Proceedings of the Nutrition Society (2018), **77**, 314–320 doi:10.1017/S0029665117004165
 First published online 15 January 2018

The Nutrition Society Summer Meeting held at King's College, London on 10–12 July 2017

Conference on 'Improving nutrition in metropolitan areas' Symposium 5: The role of regulation to improve nutrition

Should we tax unhealthy food and drink?

Emma Smith[1], Peter Scarborough[2], Mike Rayner[2] and Adam D. M. Briggs[2,3]*
[1]*Oxford University Medical School, Medical Sciences Division, University of Oxford, Level 3, John Radcliffe Hospital, Oxford OX3 9DU, UK*
[2]*Centre on Population Approaches for Non-Communicable Disease Prevention, Nuffield Department of Population Health, University of Oxford, Old Road Campus, Headington, Oxford OX3 7BN, UK*
[3]*The Dartmouth Institute for Health Policy and Clinical Practice, Level 5, Williamson Translational Research Building, One, Medical Centre Drive, Lebanon, NH 03756, USA*

The global burden of obesity leads to significant morbidity and has major economic implications. In April 2018, Britain will join a growing number of countries attempting to tackle this using fiscal measures when the UK Soft Drinks Industry Levy is introduced. We review recent evidence from natural experiments of the impact of health-related food and drink taxes on consumer behaviour, and discuss the possible consequences of these approaches on purchases and health. We highlight some of the potential indirect consequences and the importance of robust prospective evaluation.

Taxes: Public health: Food and beverages

In recent decades, the global burden of obesity and related conditions has surged. In 2014, 13 % of the world's population were obese[1], with an estimated cost to the global economy of $2 trillion[2]. Britain will join a growing number of countries attempting to tackle the consequences of obesity using fiscal measures when the Soft Drinks Industry Levy (SDIL) is introduced in April, 2018[3]. Recent data on the impact of health-related food and drink taxes from natural experimental evaluations are allowing us to better understand how fiscal measures affect behaviour. In this review, we draw on this new evidence and discuss how health-related food and drink taxes might change purchasing habits and improve health.

Why implement food and drink taxes?

Unhealthy diets are the second leading behavioural risk factor behind tobacco for all-cause morbidity and mortality in the UK[4]. A poor diet can cause disease both directly and via mediating factors such as weight gain and high blood pressure. As well as the energetic contributions of energy-dense food and drinks, saturated fat leads to CVD[5], salt increases the risk of hypertension[6,7] and as discussed in more detail later, sugary drink consumption is related to diabetes independently of weight gain[8].

Health-related food and drink taxes implemented internationally commonly aim to reduce the burden of obesity. In the UK, 20 % of 4–5-year olds and 33 % of 10–11-year olds are either overweight or obese[9]. Furthermore, children from the most deprived backgrounds are twice as likely to be obese than those from the least deprived[10]; a disparity that only serves to entrench inequality as these children are more likely to become obese adults[11]. Childhood obesity, alongside an adult obesity prevalence of more than 25 %[12], is estimated to cost the UK over £6 billion/year in direct healthcare costs[2] and £27 billion when losses to productivity are included[13].

Reducing the consumption of unhealthy food and drinks would benefit health, and taxes are a powerful lever by which to achieve this[14,15]. As such, the UK government is introducing the SDIL, a key component of the

Abbreviation: SDIL, Soft Drinks Industry Levy.
***Corresponding author:** A. D. M. Briggs, email adam.briggs@dartmouth.edu

childhood obesity plan. Internationally, sugary drinks are the food or drink product most commonly taxed to improve health and this is with good reason. Both observational studies[16–19] and randomised control trials demonstrate that sugar and sugary drinks lead to increased weight among children[20,21] and adults[22–25]. Sugary drinks are also directly associated with diabetes independent of adiposity; their high glycaemic load means that consumption results in spikes in blood glucose and insulin concentrations, which may lead to insulin resistance and β cell dysfunction[26]. In a recent meta-analysis, Imamura *et al.* estimated a 13 % increase in the incidence of type two diabetes for each additional daily serving of sugary drink after adjusting for obesity, and predicted that 79 000 cases of the disease (3·6 % of all cases) over the next 10 years would be attributable to these drinks at present consumption levels[8]. In addition to diabetes, sugary drinks are associated with dental caries[27], CVD[28] and lipid dysfunction[29,30].

