The Impacts of Sugar Taxation Policies on Oral Health: A Mixed Methods Study

Maria Josefina Valenzuela

PhD

University of York

Health Sciences

June 2021

Abstract

Background: Sugar-sweetened beverage (SSB) consumption is associated with increased risks of several health conditions. The Chilean government implemented a SSB tax as part of a tax reform in 2014. However, evidence on the effects of such taxation policies on oral health is limited. In this thesis I aimed to estimate the impacts of Chile's Sugar Tax on population oral health.

Methods: I used convergent mixed methods across three linked studies: i) a systematic review exploring the association between different levels of SSB consumption and risks of caries and erosion; ii) a quantitative study assessing distributional changes in SSB consumption levels following implementation of Chile's Sugar Tax policy; and iii) a qualitative case study exploring the policymaking process in Chile and its implications for oral health.

Results: People who consume larger quantities of SSB have greater odds of having caries and erosion, and higher caries rates than people who consume smaller amounts. Baseline levels of SSB consumption were high in Chile, and increased further after implementation of the Sugar Tax. Between 2011/12 and 2016/17 there was a net movement from low to high consumption levels for all socioeconomic groups, suggesting that future consumption levels will continue to expose the population to serious dental risk. The apparent failure of the policy might be explained by sub-optimal design resulting from a policymaking process that was more focused on raising revenue than improving population health, and which lacked transparency, public awareness and a clear evidence base.

Conclusion: Chile's Sugar Tax had the potential to reduce SSB consumption and lower the population risk of oral disease, but policy implementation was flawed. Taxation policy remains a potentially useful tool for improving dental public health, but a more public health oriented and evidence-informed policymaking process is required, which combines taxation changes with complementary public health approaches.

Table of Contents

List of Tables

List of Figures

Acknowledgements

There are many people who I am grateful for their help and support. Firstly, I would like to thank my supervisors, Professor Tim Doran, Professor Karen Bloor and Dr Jo Taylor, for their time and commitment throughout my PhD and for the continued guidance, support, encouragement and patience they provided me in the last four years. I also thank my Thesis Advisory Panel members, Dr Vishal Aggarwal and Professor Richard Cookson, for their guidance and help.

I am grateful to my sponsor Becas Chile - CONICYT for providing me with the funding I needed to conduct my PhD. My thanks also go to the participants who gave their time to take part in my research.

I would like of course to express my eternal gratitude to my family, especially my husband Carlos Solar, who has been an inspiration and has always believed in me and supported me unconditionally in all my adventures since I met him. I am also grateful to my son Nicolás who gave me the most precious gift of becoming a mom during the PhD and my soon-to-be born baby that gave me the last encouragement to finish the thesis.

Finally, but not last I would like to thank my friends and fellow PhD students and all those I met during my PhD journey for the time and extra boost that they gave me during these past four years.

Author's declaration

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

Parts of this PhD thesis have been disseminated in the following formats:

1. Article in a peer-reviewed journal:

Valenzuela, M. J., Waterhouse, B., Aggarwal, V.R., Bloor, K., Doran, T. (2021). Effect of sugar-sweetened beverages on oral health: a systematic review and meta-analysis. *European Journal of Public Health*, 1;31(1):122-129. [Impact Factor: 2.391].

2. Conference presentations:

Valenzuela, M. J., Waterhouse, B., Aggarwal, V.R., Bloor, K., Doran, T. (2019). The effect of sugar-sweetened beverages on oral health: a systematic review and dose-response meta-analysis. Poster presentation at the British Society for Oral and Dental Research (BSODR) Annual Conference, Leeds, UK.

Valenzuela, M. J., Aggarwal, V., Bloor, K., Taylor, J. and Doran, T. (2018). Attitudes to the Sugar-Tax in Chile: Implications for Oral Health. *Journal of Dental Research*, 97 (Spec Iss B): abstract no. 0769. Poster presentation at the International Association for Dental Research (IADR), General Session, London, UK.

3. Protocol publications:

Valenzuela, M. J., Waterhouse, B., Aggarwal, V.R., Bloor, K., Doran, T. (2017). The effect of sugar-sweetened beverages on oral health: a systematic review. *PROSPERO: International prospective register of systematic reviews*, CRD42018088720.

Chapter 1

Introduction, aims and thesis structure

1.1 Thesis rationale

Sugar-sweetened beverage (SSB) consumption has increased rapidly across the globe, as these products are cheap and readily available almost everywhere (Tahmassebi and BaniHani, 2020). The most significant recent increase in SSB consumption has been among children and adolescents, particularly those from low-socioeconomic backgrounds (Restrepo and Cantor, 2020). Evidence shows that excess SSB consumption is associated with an increased risk of several health conditions, such as overweight, obesity, type 2 diabetes and other cardiovascular conditions (Malik et al., 2010). The high content of sugars and acids in SSB has also been linked to an increased risk of dental caries and tooth erosion (Tahmassebi et al., 2006). Although greater prevention efforts and treatment advances have led to an overall improvement in oral health, dental caries remains the most prevalent non-communicable disease (NCD) worldwide (Do, 2012). The World Health Organization (WHO) estimates that between 60 and 90% of school children and the vast majority of adults have suffered from dental caries and around half of the global population tooth erosion (Petersen et al., 2005). In the United Kingdom, for example, dental caries is the most common cause for 5 to 9-year-olds to be admitted to hospital and the number of hospital tooth extractions on 0–4-year-olds have risen 24% over the last decade (Quinlan, 2017; BaniHani et al., 2018).

Dental diseases seriously impact individuals and populations. If untreated, dental problems cause pain, discomfort, and functional impairments, which eventually affect the oral health-related quality of life (Bagramian, Garcia-Godoy and Volpe, 2009). Poor oral health also affects social well-being, such as school children's attendance, performance and productivity (Seirawan, Faust and Mulligan, 2012). Dental diseases also impose a substantial economic burden on societies, including direct costs (treatment expenditures) and indirect costs (reduced productivity due to work or school absence) (Peres et al., 2019). The global economic impact of dental diseases has been estimated to be around US$544 billion (Righolt et al., 2018).

A wide range of factors, some beyond the control of individuals, influence behaviours and lifestyle choices associated with disease risk. These factors are known as the social and commercial determinants of health, which are important underlying drivers of poor oral health (WHO, 2008; Peres et al., 2019). Although dental diseases are largely preventable, prevalence rates remain very high and very unequal, reflecting widespread social and economic inequalities. The evidence shows a strong relationship between dental caries and tooth erosion and socioeconomic status (Bagramian et al., 2009; Peres and Vargas-Ferreira, 2021). Moreover, oral diseases are socially patterned across the entire social spectrum with a clear association between social status and oral health, as there is between social status and other health outcomes (this is often referred to as the social gradient in health) (Watt and Sheiham, 2012).

The social gradient in oral health inequalities has important policy implications. Given that general and oral health inequalities have persisted and even widened in recent years, future health policy should address the underlying social and commercial causes (Watt and Sheiham, 2012). Implementing public policies such as sugar taxes and marketing and advertising restrictions has, however, become challenging for governments, given the food and beverage industries' economic interests and the influence they often have with policymakers and the policy decisions they make (McKee and Stuckler, 2018). Companies use a wide range of strategies, such as funding sympathetic research, using the media to distract attention and lobbying politicians.

Despite this pressure, some governments have implemented fiscal policies such as placing taxes on SSB as a strategy to discourage SSB consumption and prevent the continued increase in associated chronic diseases (Howlett and Ramesh, 2003; Sassi et al., 2018). These relatively coercive policies raise philosophical questions around the role of the State in restricting individual choice with respect to the amount of sugar consumed, although proponents argue that the State has a duty to protect public health and reduce levels of sugar consumption when market failures occur (Mytton, Clarke and Rayner, 2012). Varied strategies, such as education programmes and treatment-oriented policies have been widely implemented around the world to improve diets and reduce the burden of NCD and oral diseases. Although understanding the need to reduce SSB consumption is an important step in behaviour change, knowledge alone is often not sufficient to change dietary behaviour (Worsley, 2002). Likewise, treatment-oriented strategies, which currently dominate the approach

taken by governments to address oral health problems, does not tackle the underlying causes of oral diseases, nor does it meet the needs of the whole population (Watt et al., 2019). Interest from politicians and academics in fiscal policies has increased over the last decade. Based on the economic theory of demand and supply, which implies that by increasing the price of unhealthy food items consumption patterns would shift toward a more healthful diet, many governments have adopted SSB taxes to improve health outcomes (Glied and Smith, 2011).

