Implications of a Sugar Tax in New Zealand: Incidence and Effectiveness

Alasdair Gardiner

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Abstract

This paper has two aims. First, it surveys some of the literature on the likely effectiveness of sugar taxes as a policy instrument for reducing morbidity and mortality associated with obesity. There is a wide range of estimates among the literature of the price elasticity of demand for sugary products. A plurality of studies found that groups most at risk from obesity have greater price sensitivity. Studies also found there is a risk of consumers substituting unhealthy but non-taxed products for taxed products, negating any potential health improvements from a tax. The paper's second aim is to build on the literature review by analysing the possible incidence of a sugar tax in New Zealand, based on New Zealand household expenditure data. The empirical analysis presented is consistent with international evidence that a sugar tax would be regressive at the general population level.

JEL CLASSIFICATION H2; H3

KEYWORDS Sugar sweetened beverages; tax progressivity

Executive Summary

Excessive consumption of sugary products, especially sugar-sweetened beverages (SSBs), is a major contributor to New Zealand's high rate of obesity, as well as causing a range of other health problems, such as type two diabetes and dental caries. Taxes on sugary products have been implemented by several countries to incentivise their substitution with healthier alternatives, in an attempt to reduce obesity rates. This paper explores the underlying logic for, and some of the challenges associated with, sugar taxes as a policy instrument for reducing obesity.

Empirical analysis of New Zealand data is consistent with international evidence that a sugar tax is likely to be regressive. Low-income consumers spend a higher proportion of their income on the targeted food groups and so bear a relatively higher burden of the tax. However, this varies based on household type and ethnicity.

The highest obesity rates in New Zealand occur amongst lower socio-economic groups, Māori, Pasifika and those with high consumption of SSBs. An argument sometimes advanced in favour of the tax is that the health gains are likely to be progressive, with the largest reductions in obesity rates occurring among those with high obesity rates or at most risk of becoming obese. Whether this is true depends on the price elasticity of demand of the targeted groups. The general population was found to have slightly inelastic demand for SSBs. Some studies suggested that the high-risk groups had a higher price elasticity of demand, but this was not conclusive.

Substitution towards other unhealthy products rather than towards the intended healthy alternatives is another potential problem, which is accentuated with higher price elasticities.

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1 Introduction

The social costs of obesity are well-established and represent a significant current and future fiscal cost to the healthcare budget (Lal et al, 2012). A primary cause is the overconsumption of high-calorie food and drink, especially sugar-sweetened beverages (SSBs) (Mytton et al, 2012). Many countries have implemented health-related taxes – a "fat tax" or "sugar tax" – to incentivise the replacement of unhealthy products with healthier substitutes, which in theory reduces the energy intake of the average consumer and decreases the prevalence of obesity.

Given New Zealand's high rate of obesity, there have been calls for a similar tax to be introduced in this country (New Zealand Beverage Guidance Panel, 2014). However, there is considerable uncertainty regarding the effects of these taxes on consumption behaviour and the extent to which they result in a measurable improvement in health outcomes (Jeram, 2016).

This paper reviews some of the current literature on the effects of sugar taxes and considers the incidence of the tax to inform debate on this policy instrument as a tool for reducing the social costs of excess sugar consumption. Further analysis, outside the scope of this study, is required to determine the effect of implementing a sugar tax on obesity rates, or other health outcomes, in New Zealand.

Section 2 provides some background information regarding sugar taxes. Section 3 briefly reviews some of the literature on sugar taxes, including empirical estimates of relevant demand elasticities. Section 4 reports on the potential incidence of such a tax in New Zealand. Brief conclusions are drawn in section 5.

2 Background to sugar taxes

2.1 Theoretical basis

The theoretical basis for a sugar tax is that overconsumption of high-sugar products is a market failure which imposes negative externalities on society through increased health costs and higher rates of premature death from a range of non-communicable diseases. Conceptually, a sugar tax could be considered an extension of existing so-called "sin taxes" applied to alcohol and tobacco. While such taxes often generate sizeable revenue, their primary goals are to improve health and social outcomes and internalise the externalities created by consumption of demerit (socially undesirable) goods (Hoffer et al, 2013). Sin taxes are sometimes criticised as being paternalistic, due to their underlying assumption that the government should guide individuals, who are incapable of making decisions in their best interest, towards making the right choices (Jeram, 2016).

Individuals often consume excess quantities of demerit goods due to behavioural biases. This can lead to consumption decisions today that are not necessarily in their best interests tomorrow. For example, hyperbolic discounting, a form of time-inconsistent preference, occurs when individuals discount the future heavily and prioritise short-term pleasure over long-term gain. In this context, regularly drinking soft drinks may be pleasurable but have adverse long-term effects on health and longevity. The addictive properties of sugar exacerbate this problem.

Incomplete information is another barrier to optimal consumption decisions. Mandatory food labelling provides consumers with information on the sugar and energy content of products. However, awareness of the cumulative effect of excess sugar consumption and the long-term effects of diet on health – for example, the relationship between consumption of SSBs and type two diabetes – is less well-understood.

2.2 Sugar taxes in practice

Many countries have imposed excise taxes on imported sugar and soft drinks since the early 20th century, including New Zealand from 1932 to 1971, as well as Ireland, Norway, Finland and Denmark (Ashton and St John, 1985; OECD, 2015). However, original excise taxes were designed primarily for revenue generation rather than to induce a significant shift in consumption.

The first health-related taxes specifically designed to discourage consumption of unhealthy foods were introduced by Denmark and Hungary in 2011 (OECD, 2015). Nevertheless, many excise taxes have recently been "re-labelled" as health taxes as the adverse effects of unhealthy diets have become more prevalent (OECD, 2015).

SSBs, defined in this paper as carbonated soft drinks, are the most common type of sugary product that is taxed. As of January 2016, nine countries imposed a sugar tax at the national level, all of which included SSBs in their scope. These include five OECD nations: Finland, France, Hungary, Norway and Mexico; as well as four Pacific Island states or territories: Fiji, French Polynesia, Nauru and Samoa (Mytton et al, 2012; McDonald, 2015). Twenty-three US states impose a SSB tax, and both the South African and UK governments have signalled their intention to introduce a tax on SSBs in 2017

and 2018 respectively (Mytton et al, 2012; Fihlani, 2016). Other sugary products taxed include chocolate, ice cream and confectionary (OECD, 2015). Denmark abolished their tax on SSBs in 2014 in an effort to increase the competitiveness of Danish firms and recoup jobs lost to neighbouring countries (Scott-Thomas, 2013).