Beyond data relating their consumption to ill health, sugary drinks are an appealing target for taxation because they contain no nutritional benefit beyond the energy obtained from sugar. Their liquid substitutes (such as diet soft drinks and water) are generally healthier and there is little evidence that people react by increasing the amount of unhealthy food they eat. Sugary drink taxes may also in part correct the negative externality that results from the price of these products not encompassing the full cost they impose on society due to ill health and reduced productivity. Finally, they are relatively straightforward to define from an administrative perspective[31].

In recent years, taxes on sugary drinks have been implemented by numerous countries, in addition to a smaller number of health-related food taxes. Table 1 (adapted from the World Cancer Research Fund[32]) lists the measures already in place, but many more are on the horizon: for example in South Africa, Estonia, Portugal, Ireland and the UK.

While sugary drink taxes are becoming increasingly common and accepted both politically and publicly[33], health-related food taxes remain relatively rare. This is likely to be because they are both politically and administratively more challenging to implement[34,35] and because it is harder to predict what people will switch to consuming instead. Unlike soft drinks, many foods are essential, so the selection of foods for taxation and design of fiscal strategies to improve population diet is challenging. Nutrient-based taxes can be bureaucratically intensive due to the need to quantify the amount of the taxed nutrient in both domestically produced and imported foods and, in the case of the Danish saturated fat tax, different cuts of unpackaged meats; however, many countries now have nutrient-labelling requirements of different foods, making it easier to quantify nutrient-based tax rates. Furthermore, any health-related food tax needs to be careful not to inadvertently worsen health because of people switching to less healthy substitutes. For example, Denmark's saturated fat tax is estimated to have led to a small rise in salt consumption, partly countering the benefit derived from reduced saturated fat consumption[36].

Evidence for taxing unhealthy foods and drinks

The majority of published evidence suggesting that taxing unhealthy food and drinks will lead to a change in behaviour and improved health comes from simulation (modelling) studies. To quantify the potential health impact of a tax, models generally estimate how the tax will impact price and then how the new price will affect purchases and subsequent consumption. The effect of the new diet on health is then quantified using risk factor–disease associations generally taken from published studies in the peer-reviewed literature. While this can give an indication of the likely impact of a tax, there are many unquantified factors that have the potential to influence the outcome, some of which are illustrated in Fig. 1. These include factors relating to industry, such as how marketing and pricing will change for both taxed and untaxed drinks and whether recipes change (reformulation) or new products emerge. Also, some possible consumer responses are unquantified, such as the educational impact of knowing that a food or drink has been taxed due to it being unhealthy, the potential that people might waste less and the possibility of shopping in nearby untaxed jurisdictions. In contrast to modelling alone, natural experiments provide a mechanism by which some of these non-economic factors can be quantified and understood.

Sugary drink tax evaluations

Empirical evidence of the effect of health-related food and drinks taxes in real settings is increasingly available, allowing us to gain an insight into how these measures work in practice. Industry sales figures for taxed drinks in Finland, France and Hungary all reported a decrease in demand following an increase in price (see Cornelsen & Carreido, 2015[37]).

Independent peer-reviewed evaluations of these policies are also emerging. In Mexico, Colchero *et al.* have published several papers assessing the effects of the sugary drink and unhealthy food tax in place since January 2014. Prospectively collected data on drink prices from the first year of the policy allowed the authors to analyse the consumer pass-on rate of the tax. They found that on average, the price of taxed drinks rose by 1 peso/litre, equivalent to a pass-on rate of 100 %. More detailed evaluation showed that this rate was greater for taxed carbonated drinks than non-carbonated, although the relative price of smaller serving sizes of both these drink types increased more than larger servings[38]. Figures on the sugary drink tax in Berkeley, California also revealed interesting outcomes in this respect. Supermarkets passed on more than 100 % of the tax, whereas pharmacies passed on 45 % and drink prices in corner shops decreased slightly[39]. Whether this was due to corner shops being less prepared for the tax than the larger stores, or whether they were attempting to out-compete their rivals is unknown.