Research on countries that have adopted SSB taxes has demonstrated that the policy encourages SSB companies to reformulate their products and that price increases effectively reduce SSB purchases after about a year of policy implementation (Colchero et al., 2016; Scarborough et al., 2020). Recent evidence indicates that at least some part of the SSB tax is being passed through to consumers in higher retail prices, and beverage availability is reduced (Cawley et al., 2019). Studies also suggest that SSB taxes are most effective in lower socioeconomic groups, which report the highest SSB consumption levels and are more responsive to price increases (Backholer et al., 2016). There is some emerging evidence showing that taxing SSB has a positive impact discouraging SSB consumption, leading to an improvement of health outcomes (Popkin and Hawkes, 2016). Modelling evaluations in OECD countries (for example, Mexico and Hungary) have shown significant health gains after implementing a tax on foods. However, these analyses focus on weight gain and type 2 diabetes, giving little attention to oral health outcomes.

Although dental caries is the most prevalent chronic disease worldwide, dental health is commonly thought of in purely cosmetic terms and is neglected in both academic studies of NCDs and in health policy prioritization (Do, 2012; Benzian et al., 2011; Watt et al., 2019). As many scholars have shown, sugar is the primary and necessary factor for dental caries, so restricting them using fiscal policies could significantly reduce the prevalence of dental diseases (Moynihan and Kelly, 2014). Oral health has, however, become marginalised from mainstream health policies and healthcare systems (Peres et al., 2019). Instead, many local governments put their efforts towards a treatment approach, knowing that dental treatment alone is insufficient to reduce the burden of oral diseases and could even widen oral health inequalities (Watt, 2012). A similar pattern is found in the research community. Limited knowledge exists about the effect of SSB taxes on dental health outcomes, as this has been the focus of very few studies. Instead, much of the current literature emphasises

the effect of SSB taxes on purchases, revenue, and NCDs such as obesity and type 2 diabetes, giving little attention to the impact of oral health policy.

Chile, a high-income country, has been identified as one of the largest SSB consumers globally (Popkin and Hawkes, 2016). In October 2014, the National Congress passed a tax policy on SSB as part of extensive reforms to the taxation system, called *Reforma Tributaria* (RT, in Spanish). The existing tax on sugary beverages (called *Impuesto Adicional a las Bebidas Azucaradas* (in Spanish, IABA), which had been in effect since 1960), was adjusted in two ways. The IABA tax was increased from 13% to 18% for beverages with a sugar content greater than 6.25 g/100ml of sugar and reduced from 13% to 10% for those with less than this sugar amount (BCN, 2015). Chile's public health policies have been recognised worldwide, including the implementation of pioneer policies such as the SSB Tax, front-of-package labelling and strict marketing regulations (FAO and OPS, 2018). Global attention on public health in Chile is the result of policy efforts to improve the population's health and reduce chronic diseases.

Chile's SSB consumption levels and the introduction of the Sugar Tax policy position the country as an interesting case study to investigate the effect of this policy on oral health. Four particular aspects of Chile's Sugar Tax, which make the policy unique globally and interesting to study, may also tarnish its public health impact. First, existing evidence suggests that the tax has to be at least 20% to drive behaviour change and reduce consumption (Brownell et al., 2009; Sowa et al., 2019). Second, the policy's design may not be optimal, as low and even no-sugar beverages are taxed. Third, while the policy has great potential as a public health strategy, Chile's Sugar Tax was conceived under a financial umbrella whose central aim was to collect revenue, not to reduce SSB consumption. Finally, limited information is available concerning the characteristics and context of policy implementation.

These knowledge gaps and uncertainty led me to conduct this PhD thesis. Understanding the policy's design, formulation, and implementation becomes critical to investigate the potential impact on oral health and to inform the development of evidence-based oral health prevention policies locally and perhaps in some neighbouring countries (Hill and Varone, 2017). This is particularly useful in Chile, considering its active role in designing and implementing relevant policies. The inclusion of oral health as the outcome of interest contributes to the limited research

activity concerning the effect of SSB on oral health and is intended to increase the visibility of oral health as part of the political agenda.

1.2 Thesis overall aim and objectives

The overall aim of this PhD thesis is to assess the effect of the Sugar Tax policy on oral health using a convergent mixed methods research design. This project is grounded in the pragmatic paradigm with two research strands: a quantitative strand and a qualitative strand. Each strand has its objectives as follows:

Quantitative strand objectives:

- To explore associations between the consumption of sugar-sweetened beverages, dental caries and tooth erosion, and to identify the strength of these associations in the general population.
- To describe changes in SSB consumption levels following implementation of the Chilean Sugar Tax policy in 2014 and variation in these changes by socioeconomic status.

Qualitative strand objective:

- To increase understanding of Chile's Sugar Tax policy's policymaking process and explore the policy implications on oral health.

1.3 Thesis structure

In **Chapter 2**, I provide the background and context to the thesis overall aim and objectives. I describe global sugar and SSB consumption trends, the mechanisms linking their consumption to adverse health outcomes and the implications for oral health inequalities. In this chapter I also outline the theory behind the use of fiscal policies to reduce SSB consumption and the context in which Chile's Sugar Tax policy was designed and implemented temporally and geographically.

In **Chapter 3**, I provide an overview of the methods and methodological approaches I used in this PhD thesis. I describe the methodology that informed the design and methods and the research paradigm underpinning the studies. In this chapter I set out the rationale for using a mixed methods research design with its advantages and challenges. I conclude the chapter by discussing the quality and rigour of mixed methods research.

In **Chapters 4 and 5,** I describe the two studies that comprise the quantitative research strand in this mixed methods thesis. In **Chapter 4**, I describe the first study

that is a systematic review of the literature. In this chapter I provide a description of the methods I followed to conduct this study and the findings of the pooled estimates from 23 empirical studies that measured the association between SSB consumption and dental caries and tooth erosion using meta-analyses and dose-response analysis.

The second quantitative strand study is a secondary analysis of survey data from two waves of the Chilean Household Budget Survey (Encuesta de Presupuestos Familiares - EPF), one before and one after the implementation of Chile's Sugar Tax. In **Chapter 5**, I describe the rationale for this study and the methods that I chose to use and the steps I followed to prepare and analyse the datasets. I finish the chapter by providing a description of the findings from the surveys and from a combination with the results from the Systematic Review (Chapter 4) using tables and graphs.

In **Chapters 6 and 7** I describe the qualitative case study. In **Chapter 6,** I provide a detailed account of the methodology and methods' rationale, including the underpinning research paradigm. I describe the selection and recruitment of the sample and the approaches that informed the data analysis, and discuss the credibility and trustworthiness, and ethical considerations of this study. **Chapter 7** follows with the qualitative study findings. In this chapter I begin with a brief description of the final themes and sub-themes and I follow with the findings providing quotes to evidence the origin of the data interpretations.

Finally, I integrate the findings from each study with reference to the wider literature in **Chapter 8**. I begin with a summary of the main findings. Next, I integrate the findings using a narrative approach and a joint display table by thesis overall aim and objectives to combine, compare, and contrast the three studies' results, assess the fit of the integrated data and provide a more comprehensive understanding of the potential effect of the Sugar Tax on oral health. I also discuss implications for policy and future research and the strengths and weaknesses of this thesis overall and each study in particular. I finish the chapter with a conclusion.

Chapter 2
Background

This chapter provides contextual background, outlining the importance of oral health in the field of health policy, especially in the context of the worldwide implementation of SSB taxes. I begin by defining sugars and sugar-sweetened beverages (SSB) to set a common understanding of terms. Next, I describe global trends in sugar and SSB consumption and the mechanisms linking them to health outcomes, emphasising dental caries and tooth erosion. I then outline current public health policies to reduce SSB consumption, providing an insight into the economic theory of taxation and the arguments behind current debates, and follow by describing the potential effects of the policy. I continue by providing an overview of Chile's contextual background and current legislations to reduce sugar consumption and the burden of oral diseases, and follow with a description of Chile's Sugar Tax policy. I finish the chapter by examining the potential benefits of SSB taxes to the oral health of populations.

Throughout this PhD thesis, when I write about Chile's SSB tax policy, I refer to the 'Sugar Tax' to make a distinction between SSB taxes from Chile and other countries.

2.1 Classification and definitions of sugars and sugar-sweetened beverages

Many terms are used to classify and describe dietary sugars. Examples used in the literature include total, added and free sugars; discretionary sugars and intrinsic sugars; and milk and non-milk extrinsic sugars. Whilst the term 'total sugars' refer to all sugars irrespective of the source, the terms 'free sugars' and 'added sugars' refer to sugars added to foods and beverages by the manufacturer, cook or consumer. They differ in that free sugars include sugars from honey, natural syrups, fruit juices and concentrates, whereas added sugars do not (WHO, 2015). In this PhD thesis, when I mention 'sugars', I refer to 'added sugars', which are most relevant to health.