2.3 Rationale for targeting SSBs

The high sugar content of SSBs, as well as their low satiety and high addictiveness, are often cited as reasons for targeting SSBs. A typical 375 millilitre can of soft drink contains 40 grammes of sugar, 33% above the UK National Health Service's total daily recommended sugar intake for an adult (2015). This is accentuated by the fact that high quantities of soft drink can be consumed before the consumer is satiated, meaning that sugar consumption through drinks can occur at a higher rate than through solid foods (Bray et al, 2004). Epidemiological and experimental evidence indicates that higher intake of SSBs is associated with weight gain and obesity (Hu and Malik, 2010). Basu et al (2013) found that a 1% rise in soft drink consumption was associated with a 7.1% rise in the prevalence of overweight or obese adults in the population. Furthermore, the risk of becoming obese increases by 60% for each additional serving of SSB consumed per day (Brownell et al, 2009). The evidence also supports a link between SSB consumption and a range of other adverse health outcomes such as strokes, cancer, impaired cognitive development, cardiovascular disease, type two diabetes, raised blood pressure, dyslipidaemia, gout and dental caries (NZBGP, 2014).

2.4 Indirect costs of obesity

Although there are many adverse health outcomes arising from excess SSB consumption, obesity and its associated diseases form the main focus of this paper due to the high rate of obesity in New Zealand and its sizeable cost to the health system. Lal et al (2012) estimated obesity-related illnesses cost $624 million per year, or 4.4% of New Zealand's healthcare expenditure, with $247 million direct and indirect costs attributed to type two diabetes (Ministry of Health, 2009). New Zealand has the third-highest rate of obesity in the OECD; 31% of New Zealand adults are obese and an additional 35% are overweight (Sassi, 2010). Obesity rates have risen 20% in the last 30 years (Ministry of Health, 2015).

Large disparities exist between ethnic and socio-economic groups: 66% of Pasifika and 47% of Māori adults are obese, compared to 12% of Asian and 29% of European New Zealanders (Ministry of Health, 2015). Obesity is also positively correlated with socio-economic deprivation (Ministry of Health, 2015). Furthermore, 32% of New Zealand children have an unhealthily high weight, which represents a significant future risk for health expenditure (Carter, 2014).

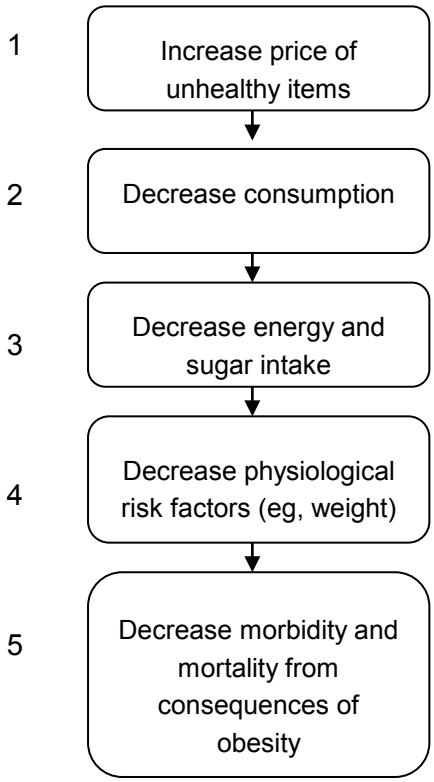
2.5 Intervention logic

A sugar tax is intended to reduce obesity by addressing excessive consumption of sugar products. While a detailed analysis of the causes of obesity is beyond the scope of this paper, the two primary causes of unhealthy weight gain are an excessive nutrient intake through consumption of fatty and sugary food and drink, combined with low nutrient outtake via lack of exercise (Ministry of Health, 2015). A sugar tax attempts to combat the former of these two causes.

By increasing the price of unhealthy food, a sugar tax disincentivises its consumption and encourages its replacement with healthier substitutes. In the case of SSBs, water is a healthy substitute that is available to virtually all New Zealand households at low cost. The intention is that a tax on SSBs would reduce the energy and sugar intake of consumers of SSBs, leading to a reduction in their weight. A healthier weight reduces the risk of developing any of the health-related problems associated with obesity, such as type two diabetes and heart disease. Ultimately, this is intended to decrease the number of deaths associated with obesity-related illnesses.

This intervention logic is summarised in the following flow diagram:

Figure 1 – Intervention logic for a sugar tax (adapted from Nnoaham et al, 2009)



Weak links between steps in this intervention logic have the potential to impair the effectiveness of a sugar tax. While a tax is expected to decrease consumption, the extent to which consumption decreases depends on a range of factors including the rate of the tax, the own-price elasticity of the taxed product and cross-price elasticities with substitute and complementary goods. All these factors, as well as individual consumption preferences, will ultimately determine whether the tax is effective in reducing sugar intake and obesity rates across the population.

3 Literature review

A review of the literature was conducted in four key areas: the share of total energy consumption from SSBs; the relationship between socio-economic status (and other household characteristics) and obesity; the elasticities of sugary products; and the effectiveness of sugar taxes. In this section, the primary focus is on SSBs rather than other sugary products, for the reasons outlined in Section 2.3.

3.1 Share of energy consumption from SSBs

SSBs are the most common sugary product taxed overseas, as stated in Section 2.2. However, to determine whether a tax on SSBs would be appropriately targeted in New Zealand it is necessary to examine whether SSBs are a significant contributor to energy consumption. A review of the available literature on SSB consumption was conducted across a range of sources, including the Ministry of Health and New Zealand Beverage Guidance Panel (NZBGP).