Further analyses of consumer data have shown that the taxes in Mexico and Berkeley were successful in

https://doi.org/10.1017/S0029665117004165 Published online by Cambridge University Press

Table 1. Health-related food and drink taxes around the world, adapted and updated from the World Cancer Research Fund[32]

Country	Date introduced	Products taxed	Tax rate
Barbados	August 2015	Sugary drinks excluding fruit juice and milk-based drinks	10 % excise tax
Belgium	January 2016	Soft drinks including those containing artificial sweeteners	€0·068/l excise duty (£0·51)
Brunei	April 2017	Sugary drinks excluding fruit juice and milk-based drinks	0·40BND/l excise duty (£0·23)
Chile	October 2014	Sugary drinks	18 % ad valorem tax for >6·25 g sugar/l, 10% for <6·25 g sugar/l
Denmark	October 2011–January 2013	Items containing saturated fat	16DKK/kg tax for products exceeding 2·3 g saturated fat/100 g fat (£1·85)
Dominica	September 2015	Food and drinks with high sugar content	10 % excise tax
Fiji	2006	Soft drinks including those containing artificial sweeteners	15 % ad valorem excise duty (imported drinks)
Finland	2011	Soft drinks and confectionary, chocolate and ice cream	€0·22/l excise tax for drinks with >0·5 % sugar, €0·11/l for all others (£0·20, £0·10) €0·95/kg excise tax for targeted foods (£0·87)
France	January 2012	Soft drinks including those containing artificial sweeteners	€0·07/l excise duty (£0·06)
French Polynesia	2002	Sugary drinks, confectionary and ice cream	$0·68/l tax (imported drinks) (£0·47)
Hungary	September 2011	Food and drink high in salt, sugar and caffeine	7 forint/l tax (£0·023) on soft drinks and 130 forint/kg (£0·42) of pre-packaged sugary/salty product
Kiribati	2014	Soft drinks including those containing artificial sweeteners	40 % excise duty
Mauritius	October 2016	Sugary drinks including fruit juice and milk-based drinks	0·03 rupee excise tax/g sugar (£0·00035)
Mexico	January 2014	Sugary drinks and food of high energic density	1 peso/l excise tax (£0·46), 8 % ad valorum excise tax on food with >1151 kJ (275 calories)/100 g
Norway	1981	Soft drinks including those containing artificial sweeteners, sugar and chocolate	3·34 NOK/l (£0·33) for beverages, 20·19NOK/kg for chocolate and 7·81NOK/kg for sugar.
Samoa	1984	Soft drinks	0·40 Tala/l excise tax (£0·12)
St Helena	May 2014	Carbonated sugary drinks	£0·75/l excise duty
Saint Vincent and the Grenadines	May 2016	Brown sugar	15 % VAT
Spain	May 2017	Sugary drinks	€0·08/l tax for drinks with 5–8 g sugar/100 ml, €0·12 for drinks with >8 g sugar/100 ml (£0·07, £0·10)
Tonga	2013	Soft drinks including those containing artificial sweeteners, animal fat products, turkey tails	1 Pa'anga/l (£0·36) import duty for drinks, 2 Pa'anga/kg for animal fat products, 1·5 Pa'anga/kg turkey tails
The United Arab Emirates	October 2017	Carbonated and energy drinks	50 % excise tax on carbonated drinks, 100 % excise tax on energy drinks
The USA: Berkeley, California	March 2015	Sugary drinks	$0·01/Fl Oz excise duty (£0·006)
The USA: Philadelphia, Pennsylvania	January 2017	Soft drinks including those containing artificial sweeteners	$0·015/Fl Oz tax (£0·012)

reducing purchases. Using detailed records from a consumer panel involving over 6000 households, Colchero *et al.* modelled expected 2014 drink sales without the tax, had purchasing trends continued. Comparison between these modelled figures and the consumer-reported purchases for that year revealed an average fall in post-tax purchasing of 6 % for 2014. In fact, the difference increased throughout the year to reach a 12 % reduction by December[40]. Rather than being a short-term effect, analysis of 2015 data showed a sustained decrease in purchasing of taxed beverages, averaging 9·7 % for the second year of the policy[41]. The figures also revealed that the tax consistently resulted in larger sales decreases among lower socioeconomic groups. Given that the study sample was biased towards urban areas, which tend to be wealthier, these studies may have underestimated the tax's overall effect size.