Intrinsic sugars are naturally integrated into the cellular structure of unprocessed food, i.e. fruits and vegetables, containing mainly fructose, glucose and sucrose, and are usually accompanied by other nutrients. Extrinsic sugars, in turn, refer to sugars added to foods. Lactose present in milk is extrinsic because it is not found

within the cellular structure; however, due to its important nutritional value, the term non-milk extrinsic sugars was introduced to indicate the group of sugars, other than intrinsic and milk sugars, that should be restricted in the diet (Cummings and Stephen, 2007). Intrinsic and milk sugars are not considered detrimental to health (WHO, 2015).

Total sugars are mono- and disaccharides (Cummings and Stephen, 2007). Single sugar molecules form monosaccharides, and the main three are glucose, fructose and galactose. The combination of any of them form disaccharides, which main two are sucrose and lactose.

From the monosaccharides group, glucose and fructose are found in honey, fruits and berries. Glucose is the most important energy source for the body because it is the only type of sugar used as fuel for physiological brain function (Mergenthaler et al., 2013). People with diabetes usually use fructose as a sweetener because it does not produce a glycaemic response; however, this has prompted a recent debate over whether the long-term consumption of diets high in fructose may increase energy intake, weight gain, and obesity (Elliott et al., 2002).

Sucrose, made of equal parts of glucose and fructose, is present in fruits, berries and vegetables, and can be extracted from sugar cane and beet. High Fructose Corn Syrup (HFCS) is produced from corn, and it is also a combination of glucose and fructose; however, the difference with sucrose is that HFCS has 55% fructose and 45% glucose. Another disaccharide is lactose, made of galactose and glucose and is naturally present in milk (Lustig, 2012).

SSB are one of the primary sugar sources in many people's diet and variously referred to as carbonated drinks, soft drinks, fizzy drinks, sugary drinks, soda, pop and cola (Duffey and Popkin, 2008). SSB include the full spectrum of carbonated beverages, still and fruit beverages, concentrates, flavoured waters and energy and sports drinks (BSDA, 2016). They are non-alcoholic, and can be carbonated (containing carbon dioxide) or non-carbonated. They can also be caffeinated, i.e. colas and some energy drinks, or caffeine-free, i.e. some fruit-flavoured fizzy drinks. Non-carbonated SSB include fruit drinks, ice tea, vitamin drinks and concentrates. Whether or not carbonated, SSB typically contain water, sugars (sucrose, glucose or fructose), sweeteners, acids (citric acid, malic acid, and phosphoric acid), fruit juice, preservatives, flavourings and colours (Tahmassebi and BaniHani, 2020).

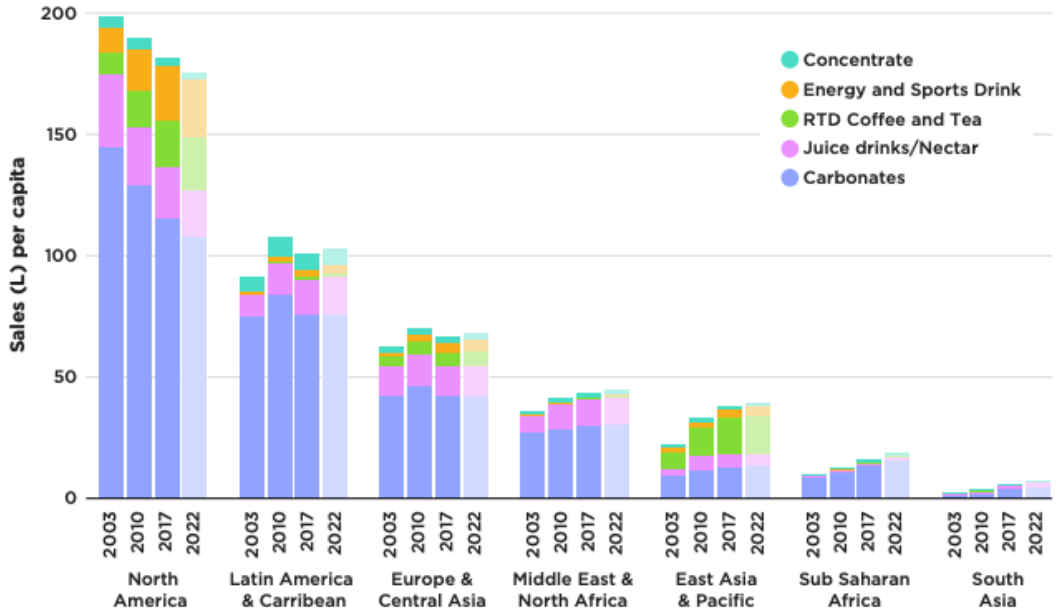
Low or zero calorie beverages contain no sugars. Instead, they are artificially sweetened with sucralose, stevia, aspartame or another non-nutritive chemical. They

were introduced by the beverage industry with an implied contribution to wellness, such as increased potential for weight loss (Pereira, 2013).

2.2 SSB consumption and health

Global SSB consumption trends in the form of SSB vary by region and country (Lustig, Schmidt and Brindis, 2012). Overall, SSB sales volumes have been declining in most high-income countries after a peak reached in 2000. In contrast, SSB sales volumes in low- and middle-income countries have been showing a steady upward trend (Figure 1) (Della Corte et al., 2021).

Figure 1. Per capita SSB sales volume (L) by region from 2003-2017, with a projection to 2022 (from TWB, 2020; source: Euromonitor Passport Global Market Information Database. Note: RTD, ready to drink)



A study on global SSB consumption found that adults consume an average of 132ml per day worldwide, and SSB consumption is higher among young adults from the Americas region particularly in parts of Latin America and the Caribbean (Singh et al., 2015). SSB constitute the largest sugar source in the diets of most children, adolescents, and young adults. SSB account for around 70% of added sugar consumption in Mexico and around 40% in the US and Brazil (Pereira et al., 2015; Sanchez-Pimienta et al., 2016; Marriott et al., 2019). SSB also contribute significantly to dietary energy intakes around the world. The Americas Region reports the most significant amount of per-person daily calories sold from SSB worldwide, with the highest per capita volumes in Chile, Mexico, the US and Argentina (Popkin and Hawkes, 2016). A US study reported that around 60% of 2-19-year-olds consumed

SSB every day, equivalent to an average of 143 kcal during 2011-2014 (Rosinger et al., 2017).

The association between sugar consumption and adverse health outcomes has been well established in the literature. Several systematic reviews and meta-analyses of the effect of sugar and SSB consumption on general and oral health show that increased consumption of high-sugar foods and SSB is associated with many non-communicable diseases (NCD), such as obesity, type 2 diabetes, cardiovascular diseases, cancer, osteoporosis, and dental caries, both in children and adults (Te Morenga, Mallard and Mann, 2013; Moynihan and Kelly, 2014; Vartanian, Schwartz and Brownell, 2007; Malik et al., 2013; Yin et al., 2021).

A variety of mechanisms explain the link between sugar consumption and adverse health outcomes. Persistently high sugar consumption elevates triglycerides and blood pressure levels, lowers HDL cholesterol levels, and leads to insulin resistance, thereby increasing the risk for coronary heart disease and type 2 diabetes (Malik et al., 2013). However, the direct link between sugar consumption and type 2 diabetes is still unclear. Lean and Te Morenga (2016) argue that type 2 diabetes is a consequence of weight gain and lifestyles in which increased consumption of SSB is a common feature. Others have found that reducing SSB consumption results in weight loss and improvements in metabolic health (Bray and Popkin, 2013).

Artificially-sweetened beverages have also been linked to adverse health conditions. Because they are sugar-free, they do not provide calories; however, evidence from cohort studies suggests that these beverages do not help people control their weight. On the contrary, consumption of low or zero calorie beverages is associated with increases in weight and waist circumference (Azad et al., 2017; Piernas et al., 2014). Due to the lack of nutritional components, heavy consumers of artificially-sweetened beverages usually compensate for the absence of caloric energy with food (Piernas et al., 2014). Findings from a study with school-children showed that those who consumed 266ml/day of SSB or more, on average, consumed around 200kcal/day more than non-consumers (Harnack, Stang and Story, 1999). A high caloric diet might happen because both artificial sweeteners and sugars consumed in beverages bypass psychological regulatory controls, so they do not feel as full as if they had eaten the same calories from solids (Pan and Hu, 2011).

High SSB consumption poses a serious public health problem as it has high economic and societal costs (Atalah, 2012; Mullee et al., 2019). In 2010, an estimated

184,000 deaths and 8.5 million disability-adjusted life years (DALYs) worldwide were attributable to SSB consumption (Singh et al., 2015). Around 80% of all deaths and DALYs linked to SSB consumption occurred in low- and middle-income countries (Singh et al., 2015). Overweight and obesity are estimated to account for 3.4 million deaths per year and 93.6 million DALYs (Lim et al., 2013). In the US, medical costs directly related to obesity are around $190 billion per year (Cawley and Meyerhoefer, 2012). Such costs could have serious repercussions, particularly in low-income countries.