While the Ministry of Health data are likely to be the most accurate source for modelling the effect of a tax in New Zealand, the data does not distinguish between different types of non-alcoholic beverage. The data from the NZBGP provide information on the proportion of sugar that is consumed from SSBs, but not on the proportion of total energy consumption that this represents. US epidemiological studies provide a more detailed analysis of the share of total energy consumption from SSBs, but these reflect American consumption patterns which may differ from those of New Zealanders. Evidently, there is no one ideal source, so a reasonable estimate of sugar and energy consumption must be obtained from pooling the data. The data are summarised in Table 1.

When the proportions are expressed as a percentage of total energy consumption the tax appears poorly targeted. For example, taking the Ministry of Health study, non-alcoholic beverages make up 5% of total calories consumed by the average New Zealander, and are only the fifth-highest contributor to total energy intake (Ministry of Health, 2015). However, SSBs constitute 17% of all sugar consumption by adults, and non-alcoholic beverages are the second highest contributor to total sugar intake (NZBGP, 2015). Attention ought to be paid to the sugar intake, as excess sugar consumption may lead to many detrimental health effects besides obesity, such as dental caries. Furthermore, as shown in Section 3.3, even small reductions in energy intake can yield health benefits.

Table 1 – Summary of literature on share of total energy consumption from SSBs and other beverages

Study	Category	Population group	Proportion of total energy consumed	Proportion of total sugar consumed	Country
Bleich et al (2009)	SSBs	Young adults Elderly	231-289 kcal/ day 63-83 kcal/day (no proportion given)	- -	US
Bray et al (2004)	Added calorific sweeteners	Total population	16%	-	US
Duffey et al (2007)	All beverages	Total population	21%	-	US
Ministry of Health (2009)	Non alcoholic beverages Sugar and sweets	Total population	5% (range: 2.2-10%) 4.2%	-	NZ
NZ Beverage Guidance Panel (2014)	SSBs	Adults Children	-	17% 26%	NZ
Ruff & Zhen (2015)	All beverages	Total population	22,663 kcal/year (no proportion given)	-	US
Wang et al (2008)	SSBs (including fruit juice)	Children and adolescents	10-15% or 204-224 kcal/day	-	US

3.1.1 Relationship between socio-economic status and SSB consumption

Data from the Ministry of Health's New Zealand Adult Nutrition Survey indicate that there is a positive correlation between the frequency of soft drink consumption and the level of neighbourhood deprivation (Ministry of Health, 2010). A US study (Lin and Smith, 2010) reinforces this conclusion, finding that, on average, low-income adults consumed an additional 61 kilocalories from sugary drinks per day compared to high-income adults. They also found that diet drink consumption increases with income, which is likely due to the substitution of diet beverages for regular soft drinks. Briggs et al (2013) found a more nuanced relationship between income and SSB consumption: low-income consumers obtain 50% more energy from SSBs than middle-income consumers, and only 15% more than high-income consumers.

Obesity rates are significantly higher among New Zealanders living in socio-economically deprived areas. Adults and children living in the most deprived areas were 1.7 times and five times, respectively, as likely to be obese as those living in the least deprived areas (Ministry of Health, 2015). According to the Ministry of Health, this finding is not explained by differences in the sex, age or ethnic composition of the child population across areas of high and low deprivation (Ministry of Health, 2012). Another Ministry of Health study corroborated this, finding that whether socio-economic position was measured at the individual, household or neighbourhood level, and whether body mass index (BMI) or waist circumference were used as measures of obesity, an inverse gradient was observed between socio-economic position and weight (Ministry of Health, 2006).

3.1.2 Other factors associated with SSB consumption

Ethnicity is another factor associated with SSB consumption. The share of total sucrose intake from non-alcoholic drinks is significantly higher for Māori and Pasifika individuals (23.5% and 23.1% respectively) compared to those of the New Zealand European/Other ethnic group (15.7%), and especially high among Māori and Pasifika teenagers (36.4% and 32.6%, respectively) (Ministry of Health, 2010). In most cases, SSBs comprised a greater proportion of sugar intake for males than for females (Ministry of Health, 2010).

Total energy consumption was similarly higher among Māori and Pasifika than other ethnic groups, with Māori and Pasifika obtaining 6.4% and 6.1%, respectively, of their total energy intake from non-alcoholic drinks, compared to 4.9% for Europeans and other ethnicities. For young Māori and young Pasifika, non-alcoholic beverages provided 8.7% and 8.1%, respectively, of their total energy intake (Ministry of Health, 2010). Utter et al (2010) found that there was a positive association between BMI and socio-economic deprivation for Pacific students, Māori students and European students, but not for Asian students and students of other ethnicities.

Age is also correlated with SSB consumption. Children drink greater quantities of SSBs than adults, and SSB consumption is a larger proportion of young consumers' energy and sugar intake than older consumers. According to the NZ Beverage Guidance Panel, children obtain 26% of their daily sugar intake from SSBs. This is significantly higher than the 10-15% reported by Wang et al (2008) in a US sample.

3.2 Summary of literature on SSB elasticities

A key part of the literature review involved summarising the literature on own-price and cross-price elasticities of SSBs. Both elasticities are important to determine the extent to which a price increase will reduce consumption.

The own-price elasticity of a product measures the sensitivity of consumers' demand for a product to a change in its price. Information on the own-price elasticity of demand for SSBs is necessary but not sufficient to determine whether a SSB tax will be effective in reducing obesity rates.

The cross price-elasticity of a product measures the sensitivity of consumers' demand for the product in response to a change in the price of a different product. Goods that are substitutes are represented by a positive cross-price elasticity whereas complements have a negative cross-price elasticity. Cross-price elasticities of taxed products are needed to assess the degree of substitution with non-taxed products that is likely to occur in the event of a price increase. For example, most existing or planned SSB taxes exempt fruit juice, which contains high quantities of sugar and is likely to be an attractive substitute to SSBs. Increased consumption of fruit juice may cancel out the health gains realised by reduced SSB consumption (Jeram, 2016).

While price elasticities indicate the sensitivity of the average consumer to a price change, they do not necessarily reflect the unique consumption patterns of those consumers who are obese or at risk of becoming obese, which are the intended target demographics for this policy. Only one study surveyed, Ni Mhurchu et al (2013), specifically focused on these target groups.

