissions from in the number of nonsmoking patient admissions for AMI during which the smoke-free law was in effect. A public smoking ban may help decrease the number of heart attacks
Shetty et. al (2010)	United States	Hospital Admission Patients admitted to hospital	In the early 1990s, California banned smoking in workplaces, restaurants, and bars	Actual	AMI	Cross Sectional and simulation	Marginal effect using linear regression model	No statistically significant reduction in admissions due to AMI among working-age adults or among the elderly. No evidence that legislated U.S. smoking bans were associated with short term reductions in hospital admissions for AMI
Stallings-Smith et. al (2013)	Ireland	Population, aged 35 and older	In March 2004, national workplace smoking ban in workplaces including restaurants, bars and pub	Actual	Ischemic heart disease (IHD); stroke	Cross Sectional	Marginal effect from time-series regression model	Smoking ban implementation was associated with a 26% reduction in IHD, and a 32% reduction in stroke related mortality; Post-ban reductions in IHD, and stroke mortalities were seen in ages ≥ 65 years, not in ages 35–64 years. The nation-wide smoking ban was associated with immediate reductions in early IHD and stroke-related mortality; however, post-ban risk differences did not change with a longer follow-up period
Tranche et. al (2008)	Switzerland	Patients admitted to hospital	In March 2008, Canton of Graubuenden, introduced smoking ban in public buildings	Actual	AMI	Cross Sectional	Percentage change in Incidence	An overall 22% reduction in the AMI incidence within the first year after enactment of the new regulation. Similar to other countries in Europe and various regions of the USA and Canada, implementation of a public smoking ban was followed by a significant early decline in the incidence of AMI
Vasselli et. al (2008)	Italy	Patients admitted to hospital aged 40- 64 years	In January 2005, a national smoking ban was implemented on all indoor public places, including cafe´s, bars, restaurants, and discos	Actual	AMI	Cross Sectional	Percentage change using linear regression model	Significant decline in the number of admissions was found in the post ban period. The effect is observed only in male patients and in the age classes 45-49 and 50-54. This study shows that there has been an appreciable reduction in the incidence of heart attacks in the period immediately subsequent to the coming into force of the non-smoking law
Vicedo Cabrera et al (2016)	Switzerland	Children aged ≤15 years old and adults aged ≥35 years old	In May 2010, nationwide federal smoking ban covering indoor public places and workplaces, with a several exceptions in the hospitality sector	Actual	CVD	Quasi-experimental (interrupted time-series)	Percentage change in mean prevalence	Post-ban changes were detected in ischaemic heart disease hospitalizations, with a 2.5% reduction for all ages and 5.5% in adults 35–64 years old. Smoking bans in Switzerland were associated with overall reductions in cardiovascular hospitalization and mortality in adults
Villalbi et. al (2009)	Spain	Patients admitted to	In January 2006, banned smoking in indoor workplaces and many enclosed settings	Actual	AMI	Cross Sectional	Marginal effect using Poisson regression model	Significant reduction in annual AMI hospitalization rates was found. The introduction of regulations on smoke-free areas was accompanied by a reduction in the AMI hospitalization rate

		hospital, aged over 24 years						
Villalbı et. al (2011)	Spain	Death registration	In January 2006, banned smoking in indoor workplaces and many enclosed settings	Actual	AMI	Cross Sectional	Marginal effect using Poisson regression model	Adjusted AMI mortality rates in the post-ban period of 2006 declined 9% for men and 8.7% for women, especially among those over 64 years of age. Although other factors may have played a role, the extension of smoke-free regulations in Spain was associated with a reduction in AMI mortality
Weaver et. al (2018)	United States	Patient admitted to hospital	in June 2012, Marion County, Indiana introduced smoke free air law, and prohibited smoking in restaurants, most indoor public places and within eight feet of public entrance	Actual	AMI	Cross Sectional	Marginal effect using Poisson regression model	Monthly AMI admissions declined 20% in Marion County and 25%in Indianapolis after the law was implemented. Decreases in AMI admissions comparable with previous studies, and former and current smokers and those without co morbidities such as congestive heart failure and hypertension were highly benefitted from the law
Studies of Other unhealthy products-related regulatory policies								
Seo and Lee (2012)	United States	Public secondary schools students	Limiting the availability of salty snacks in schools	Actual	Overweight	Cross Sectional	Odds ratio	Children who attended schools where non-low-fat salty snacks (OR = 2.46) could be purchased were more likely to be obese. School nutrition policy is associated with the children's overweight status

Acronyms: BMI: body mass index; MI: myocardial infarctions; AMI: acute myocardial infarction; IHD: ischemic heart disease; ACS: acute coronary syndrome; CVD: cardiovascular diseases; CHD: coronary heart diseases; CMD: cardiovascular disease and diabetes