2.2.1 SSB consumption and oral health

Increasing fluoride use trends and better oral hygiene practices have led to an overall improvement of oral health; however, tooth erosion remains a common oral condition, and dental caries is still the most prevalent chronic disease worldwide (Do, 2012). The Global Burden of Disease Study 2017 suggests that 3.5 billion people live with dental conditions worldwide, and untreated dental caries in permanent teeth accounts for 34% of the global prevalence (GBD, 2018). This proportion has remained almost unchanged over the last 30 years, with only a 4% decrease in the prevalence of untreated dental caries globally from 1990 to 2017 (Peres et al., 2019). The prevalence of tooth erosion ranges widely, given different indices and criteria to measure this condition. According to a recent systematic review around a third of children and adolescents have tooth erosion in permanent teeth (Salas et al., 2015; Peres and Vargas-Ferreira, 2021).

Both conditions have been associated with dietary habits (Lussi et al., 2004). The acidity and sugar content of SSB may lead to a simultaneous occurrence of dental caries and tooth erosion. The evidence suggests that people with dental caries are at a higher risk of developing tooth erosion (Dugmore and Rock, 2004; Ab Halim et al., 2018). The mechanism and the location of the lesions, however, are usually different. Whilst tooth erosion occurs in plaque-free sites, dental caries is often located in plaque-accumulation areas (Peres and Vargas-Ferreira, 2021). Plaque-accumulation areas are those sites where it is more difficult to clean mechanically and therefore are likely to increase bacterial adhesion. These are more common in the margin between the tooth and gum, fissures in the occlusal surfaces and in-between teeth (Marsh and Martin, 2009).

For a long time, dental caries was considered a multifactorial disease; however, now sugars are considered not only a significant contributor but the necessary factor

for the initiation and progression of this disease (Moynihan and Kelly, 2014; Sheiham and James, 2015). The evidence now shows that factors such as salivary flow and fluoride exposure modify the cariogenic process. In the absence of sugars, the chain of causation is broken, and the disease does not occur (Sheiham and James, 2014; Heilmann et al., 2021). Wartime studies show that before the World War II, in countries where sugar consumption was very low, dental caries was almost non-existent (Takeuchi, 1961).

SSB contain large amounts of sugars in the form of sucrose or HFCS. A regular SSB 350 ml can, for example, contains around 35 g of sugar. Dental caries occurs when the endogenous bacteria in the biofilm produce organic acids due to fermentable carbohydrates' metabolism, such as sugars from the diet. As a result, the equilibrium between tooth minerals and oral microbial biofilms is disrupted, and demineralisation occurs (Scheie and Petersen, 2004). However, the early stage of demineralisation can be reversed by re-mineralising the affected surface by restoring the pH with fluoride and saliva, which act as a buffer. If the pH is not restored, the bacterial acids dissolve the surface, and the lesion appears as a white spot (Featherstone, 2008). If the lesion progresses, it may lead to cavitation, a condition that may cause significant pain and discomfort, which can end up in infection and sepsis if spread to the dental pulp (Peres et al., 2021).

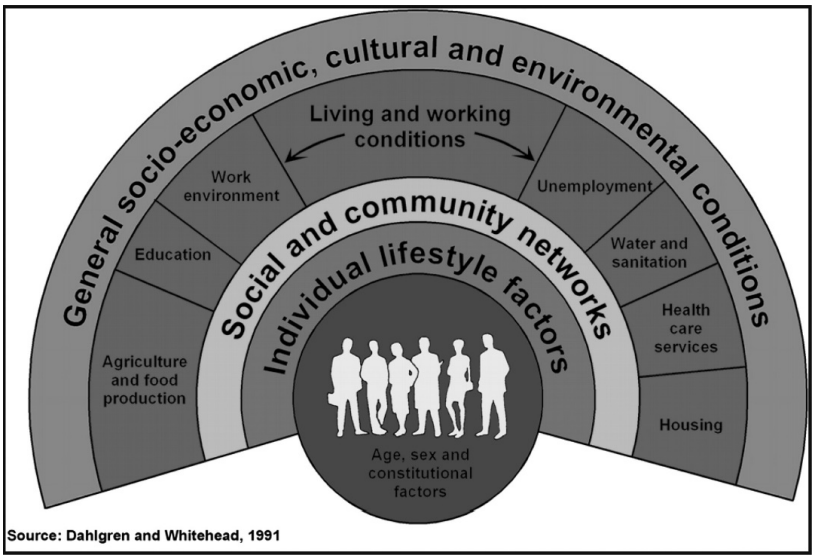
In contrast, tooth erosion is a chemical-mechanical process caused by intrinsic and extrinsic acids, such as gastro-oesophageal reflux and SSB, not by bacteria (Peres and Vargas-Ferreira, 2021). One of the main factors linked to a higher risk of tooth erosion is SSB consumption because regardless of sugar content, SSB are highly acidic (Auad and Moynihan, 2007). Even artificially-sweetened beverages contain similar phosphoric and citric acid levels compared to regular SSB (Tahmassebi and BaniHani, 2020). Overall, SSB are highly acidic with an average pH of 3.4, whereas the mouth's normal pH is around 7 (neutral) (Chowdhury et al., 2018). When the oral pH drops below 5.5, demineralisation and erosive damage on the tooth's surface occur (Stephan and Miller, 1943; Tahmassebi and BaniHani, 2020). This leads to the loss of calcium and phosphate from the mineral substance of the tooth.

2.3 Oral health inequalities

Health inequalities are variations in health between social groups that are systematic, socially determined and judged to be unfair (Whitehead and Dahlgren, 2006; Singh et

al., 2021). As these variations in health are systematic, they are universal, being found in every country, and are largely beyond the individual's control. In common with general health inequalities, oral health inequalities are caused by a series of conditions known as the social determinants of health (Figure 2). Marmot (2007) describes the social determinants as "the fundamental structures of social hierarchy and the socially determined conditions these create in which people grow, live, work, and age" (p.1153).

Figure 2. The social determinants of health model (Dahlgren and Whitehead, 1991)



Although significant improvements in health determinants such as rising living standards and reductions in smoking rates have led to overall improvements in people's general and oral health in recent years, these improvements have not benefited individuals with lower socioeconomic status (SES) to the same extent (Guarnizo-Herreño et al., 2021). Health and oral health inequalities have therefore persisted, and in some cases widened. In most countries, there remains a strong relationship between SES and the prevalence of dental caries (Bagramian et al., 2009; Peres and Vargas-Ferreira, 2021), with decreasing status associated with increasing caries (Watt and Sheiham, 2012). This social gradient appears to be universal, even in high-income countries with low indices of people living in poor conditions (Leon et al., 2001; Poulton et al., 2002). Low SES in early life is particularly strongly associated with adverse oral health outcomes (Shearer et al., 2012), and experiencing poverty during childhood up to the age of 15 negatively affects dental caries experience, oral health-related behaviours, and dental service use (Peres et al., 2018). For tooth erosion, however, the evidence remains inconclusive; some studies have reported that tooth erosion is higher among high SES groups, and others have found the opposite (Peres

and Vargas-Ferreira, 2021). This might be due to different dietary habits among socioeconomic strata between developing and developed countries.

The social gradient in oral health inequalities has important policy implications. Given that general and oral health inequalities have persisted and even widened in recent years, future health policy should be informed by an understanding of the underlying causes of health inequalities (Watt and Sheiham, 2012). Dental researchers have traditionally focused their attention on oral diseases' biological and behavioural aspects; however, they alone do not explain health inequalities. Focussing solely on individual 'lifestyle' ignores the complex array of social and environmental factors that influence people's choices. A social determinants perspective widens the focus on the distal structural factors that are the underlying drivers of the proximal biological and behavioural determinants of oral health inequalities patterns.

Through the Commission on Social Determinants of Health (CSDH), the WHO has been an active actor setting a global public health policy agenda to reduce health inequalities (WHO, 2008). The CSDH proposed a framework for action highlighting the importance of addressing the structural determinants of health inequalities. These include the socioeconomic and political contexts that determine the social hierarchy in any society. Watt and Sheiham (2012) proposed a modified version of the CSDH framework that considers the broader causes of oral health inequalities in the general population (Figure 3), and Peres and colleagues (2019) further adapted the framework combining the social with the commercial determinants of oral health (Figure 4).