The studies surveyed used a range of methods of analysis. Some studies, such as Powell et al (2013) and Escobar et al (2013), are meta-analyses of other studies, whereas others empirically derived the own-price and cross-price elasticities from a demand system (Lin and Smith, 2010; and Sharma et al, 2014). Two studies separated consumers into high and low-income groups, taking account of the differing price sensitivities of consumers with different incomes (Finklestein et al, 2010; and Lin and Smith, 2010). Three studies also distinguished between regular and diet drinks (Andreyeva et al, 2010; Lin and Smith, 2010; and Sharma et al, 2014). Due to differences in the robustness of methods between studies, a direct comparison should be treated with caution.

Tables 2 and 3, respectively, provide a summary of the literature on own-price and cross-price elasticities of demand for SSBs.

Table 2 – Summary of literature on own-price elasticities for SSBs[1]

Study	Own price elasticities		
	Total population	**High income**	**Low income**
Andreyeva et al (2010)	All SSBs: -0.9 (range: -0.8 to -1.0) Regular: -1.05 Diet/low calorie: -1.26	-	-
Escobar et al (2013)	-1.299	-	-
Finklestein et al (2010)	-0.73	-1.02[2]	-0.49[3]
Lin & Smith (2010)	-	Regular: -1.29 Diet: -0.46	Regular: -0.95 Diet: -0.7
Ni Mhurchu et al (2013)	-1.27	Quintile 1: -2.20 Quintile 2: -3.47 Quintile 3: -0.14 Quintile 4: -2.95 Quintile 5: -1.26	
Miao et al (2013)	-0.95	-	-
Powell et al (2013)	-1.21	-	-
Sharma et al (2014)	Regular: -0.63 Diet: -1.01	-	-

Across all studies surveyed, own-price elasticities for all SSBs range between -0.63 and -1.30 across the total population. While the addictive properties of SSBs would suggest inelastic price elasticity of demand, this is moderated by the wide variety of substitute products available. Ni Mhurchu et al (2013) found that the income effect varied with ethnicity. Māori were found to have less elastic demand, at -1.11, than non-Māori, at -1.38.

1 Unless otherwise stated, elasticities refer to all SSBs.

2 For 50 to 75% income quartile.

3 For 0 to 25% income quartile.

Consistent with the economic theory that increasing the number of substitutes for a product yields more elastic demand, Andreyeva et al (2010) noted that separating all SSBs into regular and diet varieties yields higher elasticities for both than combining them into one group. Powell et al (2013) found that a broader tax including both regular and artificially sweetened soft drinks will have a greater impact on soft drink consumption than a tax on only regular soft drinks. Furthermore, Andreyeva et al (2010) found that consumption outside the home is more elastic.

Table 3 – Summary of literature on cross-price elasticities of SSBs with respect to related products

Study	Cross-price elasticity		
Escobar et al (2013)	Fruit juice	0.388	
	Whole milk	0.129	
	Diet soft drinks	-0.423	
Lin & Smith (2010)		*Low income*	*High income*
	Diet soft drinks	-0.695	-0.464
	Skim milk	-0.367	-0.883
	Low fat milk	-0.820	-0.383
	Whole milk	-0.631	-0.804
	Juices	-1.017	-0.928
	Coffee/tea	-0.802	-0.331
	Bottled water	-0.718	-0.832
Ni Mhurchu et al (2013)	Chocolate, confectionary and snacks	0.05	
	Ice cream	0.06	
	Other non-alcoholic beverages	-0.07	
	Energy drinks	-0.25	
Sharma et al (2014)	Diet soft drinks	0.16	
	Cordial	-0.51	
	Bottled water	0.37	
	Fruit juice	0.18	
	High fat milk	0.46	
	Low fat milk	0.12	
	Tea	-0.89	
	Coffee	-0.89	

According to Escobar et al (2013), fruit juices and possibly milk act as substitutes for SSBs. However, diet soft drinks are categorised as a complement. Analysis by Lin and Smith (2010) found that diet soft drinks as well as milk, juice and other beverages are complementary to regular soft drinks. This is contrary to the intuitive outcome of diet drinks acting as substitutes for regular soft drinks. No explanation or mention of this surprising result is given in these papers, and there are limited other data on cross-price elasticities to assess the veracity of these findings.

3.3 Review of effectiveness of sugar taxes

This section provides a summary of the literature on the effectiveness of sugar taxes in achieving the desired improvement in health outcomes. The majority of studies support the conclusion that sugar taxes can have a measurable impact on consumption. However, the extent to which the reduction in consumption results in a reduction in weight and obesity rates is less clear. Higher tax rates (those above 20% of the pre-sugar tax price of the product) were found to induce statistically significant improvements in weight and obesity rates, but lower tax rates have little to no effect. Most studies surveyed advocated for a sugar tax to be included in a broader policy package to be effective.

There are some limitations to this literature review. There are few studies available which evaluate the effectiveness of health-related taxes using empirical data. Those that do primarily focus on taxes set at a low rate, which are found to have negligible health impacts (OECD, 2015). Most studies cited below are meta-analyses or use econometric modelling, using price elasticity measures, to estimate the likely impact of price changes on consumption and diet. A key assumption made in these models is that the cost of the tax will be fully passed on to consumers.

Table 4 – Summary of literature on effectiveness of sugar taxes

Study	Comments on effectiveness
Alemanno & Carreno (2011)	• The responsiveness of consumers to price changes varies depending on the level of consumption, with heavy users and obese consumers being less price sensitive, similar to tobacco and alcohol taxes. • To be effective, sugar taxes need to be introduced as part of a broader policy package. They are unlikely to be effective on their own.
Briggs et al (2013)	• A 20% tax on SSBs is estimated to reduce the number of obese and overweight adults in the UK by 1.3% and 0.9% respectively.
Brownell et al (2009) [4]	• Sugar taxes can have a strong positive effect on reducing consumption. An excise tax of 1c/oz would lead to a minimum reduction of 10% in energy consumption from sweetened beverages, or 20kcal per person per day, which is sufficient for weight loss and reduction in risk. (However the study does not provide a reference to the data this is based on, nor does it quantify the reduction in weight and obesity.) • Current US sales taxes (imposed in 33 states) are set at too low a rate to affect consumption.
Escobar et al (2013)	• Sugar taxes may benefit health and lead to a modest weight reduction, but should be used as part of a policy package.
Finklestein et al (2010)	• This study modelled associations between beverage prices, energy intake and weight using multivariate regression models. • The results found that a 20% and 40% tax on soft drinks would reduce energy intake by 4.2 and 7.8kcal/day/person respectively, and this would translate to a mean weight reduction across the population of 0.2 and 0.37kg/year/person. • Extending the tax to other beverages containing sugar, at a rate of 20% and 40%, would result in a reduction of 7.0 and 12.4kcal/day/person respectively, resulting in a mean weight reduction of 0.32 and 0.59kg/year/person.