Similarly, the first year following the introduction of the Berkeley soft drink tax resulted in a 10 % reduction in sales of targeted drinks, with no change in total drink spending due to an increase in water sales. However, purchases in neighbouring towns without a tax rose by 7 % indicating some cross-border shopping which partly mitigated the tax's effect[39].

It is important to note, however, that since data from both Mexico and Berkeley are from natural experimental evaluations, results cannot be attributed solely to the tax. Parallel public health campaigns publicising the risks

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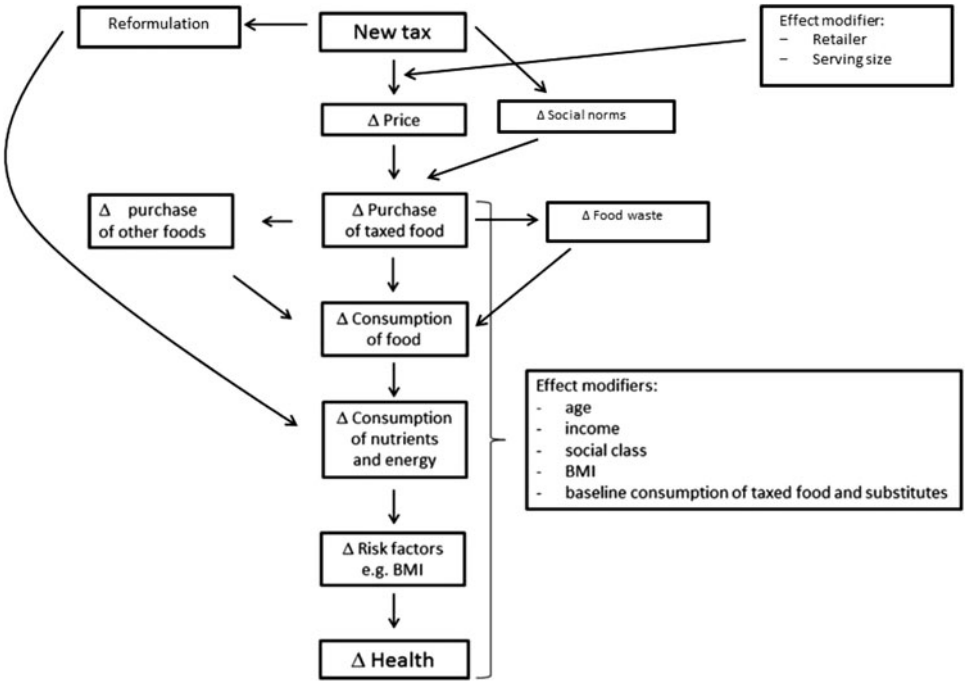

Fig. 1. A flowchart illustrating how a health-related food and drink tax might impact health (update of Fig. 1 'Implicit framework for how food taxes may influence health', with permission of Springer, from Mytton *et al.*[15]).

associated with sugary drinks and advertising restrictions on high-energy food and drink in Mexico may have also influenced sales, making it impossible to isolate the independent effect of the tax.

While these studies suggest that sugary drink taxes are indeed effective in reducing purchases, further work is required to understand whether these potential consumption changes lead to better health outcomes.

Food tax evaluations

There are also published data on the effects of health-related food taxes. A paper studying the Danish saturated fat tax measured how the policy had changed consumption of saturated fats and other nutrients[36]. The price changes following the policy's introduction were varied and, in some cases, substantial: for example, the price of a standard pack of butter rose by 20 %. Despite only being in place for 15 months, the authors found that the tax reduced consumption of saturated fat by 4·0 % and increased consumption of vegetables and fibre by 7·9% and 3·7 %, respectively. However, the changes in diet were not all good for health: a 0·4 % rise in salt intake was observed alongside a 0·2 % fall in fruit consumption. The authors also modelled the effects of these dietary changes on mortality from non-communicable diseases and estimated that the changes in fat, fruit and vegetables, and fibre intake would prevent 165 deaths/year. However, the increase in salt consumption would lead to forty-one additional deaths due to the increased risks of hypertension and CVD, leaving the total number of deaths averted by the policy at 123[36]. This highlights the potential danger of substitutions when fiscal measures targeting foods are used. Indeed, a previous UK study modelling the effects of a 17·5 % tax on saturated fats found that this would worsen population health due to increased salt intake[42].