Figure 3. Conceptual model for oral health inequalities (Watt and Sheiham, 2012)

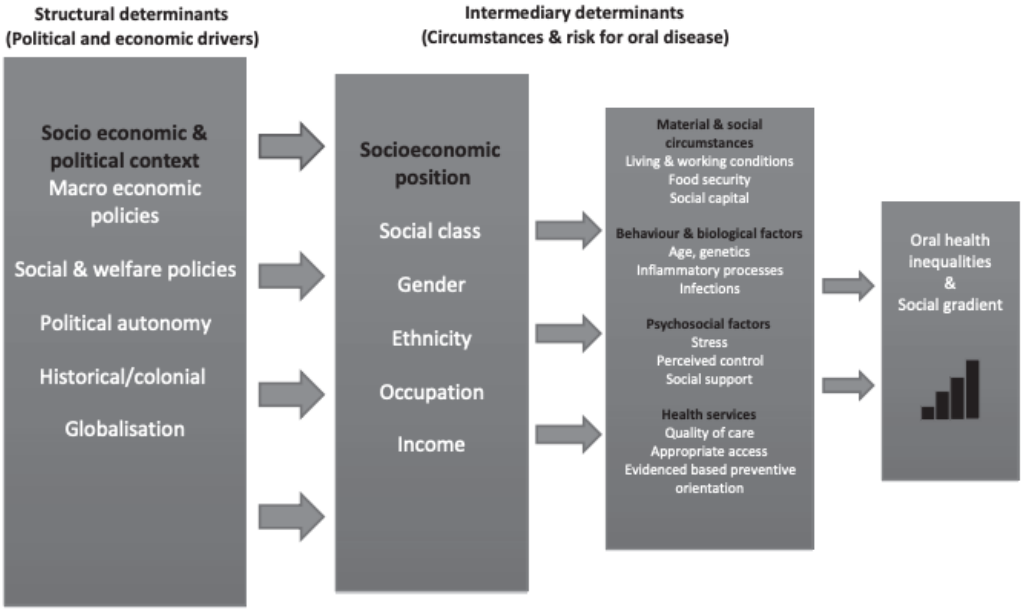
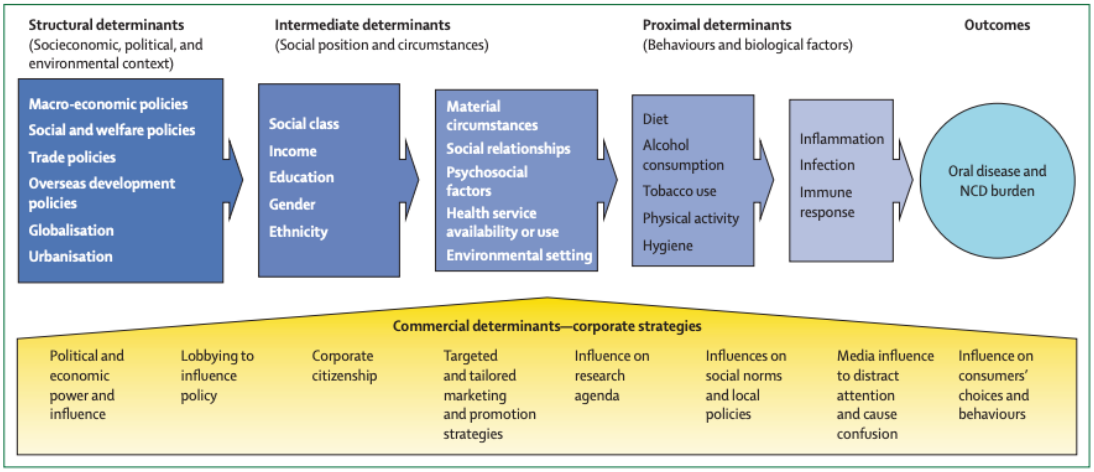


Figure 4. Social and commercial determinants of oral diseases (Peres et al., 2019)



The commercial determinants of health are the strategies that corporate companies use to promote their products and induce choices and consumption of items that are detrimental to health (Kickbusch et al., 2016). Commercial determinants of health impose a significant challenge to local governments in their efforts to prevent NCD as it goes against the industry sector's interests. The SSB industry is an excellent example of a powerful industry relevant to oral health.

Regardless of developmental level, the evidence suggests a strong association between people living in places with more significant social inequalities in health or lower socioeconomic status with increased sugar and SSB consumption (Mazarello Paes et al., 2015, Bolt-Evensen et al., 2018). This could be explained as foods and

beverages high in sugar are usually cheaper, readily available and heavily marketed. In contrast, healthier options, apart from tap water, are often more expensive, creating an economic barrier for people with reduced resources. The food and beverage industry plays an important role in promoting sugar and SSB consumption, especially in low-SES groups (Watt and Rouxel, 2012). The international SSB market is dominated by a small number of companies, particularly by Coca-Cola and PepsiCo. These two corporations alone account for more than a third of the global SSB sales (Nestle, 2015). Coca-Cola, PepsiCo, and the American Beverage Association spent around $114 million lobbying at the US federal level between 2009 and 2015 (Kickbusch et al., 2016). The SSB industry also spends large amounts of money advertising and marketing its products. In 2018, US SSB companies spent $1.04 billion on advertising SSB and energy drinks in addition to the $21 billion spent on advertising of children's sweetened beverages (Harris et al., 2020).

Marketing strategies usually target children and adolescents and are particularly intense in low-SES neighbourhoods, where highly-processed foods and SSB are in high demanded due to their relatively low price (Roberto et al., 2015). This is important as early exposure to highly-processed foods shapes children's preferences for unhealthy products later in life (Volkow et al., 2013). Taste preferences and cravings for sweetness are often identified as key elements associated with increased SSB consumption, along with a strong social component as SSB are deeply rooted in family and cultural norms (Theodore et al., 2011; Ortega-Avila et al., 2019).

Policies designed to reduce sugar and SSB consumption can have a significant impact on population oral health. Moreover, as these items' consumption is usually higher in low-SES communities, these policies also tend to reduce oral health inequalities (Guarnizo-Herreño et al., 2021). However, implementing public policies such as sugar taxes and marketing and advertising restrictions has become challenging to local governments, given the food and beverage industries' economic interests and the power they can exert over policymakers (McKee and Stuckler, 2018).

Addressing the social, economic, political and commercial root causes of poor oral health and inequalities is necessary to create conditions conducive to better health (Watt and Sheiham, 2012). However, the distribution of relevant resources to oral public health is mainly determined by political decisions on public policies and oral diseases are usually neglected and rarely considered a priority in public policy (Benzian et al., 2011). Oral health conditions have been isolated from mainstream

health policies and healthcare systems and many local and national governments have focused on a treatment approach in tackling the burden of oral diseases. However, dental treatment alone is insufficient to reduce the burden of oral diseases and could even widen oral health inequalities (Watt, 2012). Moreover, oral diseases remain untreated in most places because the associated costs exceed the available resources (Peres et al., 2019). There has been an increased recognition that clinical approaches need to move to policy-oriented initiatives. This would tackle oral health inequalities at the structural level focusing on the social determinants of health and the common risks factors for oral diseases and other NCDs, such as consumption of sugar, SSB, tobacco and alcohol (Bedos et al., 2017; Peres et al., 2019).

2.4 Public health strategies to reduce SSB consumption

Despite declines in sugar and SSB consumption in some countries, consumption levels still exceed local government and international organisations' recommendations (Guarnizo-Herreño et al., 2021). Tackling sugar consumption has now shifted from being a peripheral topic to mainstream global public health priority (Watt et al., 2019). Several health-related entities have taken action and published guidelines with sugar intake recommendations for adults and children and many countries have implemented fiscal policies and interventions to reduce consumption (Thow and Hawkes, 2014). In 2015 the WHO published a report that strongly recommended reducing the intake of sugars to less than 10% of total daily energy intake and included a conditional recommendation to further reduce the intake to 5% of total energy intake (WHO, 2015). However, some scholars claim that to prevent dental caries, the daily sugar consumption should be even lower and not exceed 3% of the total energy intake (Sheiham and James, 2014). The American Heart Association in the US, the Canadian Heart and Stroke Foundation and The Scientific Advisory Committee on Nutrition (SACN) in the UK published similar guidelines that recommend no more than 10% of calories from added sugars. Ideally, it should be less than 5% (Nestle et al., 2015).

These recommendations have led health officials into a comprehensive policy action on unhealthy diets. Most policies aim to create supportive environments with high-sugar products less affordable, acceptable and available, and healthier alternatives more accessible. For example, the World Cancer Research Fund International (WCRFI) framework 'NOURISHING' recognises health policies within three domains, all mutually reinforcing, to promote healthy eating. These are food environment, food system and behaviour change communication, and across these

three domains, there are ten evidence-informed policy areas (Table 1). This framework helps identify policies that have been successful elsewhere and report, categorise, and monitor policy actions around the world (Hawkes, Jewell and Allen, 2013).