[4] This study was funded with grants from the Rudd Centre for Food Policy & Obesity, a health lobby group, the National Institutes of Health, and the Robert Wood Johnson Foundation, a health-focused philanthropic organisation.

Study	Comments on effectiveness
Lin & Smith (2010)	• 20% tax on SSBs: average reduction of 34 and 40 calories among adults and children, respectively. Translates to weight reduction of 3.6 and 4.2 pounds for adults and children and would reduce obesity by 3.5% in the United States, from 33.5% to 30.8% for adults and 16.1% to 13.4% for children • A SSB tax would be regressive.
Moodie et al (2013)	• A high tax rate (>20%) could influence dietary intake and health outcomes but is not definitive.
Mytton et al (2012)	• Higher taxes are likely to have a greater impact. The effects are greatest for the young, poor and those most at risk of being overweight. • The literature points to the conclusion that a SSB tax would be well-targeted on the young, poor, and most at risk of being overweight.
Nnoaham et al (2009)	• Positive health effects, but not necessarily greater for low-income groups.
OECD (2015)	• SSB taxes can be effective in reducing consumption, and if sufficiently high can lead to positive health outcomes. Studies based on low level (1-8%) ad valorem sales taxes on soft drinks in the United States found there was no statistically significant effect on obesity. Modelling of higher tax rates, however, found a positive impact on obesity rates.
Powell et al (2013)	• Own-price elasticity of -1.21 implies price rise of 20% would reduce consumption by 24%, but mixed evidence on the extent of the effect on weight outcomes. • The magnitude and design of a tax considerably influences its effectiveness. Studies that show a small impact on weight outcomes used existing tax rates which are low. A study that used beverage price rather than tax measure found a significant association with children's weight.
Sharma et al (2014)	• This study modelled the effect of both a 20% flat rate sales tax and a 20c/L volumetric tax on SSBs. Lower tax burden and higher weight reduction under volumetric tax. • 20% flat rate sales tax would result in a weight reduction per capita of 0.29kg for average SSB purchasers and 1.49kg for heavy SSB purchasers. • Substitution towards diet drinks (3.2% increase in consumption) as a result of the tax. Other substitutions are small in magnitude. • High-income households have the least elastic demand for regular soft drinks. • The average SSB tax burden is 0.22% of household income for low-income households and 0.027% of household income for high-income households. • Progressive health gains: biggest improvements in health accrue to lower-income households despite higher tax burden. • The study also comments on changing social norms. Tobacco taxes have risen at least 200% over past 30 years. If social stigma attaches to soft drink consumption in the same way it has to smoking, governments have scope to increase taxes on SSBs to a much larger extent, with potentially much more effective results on reducing consumption and obesity rates.

Study	Comments on effectiveness
Wang (2010)	• This study notes the possible regressitivity of an SSB tax, but emphasises the disproportionate burden of negative health outcomes felt by low-income consumers. • The reduction in consumption is greater among groups with high baseline consumption: the young (20-44 year olds), ethnic minorities and low-income groups. • A 100% pass-through rate is a valid assumption. One study has shown a 129% pass-through rate. • A 22% increase in SSB price in New York state will result in an 18% decrease in consumption under ideal conditions. Across the state, expected to reduce the proportion of adults consuming one or more drink a day by 2-4%, and the proportion of adults consuming two or more drinks a day by 2-6%. • Estimated to prevent 3.5% of new diabetes cases in men and 3.0% in women. Health benefits may take time to materialise, but over a decade are expected to prevent in excess of 37,000 cases of type-2 diabetes across the state. Preventative benefit is greater for young adults due to their higher baseline consumption.

Some studies have claimed that a sugar tax would improve health outcomes to a greater extent among lower socio-economic groups (Ni Mhurchu et al, 2015; Mytton et al, 2012), which they have referred to as a "progressive health impact". This is due to groups with higher obesity rates, such as Māori and lower socio-economic groups, having more price elastic demand, resulting in a larger reduction in consumption from a given price change (Ni Mhurchu et al, 2013). The implication is that those groups most affected by obesity will experience a greater improvement in diet and health. Whether this is true depends on the degree of the substitution effect, as outlined in Section 3.2.

4 Incidence of a sugar tax

4.1 Method of analysis

To consider the incidence of a sugar or SSB tax on New Zealand households with different demographic characteristics, a dataset was constructed using household expenditure data from the Household Economic Survey (HES), a nationally representative survey of approximately 3,000 New Zealand households, for the years 2007, 2010 and 2013. Expenditure in the HES is classified to a fine level of detail, enabling an analysis of the implications of taxing different food groups. Data from these three surveys were pooled and the expenditure converted to 2013 dollars using the Consumer Price Index (CPI). Consumers were divided into twenty groups based on their total annual household expenditure, from $0 to $150,000 in increments of $10,000, and from $150,000 to $400,000 in increments of $50,000.

Two scenarios were evaluated: a tax on SSBs only; and a more comprehensive sugar tax encompassing SSBs and other sugary foods. To do this, the proportion of each household's total expenditure on three commodity groups was calculated: category one being all soft drinks (SSBs); category two containing other clearly defined food groups which are high in sugar (chocolate, ice cream, cakes and biscuits, confectionary, desserts as well as sugar itself and variants thereof); and category three containing all other goods. Goods such as

tomato sauce and jam, while high in sugar, were not included in category two due to the lack of international precedent on including these products in a sugar tax.

A weighted average of budget shares for these three categories for each total expenditure group was calculated. The household type and ethnicity variables were incorporated into the model and output tables produced for:

1) All households
2) Households with two or more adults, without children
3) Households with two or more adults, with children
4) Single adult households
5) Households where the head of the household[5] is Asian
6) Households where the head of the household is European
7) Households where the head of the household is Māori
8) Households where the head of the household is Pasifika.