Along with its tax on sugary drinks, Mexico has an 8 % tax on non-essential foods with an energy density of greater than 1151 kJ (275 kcal)/100 g. Analysis of its effects on packaged foods showed that in its first year, purchases of taxed products fell by an average of 5 %. The greatest purchasing reductions were seen in the lowest socioeconomic tertile, with a fall of 10 %, and no change in purchasing was observed in the highest tertile[43]. These data may be relevant to the UK, where the greatest burden of diet-related disease is in the most deprived groups. However, at this stage the effect of the tax on the entire diet is unknown.

The failure of Denmark to maintain their saturated fat tax for more than 15 months shows the challenges of implementing health-related food taxes. Denmark's tax received very little input from public health professionals during its formulation, while the food industry had a substantial influence on the design and revision of the policy[34]. Moreover, the stated aim of tax was to generate revenue, rather than to improve population health, which may have compromised its ability to maximise health outcomes[35].

Overall, empirical data from health-related food and drink taxes suggest that almost all have been effective in reducing consumption of the targeted product or nutrient. For sugary drinks, this will likely lead to health benefits, though the scale of these is as yet unknown. The evidence is less compelling for health-related food taxes,

https://doi.org/10.1017/S0029665117004165 Published online by Cambridge University Press

and there is a danger of poorly designed taxes causing harm through unforeseen substitution effects.

What does this mean for the UK?

In April 2018, the UK is due to introduce the SDIL to tackle obesity. While observing the effects of policies in other countries is useful when predicting what might happen, the SDIL is distinct from sugary drink taxes introduced elsewhere. Rather than a single tax rate applied to the product, the SDIL is a two-tiered industry levy where producers are taxed according to a drink's sugar concentration. Drinks containing more than 8 g sugar/100 ml face a 24p tax/litre, 5–8 g sugar/100 ml will be taxed at 18p/litre and drinks containing <5 g/100 ml sugar will not be taxed[3]. The levy is explicitly designed to encourage changes to industry behaviour rather than to directly affect consumer behaviour. Aside from passing on the tax to consumers, industry could reduce their tax burden by reformulating drinks to decrease sugar content, changing their advertising to encourage consumers to switch to untaxed alternatives, or changing their portion sizes such that taxed drinks are sold for the same price but at a lower volume. Indeed, reformulation is already occurring, with producers including Tesco and Ribena-Lucozade-Suntory either pledging to or already reformulating their products to below 5 g sugar/100 ml[44,45].

Recent modelling of the SDIL estimated how different industry responses may affect sugary drink consumption and health in the UK. The authors compared three possible scenarios: reformulation of high- and mid-sugar drinks to reduce sugar by 30 and 15 %, respectively, a price change based on 50 % of the levy being passed on to consumers, and changes to marketing strategies such that there is a 20 % reduction in sugar consumption from high and mid-sugar drinks. The largest reductions in disease burden were estimated to occur following reformulation, with the greatest relative health benefits accruing among children compared with adults. The reformulation scenario was estimated to lead to an overall fall in obesity prevalence of 144 000 people (equivalent to 0·9 % of the obese population), to reduce annual diabetes incidence by 19 000 and to result in 270 000 fewer decayed, missing or filled teeth per year[46].

However, some of the wider potential impacts of sugary drink taxes (shown in Fig. 1) have not yet been quantified. In order to understand the range of possible consequences of the SDIL, prospective evaluation is crucial. Such a study is already underway, funded by the National Institute of Health Research and involving the Universities of Cambridge and Oxford, and the London School of Hygiene and Tropical Medicine. The study adopts a systems perspective covering three major areas: whether the levy has an effect on health (and for whom), the process underlying how the levy was introduced and how wider attitudes to the levy change over time[47]. Data on the price, sugar levels, purchases and consumption of sugary drinks and their substitutes and complements are being collected and analysed. Short-term health outcomes will be estimated where possible, with longer-term outcomes (beyond 2020) being modelled. Industry costs and government revenues will be measured, as well as wider consequences for the economy and there is an ongoing in-depth analysis of how the levy is changing consumer attitudes and behaviours using both qualitative and quantitative methods.