Table 1. NOURISHING Framework policy areas

Domain		Policy Area for Action
Food Environment	N	Nutrition label standards and regulations on the use of claims and implied claims on foods
	O	Offer healthy foods and set standards in public institutions and other specific settings
	U	**Use economic tools to address food affordability and purchase incentives**
	R	Restrict food advertising and other forms of commercial promotion
	I	Improve the quality of the food supply
	S	Set incentives and rules to create a healthy retail environment
Food System	H	Harness supply chain and actions across sectors to ensure coherence with health
Behaviour Change Communication	I	Inform people about food and nutrition through public awareness
	N	Nutrition advice and counselling in health care settings
	G	Give nutrition education and skills

Governments have considered many strategies to improve diets and reduce the burden of NCD and oral diseases, and consensus is emerging that SSB taxes are one of the most effective approaches to reduce sugar consumption (WCRFI, 2018). However, prevention of NCD and oral disease is complex and will not be solved by a single policy measure, rather a comprehensive and coordinated set of interventions aimed at tackling these health problems is required. These interventions should be

based on evidence-based recommendations and include marketing regulations and nutrition labelling.

Public health campaigns are beneficial in raising awareness and even changing attitudes towards healthy living; however, evidence shows little success in reducing diseases' risk when individually focused approaches are taken (Worsley, 2002). Dietary guidelines provide useful information on what constitutes a healthy diet; however, people's compliance with guidelines is low, suggesting that this approach should be complemented with other intervention strategies to encourage an active behaviour change (Hendrie et al., 2017). Conversely, evidence from alcohol and tobacco prevention strategies has demonstrated that public regulation and market intervention in the supply side, such as taxes, effectively reduce consumption and related health outcomes (Moodie et al., 2013). Policies should be mutually integrative, ensuring that people are fully informed about healthy diets and surrounded by a healthy environment reinforced by a supportive food system (Lustig et al., 2012).

2.5 SSB tax policies

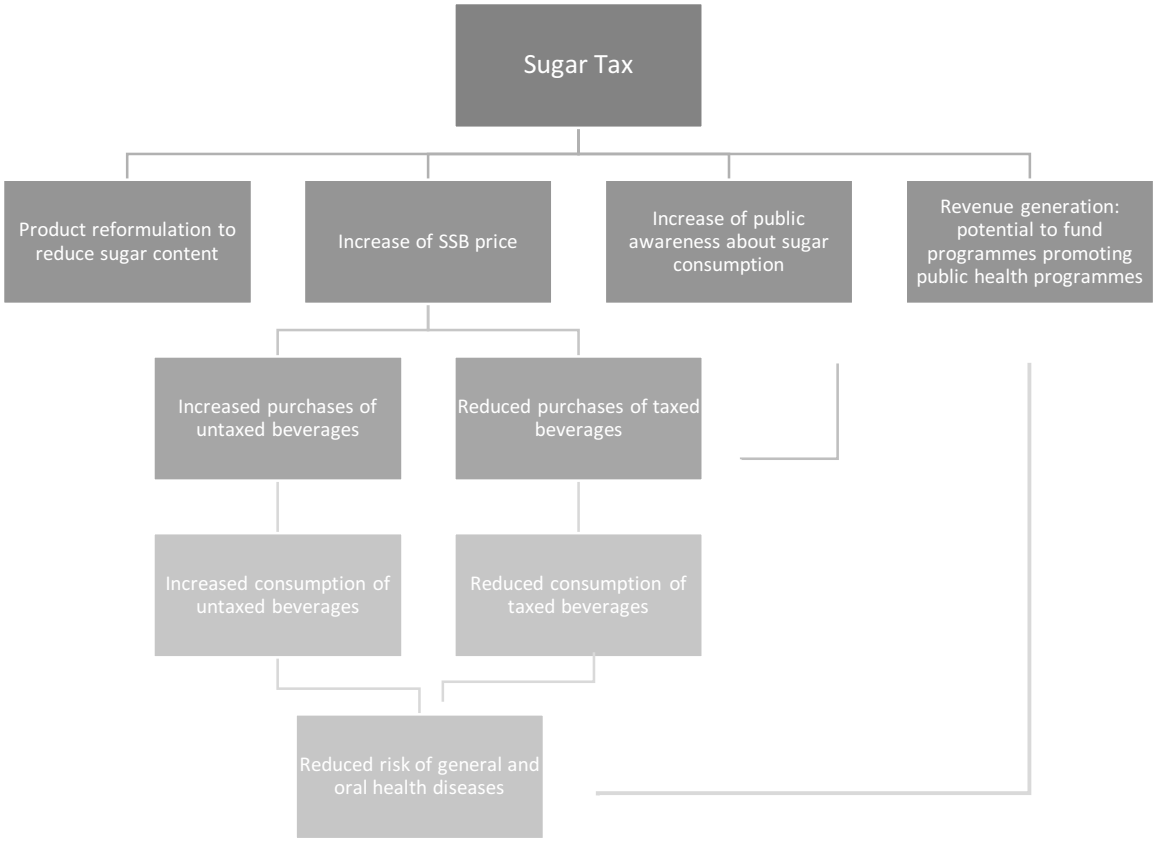
During the last ten years, many countries and cities have enacted SSB taxes. Interventions differ in magnitude, type of SSB taxed and the form in which the tax is applied. Taxes can be levied as an excise tax, before sales to producers, or as a sales tax to consumers. SSB taxes can be specific or ad-valorem. Whilst specific taxes are applied based on product volume or sugar content, e.g., 1 cent per ounce, ad-valorem taxes are applied as a percentage of the product value, e.g., 10% of the price (Cawley et al., 2019). The SSB tax has also been expanded to high-sugar foods. Countries such as Chile, France, and Berkley (California, US) only taxed SSB, whereas others also applied this policy to high-density foods. For example, Mexico combined a specific excise tax of 1 peso/L on SSB (approximately 10% price increase) and an ad-valorem tax of 8% on several high energy-dense foods with more than 275 cal/100 gr (Colchero et al., 2016). Hungary and Finland are other examples. Hungary levied a tax on foods high in sugar, fat or salt and sugary drinks, and Finland on sweets, ice cream and soft drinks (WHO, 2016).

The use of tax policies to reduce sugar and SSB consumption builds on the assumption that increasing the price of unhealthy foods and beverages, compared to that of more healthy items, will eventually shift consumption patterns toward a healthier diet and outcomes (Lustig, 2012). This assumption has generally been effective for

alcohol and tobacco; however, dietary changes are more complex because food is essential for humans and because usually, healthier options are more expensive (Glied and Smith, 2011).

An integral component of a successful design, implementation, monitoring, and evaluation of the SSB tax policy is understanding the pathways through which SSB taxes operate (WCRFI, 2018). Figure 5 illustrates how the SSB tax may affect SSB consumption and reduce the risk of NCD and oral diseases.

Figure 5. Sugar Tax pathways of effect (adapted from World Cancer Research Fund International. Building momentum: lessons on implementing a robust sugar sweetened beverage tax, 2018).



2.5.1 The economic rationale for the SSB Tax

According to neoclassical welfare economics, the government should not intervene in the allocation of goods and resources unless there are critical market failures (Cawley et al., 2019). However, other commentators assert that governments are accountable for aspects of public health and when exposures to marketed goods become harmful, governments have a duty to intervene to restrict consumption (Mytton, Clarke and

Rayner, 2012). Taxation is one of the four public policy approaches to address market failures relating to addictive substances, in addition to the provision of information, regulations and prohibition (Glied and Smith, 2011). Market failures result in harmful consumption, preventable deaths, and high economic costs to society. Two main market failures have been described for SSB. First, due to internalities - future costs that consumers impose on themselves through their behaviour in the present. The evidence shows that people sometimes ignore effects that may be harmful or beneficial to themselves. This may happen because they do not fully understand the consequences of their overconsumption because of misinformation, or they chose to ignore them. Due to time-inconsistent preferences, a person may choose to consume SSB despite having full knowledge about health's potential risks. This behaviour may be due to believing that the enjoyment driven by the SSB outweighs any health harms (Allcot et al., 2019). The second market failure results from financial externalities. These are external costs that consumers impose on others from their consumption behaviours (Brownell et al., 2009). SSB consumption may impose external costs on society because healthcare systems spend large amounts of money treating health conditions associated with sugar and SSB consumption. These costs may be passed on to society through higher taxes to fund the health care system and higher private health insurance premiums. Therefore, taxation policies internalise external costs by adding the price that reflects the marginal harm imposed on society to the market price when the individual buys SSB (Glied and Smith, 2011).

Taxing policies follow the economic theory of supply and demand, which predicts that as a product's price increases, the consumer will be less likely to afford it. Thus, consumption will decrease. Modelling studies of SSB consumption have found that purchasing patterns respond to price. This is particularly relevant for people from lower SES groups as they are more sensitive to price changes than other groups (Powell et al., 2013; Backholer et al., 2016). Therefore, they are more likely to change behaviours due to a tax increase. However, the extent of the response may vary across countries due to differences in incomes, cultural factors, local SSB preferences, and availability and prices of other items that can act as substitutes (Drewnowski and Darmon, 2005). The extent of consumption change is dependent on the price elasticity of demand, which measures the percentage change in consumption for one percentage change in price. A systematic review estimated that the price elasticity for SSB is in the range of –0.8 to –1.0 (Andreyeva, Long and Brownell, 2010), i.e. a one percent increase in price leads to a 0.8 to 1.0 percent reduction in consumption.