4.2 Budget shares

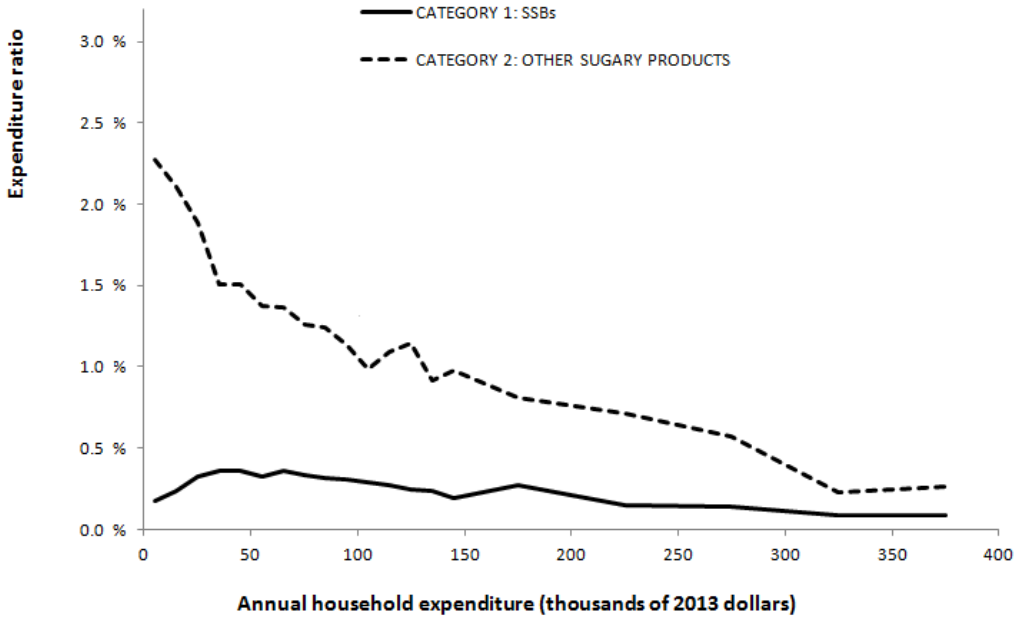
In considering the progressivity of indirect taxes, it is appropriate to consider the tax base to be total household expenditure, rather than income. A tax on SSBs is therefore progressive if the average tax rate increases as the total household expenditure increases. A fixed ad valorem tax rate imposed on SSBs implies that the average tax rate varies in exactly the same way that household budget shares attributed to SSBs vary. Hence the expected progressivity or regressivity of an ad valorem SSB tax can be examined by considering how the average budget share, at each household total expenditure level, varies. The present section reports evidence on the variation in budget shares for a range of population groups. The empirical analysis confirms the expected result that for most population groups there is a negative correlation between total household expenditure and expenditure on the targeted products. The budget shares for various household types and both categories of sugary product (SSBs only and other sugary products) are illustrated in figures 2 to 9. Adding the budget shares for both categories gives an indication of the incidence of a broader sugar tax, as opposed to an SSB tax.

4.2.1 All households

For the entire sample, a tax on SSBs shows mildly regressive effects, and a tax on all sugary products is moderately regressive, as shown in Figure 2.

[5] Defined here as the household member with the highest income.

Figure 2 – Weighted average expenditure proportion for all households



4.2.2 By household type

Budget shares for households with two or more adults without children correspond closely to the total population, except for low-income households in this category for which the proportion is moderately higher than all households. This is shown in Figure 3.

Average SSB consumption among lower-income households with children is higher than among lower-income households without children, but the presence of children in the household has negligible effect on expenditure proportions among higher-income groups.

Figure 3 – Weighted average expenditure proportion for two or more adults without children

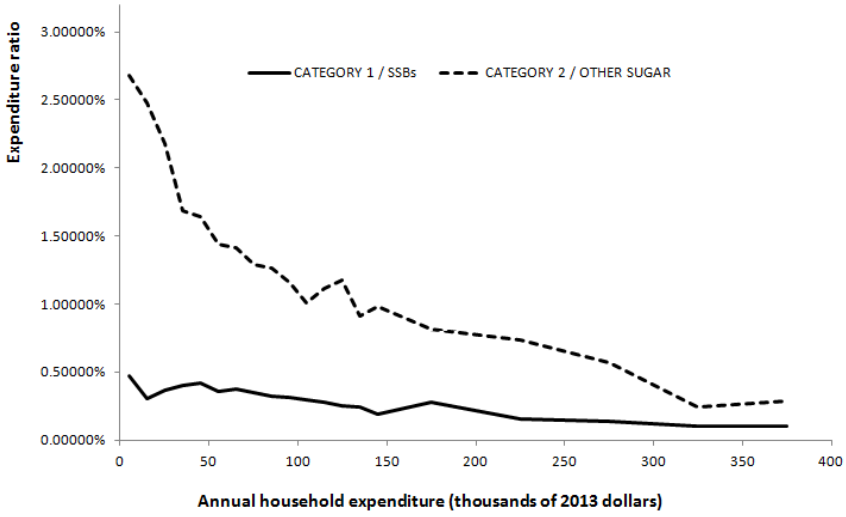
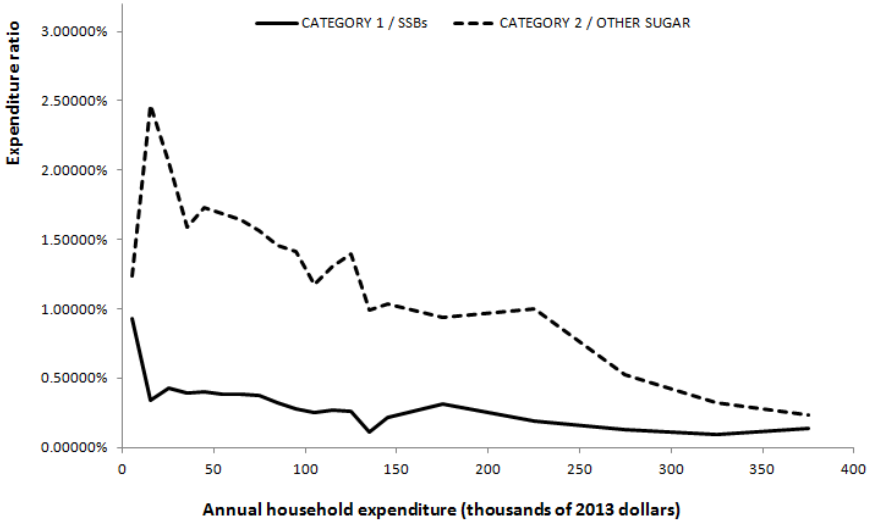
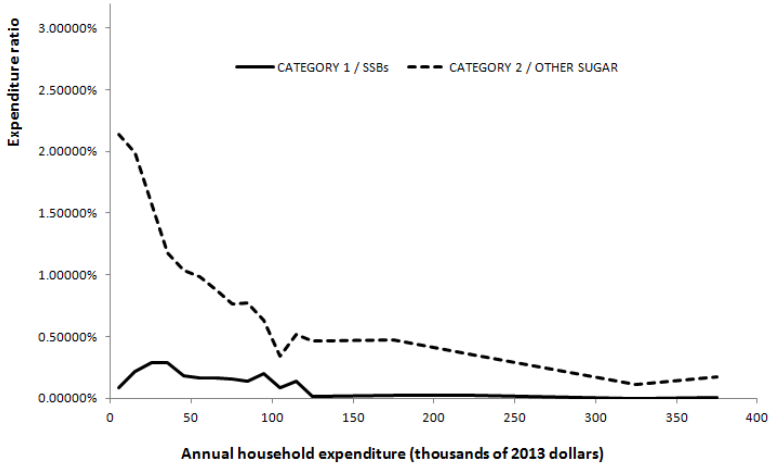