Criticisms of the Soft Drinks Industry Levy

Despite the success of sugary drink taxes abroad, as well as modelling suggesting the UK levy will improve public health, the policy still faces criticism. One of the most common objections is that it will cause job losses. An industry-funded report predicted that 4000 posts would be lost as a result of the levy[48]; however, the calculations performed failed to adjust for employment gains resulting from increased sales of non-taxed drinks and jobs created in the administration of the policy itself. Indeed, researchers found no reduction in employment in relevant manufacturing and commercial industries associated with the introduction of the Mexican sugary drink tax[49], while modelling from the USA estimates that sugary drink taxes could even lead to a net gain in employment[50].

Opponents of the SDIL also rightly point out that it is regressive. However, like other taxed products including alcohol and tobacco, these drinks are non-essential and the levy may be progressive for health. This is because more deprived populations generally have a higher prevalence of obesity[9]. Furthermore, as seen with the Mexican data, those from lower socioeconomic groups may also be more price sensitive. Finally, the SDIL comes alongside a commitment to use the revenue to increase funding for breakfast clubs and after school activities, which may offer greater benefits to those who are less well off.

Conclusions

Health-related food and drink taxes have the capability to modify population diets and reduce disease. Both modelling studies and a growing number of natural experiments indicate that fiscal measures are likely to be effective in bringing about desired price and purchasing changes, while the weight of published data on sugary drink taxes suggests that they will improve population health. However, the evidence is less clear for health-related food taxes, where the consequences of unforeseen changes in substitutions and complementary foods are not as easy to predict and could mitigate any health gain if the tax is poorly designed. This is more likely to happen with taxes on specific nutrients rather than broader food categories because the complexity of a nutrient tax makes it harder to model and evaluate how the overall diet will be affected. Any health-related food tax should, therefore, be both carefully designed and closely evaluated to minimise these unintended consequences and maximise population health.

https://doi.org/10.1017/S0029665117004165 Published online by Cambridge University Press

In this review, we outline the potential for unhealthy food and drink taxes to improve health and highlight where their possible consequences remain uncertain. In addition to their direct effects, the use of these policies alongside other public health strategies could further increase their impact and the revenue generated could be channelled into other health-related interventions. Taxes alone will not solve the burden of diet-related ill health, but they will make an important contribution to shifting both industry and consumer behaviour in the right direction.

Acknowledgements

The authors thank their colleagues at the Universities of Cambridge and Oxford, and at the London School of Hygiene and Tropical Medicine who form the UK Soft Drinks Industry Levy Evaluation Study team, listed here: http://www.cedar.iph.cam.ac.uk/research/dietary-public-health/food-behaviours-public-health-interventions/sdil/, for discussions about evaluating the SDIL which have directly informed the evaluation section of this review. The authors are particularly grateful to the team's Principal Investigator, Professor Martin White, for his detailed comments and suggestions on the manuscript.

Financial support

P. S. is funded by a BHF Intermediate Basic Science Research Fellowship (FS/15/34/31656). M. R. is funded by the British Heart Foundation (006/PSS/CORE/2016/OXFORD). A. B., P. S. and M. R. are co-investigators on NIHR Public Health Research funded grants 16/130/01 and 16/49/01 to evaluate the health impacts of UK Soft Drinks Industry Levy. No other specific grant from any funding agency, commercial or not-for-profit sector was received for this work.

Conflicts of interest

A. D. M. B. is a member of the Faculty of Public Health and the UK Health Forum. M. R. is Chair of Sustain: the alliance for better food and farming and is a member of the UK Health Forum. These three organisations have position statements supporting taxes on sugar-sweetened beverages. There are no other conflicts of interest.

Authorship

E. S. wrote the first draft of the manuscript. All authors contributed to the manuscript's content and made suggestions and edits to manuscript drafts. All authors have read and approved the final version of the manuscript.

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https://doi.org/10.1017/S0029665117004165 Published online by Cambridge University Press