However, another review suggested a higher SSB price elasticity of around -1.21 (Powell et al., 2013). Both estimates indicate that any price increase would have to be at least 20% to translate into a meaningful impact on health outcomes (Brownell et al., 2009).

2.5.2 The tax debate

Regulatory policies to reduce the consumption of harmful items often face opposition. Opponents use common strategies to resist the introduction of such regulations, and the claims against the SSB tax have been similar to those used against tobacco and alcohol taxes (Hilton et al., 2019). Common claims include that this policy is not effective, is highly regressive, affects small business, employment and economic growth. These claims have been used mainly by the SSB industry and marketers, the principal opponents to implementing SSB taxes in many countries. The industry usually fights back by lobbying politicians and public officials, encourage voters to oppose public health regulations, undermines the current scientific evidence by funding their own research that typically shows contrary evidence and presents their claims in the media to persuade mass audiences (Hilton et al., 2019).

Many arguments challenge the SSB industry claims. The regressive claim can be countered with evidence showing that low-SES people face a disproportionate burden of sugar-related diseases, especially the youngest due to SSB overconsumption (Sassi et al., 2018). Therefore, SSB taxes impose a progressive way to rebalance the regressive health impacts of SSB. If the price of harmful products increases, purchasing and consumption will decrease as low-SES consumers have been more responsive to price changes, thus increasing the likelihood of suffering from NCD and healthcare costs (Powell et al., 2013). Those from low-SES backgrounds would also benefit from tax revenues if used for health programmes to reduce health inequalities (Wright et al., 2017). Going further, if revenues are used to subsidise healthier beverages, that may alleviate the regressive criticism and maximise health gains (Cawley et al., 2019). Moreover, if SSB are more expensive than water, consumers will likely shift to a more affordable option, and the poor would be benefited by improving health and lowering their expenses in beverages.

The SSB industry also claims that taxes would cause job losses, harm businesses and hurt the economy. Opponents claim that taxes will reduce jobs, which would affect struggling families and the entire economy. However, the evidence shows

the opposite (Mounsey et al., 2020). Improvements in health from SSB taxes benefit the economy rather than harming it. Studies from the US and Mexico have found that SSB taxes have not impacted employment rates in beverage manufacturing or the food industry (Powell et al., 2014; Guerrero-Lopez et al., 2017). Moreover, people who stop buying unhealthy beverages are likely to start buying healthier options, which will benefit other businesses (Colchero et al., 2016).

The claim about lack of effectiveness is based on the idea that consumers will substitute taxed beverages with other unhealthy products. However, as already described, well-designed SSB taxes have shown to be effective in reducing SSB purchases and consumption. Further claims from the opposition include that SSB taxes are discriminatory, that other foods contain equally large amounts of sugar and that they are unconstitutional or illegal (Niederdeppe et al., 2013; Tselengidis and Östergren, 2019).

2.5.3 Evidence of effectiveness

There has been substantial progress in introducing SSB taxes in several countries and cities (WCRFI, 2018). There is growing evidence showing that SSB taxes effectively reduce purchases, consumption and the prevalence of diseases caused by excess sugar consumption. Modelling studies have also predicted that SSB taxes could save millions of years of life (Park and Yu, 2019; Hangoma et al., 2020).

Mexico was one of the first countries to introduce the SSB tax. The policy consisted of 1 peso per litre of beverage, approximately 10% increase in price. Economic evaluations of the Mexican SSB Tax found that after a year of implementation, on average, SSB sales decreased by 6% and 8.2% over two years (Colchero et al., 2015; Barrientos-Gutierrez et al., 2017). The decrease in SSB consumption was higher among lower and higher-SES consumers, the two income groups with the most significant health risk (Ng et al., 2019). A year after implementation, SSB purchases reduced by 17% amongst the lowest SES group of the population compared to 12% on average (Colchero et al., 2016). A recent study found that the Mexican tax also had a positive effect on oral health (Hernandez et al., 2021) (see section 2.7 for more details). The Philadelphia, US 1.5 cents per ounce of SSB tax policy, that corresponds on average to a 21% increase in price, was found to reduce SSB purchases by 51%; however, in border cities, volume sales increased by 24.4% (Roberto et al., 2019).

Apart from significantly reduced SSB consumption, evidence also suggests that SSB taxes lead to an increase in consumption of healthier beverages, such as water and milk (Roache and Gostin, 2019; Restrepo and Cantor, 2020). In Mexico, water purchases increased by around 4% after the first year of tax implementation (Colchero et al., 2016).

SSB taxes have also been effective in reducing SSB consumption and improving health in low-SES societies who have shown to be more responsive to price increases (Backholer et al., 2016; Teng et al., 2019). This is particularly relevant as those from low-SES backgrounds often suffer from an increased risk of NCD as they generally consume higher volumes of SSB (Allcot et al., 2019).

Another benefit associated with the SSB tax implementation is that these policies often increase public awareness of the potential harms of SSB and incentivise the beverage industry to reformulate their products and shift their markets into healthier beverages (Briggs et al., 2017). In the UK, a study found that after introducing a sugar levy in 2018, which consisted in £0.24 per litre on drinks with >8 g total sugar per 100 ml and £0.18 per litre on drinks with 5–8-grams of sugar per 100 ml, the industry reformulated most of its products and reduced sugar content (PHE, 2018).

SSB taxes also have the potential to generate increased revenue for local governments. This revenue has a great potential to support other efforts on reducing diseases related to sugar consumption (Roache and Gostin, 2019; Hangoma et al., 2020). The allocation of the revenue can reduce the additional cost imposed on society and provide incentives for healthy foods. In Berkeley, after its US 1 cent per ounce volume-based excise tax on SSB, around US$2 million of SSB tax revenue has been allocated to programmes designed to improve diets and reduce SSB consumption. In Mexico, the SSB tax generated approximately US$1.2 billion in 2014 (Roache and Gostin, 2019). In some countries, such as the UK, collected revenue goes directly to prevention programmes related to oral and general health. In others, such as Chile, tax revenues cannot be earmarked and go the general fund. There are many arguments against earmarked taxes, however, the ability to earmark the generated revenue to fund social and health strategies may increase SSB taxes' success and the public and political acceptability (Jou et al., 2014). Also, earmarking the tax for social and public goods helps policymakers counter regressive arguments against the tax.

2.6 Chile's health and social demographics

With an estimated population of around 19 million inhabitants in 2019, Chile stretches along 4,329 km in Latin America's southern cone, between the Andes Mountains and the Pacific Ocean.

After returning to democracy in 1990, Chile has experienced substantial economic and political stabilities (Burrows, 2008). In 2010, it entered the Organization for Economic Co-operation and Development (OECD) and started to be categorised as a high-income country by the World Bank (The World Bank, 2016). Its gross domestic product (GDP) was estimated to reach US$ 12,938 per capita in 2016, with low inflation and low employment (IMF, 2016). People living under poverty went from 39% in the early 1990s to 14.4% in 2013. Illiteracy, average years of education, and primary and secondary school attendance also improved significantly in the same period (Vasquez et al., 2013). This success largely stems from good socioeconomic living conditions; however, Chile ranks first in income inequality at least among OECD countries (OECD, 2014). While the upper quintile holds 50% of the total income, the lowest one only holds 6% (Vasquez et al., 2013). Likewise, the GDP per capita of two out of 15 administrative regions (Metropolitan and Antofagasta) account for more than half of Chile's total GDP.

Those from lower SES are 70% more likely to suffer hypertension, 60% more likely to be obese and twice as likely to have diabetes as those from higher SES groups (MINSAL, 2003). The last National Health Survey in 2016/17 showed that one out of ten adolescents between 15 and 19 years were obese, and one third were overweight (MINSAL, 2017). Adults in Latin America with excess weight account for more than half of the population. Chileans have the highest proportion of overweight, obese and extremely obese (BMI ≥40 kg/m²) adults. Adding up these three conditions, for every three adults, two suffer from excess weight (MINSAL, 2017). Overweight and obesity account for 234.107 DALYS (6.3% of the total) and 7.877 deaths (9.1% of the total) (MINSAL, 2007).

The burden of oral diseases among Chileans is high compared to other developed countries. While 70% of 6-year-old children have experienced dental caries (Soto, 2007), this proportion is much higher (98%) among adults (MINSAL, 2003). As in many countries, health authorities have committed to tackling oral health inequalities. However, current public policies have somewhat turned into a restorative treatment approach instead of tackling health's structural determinants (Schendicke et al., 2015).

The current administration has committed to equity in health, and its strategies and programmes are designed to reduce inequalities; however, they have been slow in reducing the gap (Gattini and Alvarez-Leiva, 2011).