Figure 4 – Weighted average expenditure proportion for two or more adults with children



Single adult households spend a lower proportion of total expenditure on sugary products than average, as shown in Figure 5.

Figure 5 – Weighted average expenditure proportion for single adult households



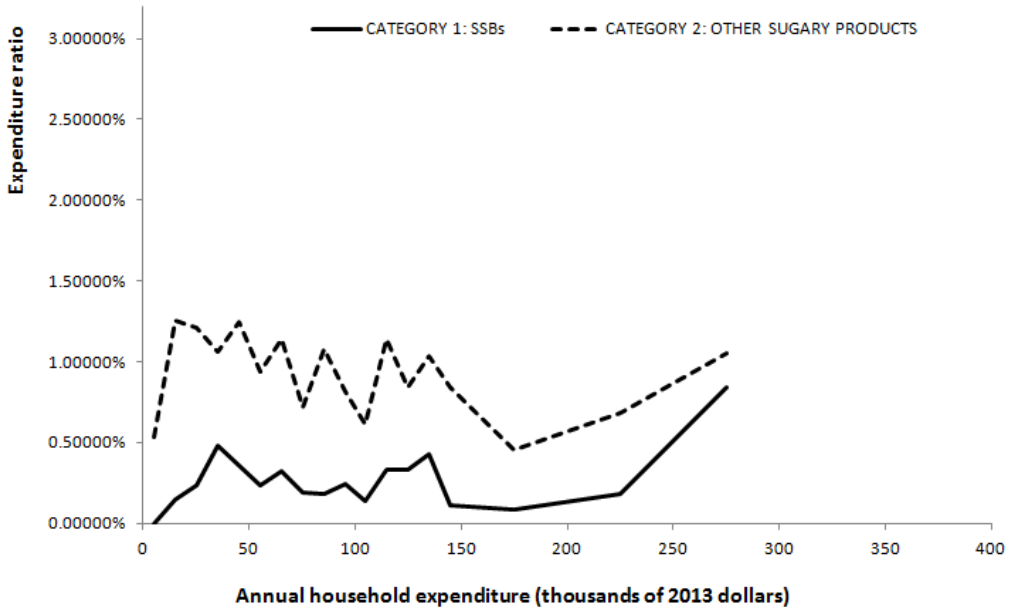
4.2.3 By ethnicity

Both consumption rates of sugary products and obesity rates vary by ethnicity as reported in section 3.1.2. Figures 6 to 9 illustrate the budget shares for Asian, European, Māori, and Pasifika households respectively.

Māori and Pasifika consume SSBs at higher rates than Europeans and Asians, and on average have lower incomes (Ministry of Health, 2010; Statistics New Zealand, 2014). Māori and Pasifika have higher rates of obesity than Europeans and Asians, and therefore we would expect these ethnic groups to spend a greater proportion of their income on sugary products. This is confirmed by HES data (Ministry of Health, 2010).

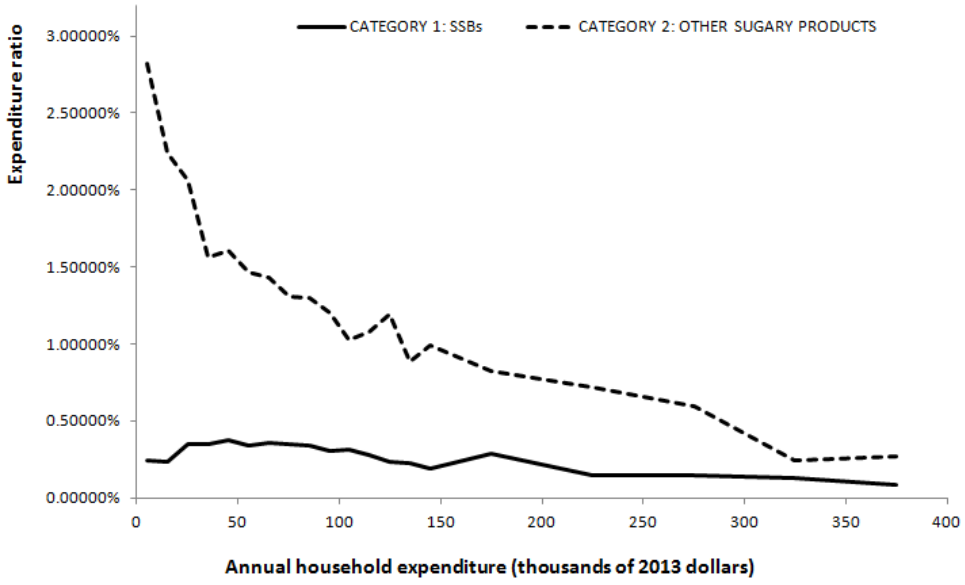
Budget shares for sugary products and SSBs are lower among Asians than the general population and this proportion does not vary significantly with total expenditure.