Supplementary Table 3: Educational policy-related study characteristics and key findings

Authors and year	**Country setting**	**Participants sampling universe**	**Description of the intervention**	**Nature of intervention: Proposal or actual**	**Outcomes**	**Study design**	**Measures of intervention effect**	**Study findings and conclusions**
Drichoutis et al (2009)	United States	General population	Nutritional label use	Actual	BMI	Quasi-experimental	Average treatment effects	The ATTs are not statistically significant. Nutritional label use generally does not have an effect on BMI
Kang (2017)	South Korea	Adults population	Pictorial Health Warning Labels on Cigarette Packs	Proposal	Diabetes; IHD	Simulation		Optimistic pictorial warning labels will prevent 85238 cases of diabetes, and 31526 of ischemic heart disease in total over the 10-year span due to the reductions in smoking prevalence
Sacks et al. (2011)	Australia	General population	Traffic-light labelling on junk foods	Proposal	Obesity	Simulation	Mean difference	Traffic-light labelling resulted in reduced mean weight by 1.3 kg (95% uncertainty interval (UI): 1.2; 1.4)
Sichieri et al (2009)	Brazil	School-aged children, 9–12-years	Program of discouraging SSBs consumption	Actual	BMI; Overweight; Obesity	Experimental (RCT)	Mean differences and marginal effects	A non-significant overall reduction in BMI (P=0.33). However, among those students overweight at baseline, the intervention group showed greater BMI reduction (-0.4kg/m2 compared with -0.2kg/m2 in the control group. Decreasing SSBs intake did not reduce BMI among children but reduced BMI among overweight children, and mainly among girls

Variyam and Cawley (2006)	United States	Adult population, stratified by race and gender	Nutrition and calorie labeling on food packets	Actual	Obesity	Quasi-experimental (pre-post)	Average treatment effects from pre-post difference-in-differences models	The estimated label use effect for non-hispanic white women from difference-in-differences regressions for BMI is -0.30 (p<0.05), and for obesity (percent) is-3.36 (p<0.01). No effect was found at the population level or for non-hispanic white men, non-hispanic black men, and non-hispanic black women. Nutrition and caloric labels had a beneficial impact, but only for one demographic group: non-hispanic white females

Acronyms: BMI: body mass index; IHD: ischemic heart disease

Supplementary Table 4. Combined policy interventions-related study characteristics and key findings

Authors and year	**Country setting**	**Participants sampling universe**	**Description of the intervention**	**Nature of intervention: Proposal or actual**	**Outcomes**	**Study design**	**Measures of intervention effect**	**Study findings and conclusions**
Basu et al. 2013	India	General population	Tobacco taxation, brief cessation advice by health care providers, mass media campaigns, and, smoke-free legislation, and advertising ban	Proposal	Mortality due to MI and stroke	Simulation	Mean difference	Smoke-free legislation and tobacco taxation would likely be the most effective strategy for reducing MI. In combination, both interventions could avert 25% of MI and strokes (95% CI: 17%-34%) if the effects of the interventions are additive
Gambaryan et. al (2018)	Russia	Persons with CVD	In 2013, Comprehensive Tobacco Control Law implemented with the following components: smoking ban in public places, excise tax; text and pictorial warnings on tobacco packages; information campaigns	Actual	CVDs	Cross Sectional and simulation	Difference between the outcome in the treated country and its synthetic control	Pre-intervention trends in CVD-related HDRs were similar between Russia and the synthetic control but became divergent after the TCL (Tobacco control Law) with greater benefit observed in Russia. A reduction in smoking-related CVD morbidity appears to benefit quite soon after implementation whilst smoking-related deaths might need a longer post-intervention period to be detectable
Jan et. al (2014)	Panama	Patients admitted to hospital	i) In January 2008, Panama introduced a nationwide smoking ban in all public and private institutions; ii) In November 2009, a tobacco tax increase (TTI) raising the retail price of a pack of cigarettes from US $1.84 to $4.20	Actual	AMI	Cross Sectional	Relative risk using Poisson regression model	Using the pre-policy period, the relative risk of AMI during the post-ban period and post-TTI period were 0.982 and 0.985, respectively. The implementation of a smoking ban and tobacco tax increase in Panama were associated with a reduction hospital admission for AMI
Jia et al. (2017)	China	Children	Unhealthy food restriction, healthy food promotion, price control and nutrition guideline in school settings	Actual	BMI	Cross Sectional	Cluster robust regression models	The policies were associated with lower likelihood for overweight/obesity and central obesity

Acronyms: BMI: body mass index; MI: myocardial infarctions; AMI: acute myocardial infarction; CVD: cardiovascular diseases