Figure 6 – Weighted average expenditure proportion for Asian households



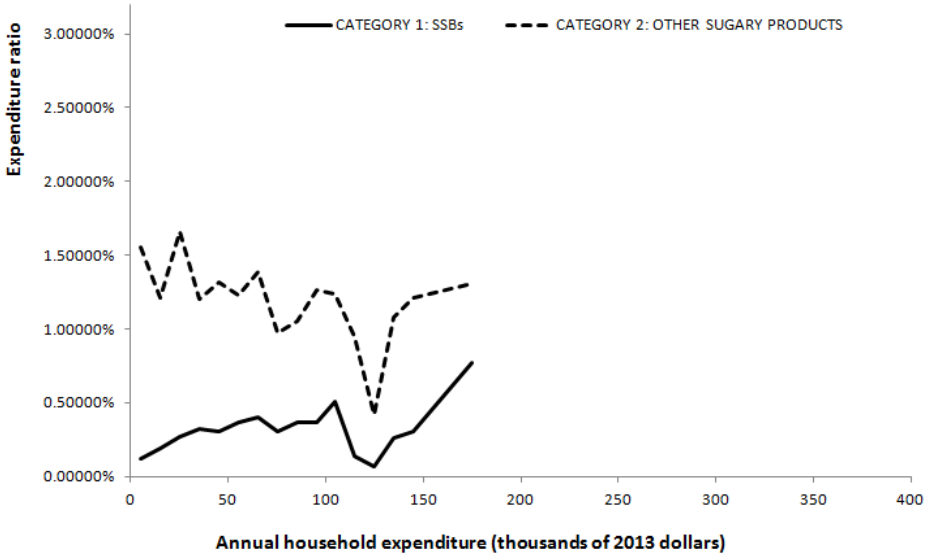
The consumption pattern for European New Zealanders closely matches that of the total population, which is expected given that 74% of New Zealand's population falls into this category (Statistics New Zealand, 2014).

Figure 7 – Weighted average expenditure proportion for European households



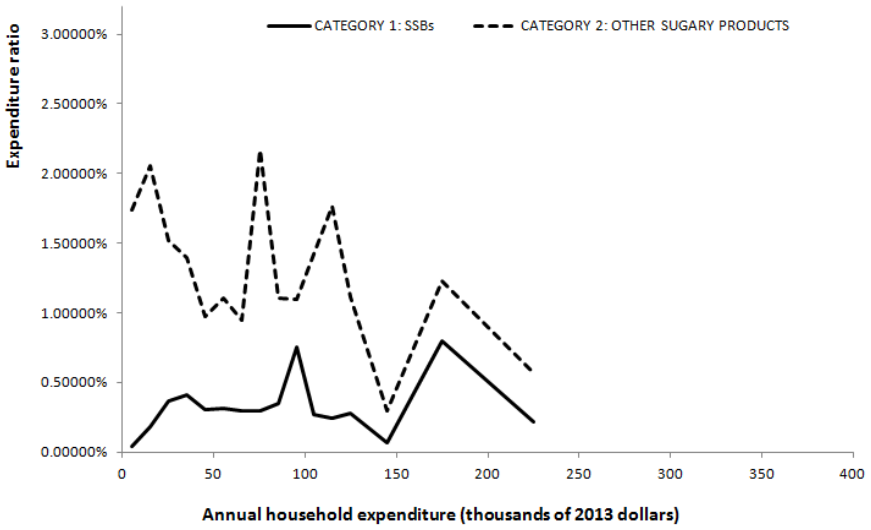
Budget shares for Māori are the opposite of the result obtained for the total population. Higher-income Māori spend a greater proportion of their total expenditure on SSBs (albeit a slightly lower proportion on other sugary products), than lower-income Māori. Therefore, an SSB tax is likely to have a progressive incidence on Māori. However, the small sample size of 873 households reduces the validity of this conclusion.

Figure 8 – Weighted average expenditure proportion for Māori households



Budget shares for Pasifika are higher than the total population for both categories of product. The high variability reflects the small sample size of Pasifika households in the HES.

Figure 9 – Weighted average expenditure proportion for Pasifika households



5 Conclusions

Analysis of New Zealand expenditure data indicates that a tax on SSBs or sugary products would have a regressive impact on the general population, which is consistent with international evidence. However, the effect varies by household type. Low-income households with children would be particularly affected. The budget shares for Māori and Pasifika contradict the general population as the proportion of expenditure on SSBs is generally an increasing function of total expenditure.

Given these results, questions remain over whether the tax would appropriately target those most at risk from becoming obese, such as Māori, Pasifika and low socio-economic groups. Three studies surveyed found the largest reduction in obesity to occur among these groups. However, a tax is a blunt instrument that affects all consumers of SSBs. Changing the behaviour of high consumers of SSBs, who are more likely to be obese or at risk of becoming obese, is necessary for greater improvements in health outcomes.

The review of the literature on the effectiveness of sugar taxes is inconclusive. Of the 13 studies surveyed, nine provided evidence to show that a sugar tax could be effective in reducing obesity rates, when set at a sufficiently high rate, and when introduced as part of a broader policy package to tackle obesity. However, there was wide variation in the methodologies used to conduct these studies, with most based on econometric modelling of demand reductions rather than empirical observations.

A potential problem of the tax highlighted in this paper is substitution to unhealthy products. Limited evidence on the degree of substitution was found in the literature, although several studies found that the high-risk groups identified have a higher price elasticity of demand for SSBs than the general population. Highly price sensitive consumers are more likely to switch to non-taxed substitute products, or cheaper but equally unhealthy taxed products, if a tax is implemented. This problem is worth exploring further before a tax is introduced.

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