Chile has been identified as one of the largest consumers of SSB globally. In 2014, Chile was the highest per capita daily SSB consumer worldwide while also recording the highest SSB consumption growth rate between 2009–2014 (Popkin and Hawkes, 2016). The Chilean National Food Consumption Survey (2010–2012) shows that the median consumption of SSB is close to 500 ml per day in children (Araneda et al., 2015). Such consumption levels can be compared with the highest-consuming 5% of United States children (Nakamura et al., 2018).

2.6.1 Policy context and legislations

The economic and political context of a country is a major driver of population health and inequalities (Navarro, 2006). Studies show that the social conditions in which people live are a crucial factor determining the distribution of health, and the political context shapes these conditions. Politicians decide which health problems are a priority for the government, and based on them, economic and social policies are designed and implemented (Brennenstuhl et al., 2012). Therefore, it becomes necessary to provide a brief overview of Chile's economic and political context relevant to the SSB tax.

Given the high levels of sugar consumption and NCD related to their consumption, Chilean authorities introduced a comprehensive set of prevention policies to regulate how SSB and other energy-dense foods were packaged, marketed and sold. Following the Sugar Tax implementation, in June 2016, the food labelling and marketing regulation Law came into effect (Corvalán et al., 2018). The Front-of-Package (FOP) policy consisted of mandatory “HIGH IN” black warning labels on all packaged beverages and foods if they exceeded the following thresholds (Figure 6). For calories, 275 calories/100g or 70 calories/100ml; for saturated fat, 4g/100g or 3g/100ml; for sugar, 10g/100g or 5g/100ml; and for sodium, 400mg/100g or 100mg/100ml. The second part of the Law consisted of restrictions to TV, radio and magazine promotion, marketing, and advertising of food items with the “HIGH IN” labels directed to children under 14 years-old and their sales in pre-school, primary and secondary schools. This ban also included promotional strategies and incentives, such

as cartoons, animations, interactive games, apps and toys that could attract children's attention.

Figure 6. Front-of-package (FOP) warning labels – Chile's Food Labelling and Advertising Law (Law 20.606)

ALTO EN CALORIAS: High in calories, ALTO EN AZUCARES: High in sugar, ALTO EN SODIO: High in sodium and ALTO EN GRASAS SATURADAS: High in saturated fat.

Several strategies have been adopted to reduce the burden of oral diseases, including water fluoridation, tobacco regulation, formulation of oral health goals, and recommendations on healthy eating. Water fluoridation was introduced in 1969 and was the first oral health policy ever implemented in Chile. Currently, 14 out of 15 regions have access to fluoridated drinking water covering around 82.3% of the urban population (Gomez et al., 2010).

Acknowledging the risks that tobacco poses to general and dental health, the government has taken several measures to regulate the tobacco industry. Since 2013 smoking has been prohibited in all enclosed spaces accessible to the public or for collective commercial use. Moreover, all forms of tobacco advertising, promotion and sponsorship have been banned, including advertisements at the points of sale, warnings covering 50% of the packages of all tobacco products are now required, and tobacco prevention is included in all levels of educational curricula.

The Ministry of Health introduced a list of goals under the National Health Objectives for the decade 2011 to 2020 that included prioritising the oral health of children and adolescents up to 20 years-old for which varied programmes have been introduced (MINSAL, 2010). Two to five-year-old children attending public schools and nurseries are covered by the 'Sembrando Sonrisas' programme introduced in 2015 by President Bachelet. They receive oral health examination, oral hygiene educational sessions, free toothpaste and brushes, and fluoride varnish applications per year. Additionally, those aged 2 to 4, 12 and 17 are entitled to receive free dental care. However, this only applies to those that are covered by the public health system (FONASA). Through the dental Explicit Health Guarantees programme (GES, for its

acronym in Spanish) introduced in 2005, all newborns with cleft palate and 6-year-olds, regardless of socioeconomic background, are granted the right to access dental care within a certain period; with maximum co-payments; and quality standards guaranteed by the state (Minsal, 2010).

Unfortunately, when people get older, dental coverage is less comprehensive. For Chileans older than 20 years, who retain an expectation of comprehensive dental care (Henríquez-Tejo and Flores, 2016), it is increasingly difficult to access dental care coverage. Among those covered are some women and 60-year-olds. Pregnant women over 20 years receive dental treatment during the pregnancy period through the GES policy. Additionally, focused on the most vulnerable women in Chile, the current administration also implemented “Más Sonrisas para Chile” (translated as more smiles for Chile), which only benefits women from low socioeconomic status. Therefore, women who are not pregnant and come from a higher SES and men over 20 years only receive free dental care through emergency consultations that are also part of the GES programme. However, when adults turn 60 years-old, they can opt for dental care through the GES policy but only until they turn 61 years.

In summary, although the Ministry of Health has committed to take prevention and promotion actions over oral health, most policies still seem to be treatment-oriented. Dental caries poses a significant public health challenge to any local government. The evidence shows that it is more efficient to tackle the causes and primary causal factors of dental caries and erosion, which are dietary sugars, rather than opting for dental treatments, which are expensive and downstream (Heilmann et al., 2021; Watt, 2012).

2.6.2 Chile’s Sugar Tax policy

The Chilean National Congress passed a tax policy on SSB in the context of an extensive reform to the taxation system, Law 20780, called Reforma Tributaria (RT, in Spanish). This reform was announced in April 2014, approved in September 2014, and implemented in October 2014. The reform introduced various adjustments in the taxation system to increase tax revenues by around 3% of gross domestic product (GDP) to finance a structural reform to the education system, social programmes, redistribute income and cover fiscal deficits (BCN, 2015).

Since 1960, all-naturally or artificially sweetened non-alcoholic beverages, energy or hypertonic drinks, syrups and mineral or thermal waters with added

colouring, flavouring or sweeteners, had an ad-valorem tax applied under a policy called Impuesto Adicional a las Bebidas Azucaradas (in Spanish, IABA) (Escalona, 2014). The tax rate went through multiple modifications until 1974, when it was fixed at 13%. With the RT, the Sugar Tax rate was increased from 13% to 18% for beverages with a sugar content greater than 6.25 grams (g) per 100 millilitres (ml) of sugar and reduced from 13% to 10% for SSB below this threshold (BCN, 2015). This created an 8% tax difference between both beverage groups. The initial plan was to increase the tax by 5% for all SSB containing any added sugar. However, after some political negotiations in congress ahead of its implementation, the policy was changed to a two-tiered tax. Beverages such as plain milk and flavoured sweetened milk-based drinks, 100% fruit juices, and plain water, remained untaxed. To put into perspective, if the tax was fully transmitted to the consumer price, a typical 500-ml SSB would increase from about 500 to 525 pesos. In contrast, with a typical 500 ml low or no sugar SSB, the price would decrease from about 500 to 485 pesos (Nakamura et al., 2018).

Chile was the first country to introduce a two-tiered tax on SSB. Other countries followed, such as the United Kingdom, Estonia, Panama and Peru, among others. However, Chile's Sugar tax structure still differs from other SSB tax policies as artificially-sweetened beverages are also taxed. For example, in Mexico and South Africa, SSB tax policies applied a single rate to all sugar-sweetened non-dairy and non-alcoholic beverages without taxing beverages with artificial sweeteners (Colchero et al., 2015; Stacey et al., 2019). The Philadelphia SSB tax is similar to Chile's Sugar tax as the policy includes artificially sweetened beverages. However, it differs in that it is a single rate to all beverages, regardless of sugar level (Roberto et al., 2019). The United Kingdom SSB levy is also two-tiered, with a differential tax rate depending on sugar content; however, this policy excludes artificially sweetened beverages (PHE, 2018).

2.7 SSB taxes to reduce the burden of oral diseases

Although the mechanisms linking SSB consumption to dental caries and tooth erosion are well established, evidence of the impact of the SSB tax on oral health outcomes is currently limited and still needs further research (Sowa et al., 2019).

Dental caries is often ignored when NCD are studied despite being the most prevalent chronic disease worldwide (Do, 2012; Watt et al., 2019). As I already described in section 2.2.1, a substantial body of evidence has documented the relationship of dental health with sugar and SSB consumption. However, only a limited

number of studies have estimated the SSB tax effect on dental health outcomes, which might be due to the misconception of oral health importance on general health. This is shown in health policy documents where dental caries is rarely considered a public health problem and is commonly excluded from the NCD group. For example, the WHO's global action for the prevention and control of NCD emphasises the need to improve diet to reduce obesity and type 2 diabetes risks. However, it does not even mention dental caries (WHO, 2013). Moreover, when improvement of unhealthy diet is the approach considered to reduce the burden of oral diseases, guidelines and recommendations of intake amount are the most common approaches considered, whereas tackling this problem by using tools at the national policy level as the SSB tax, is rarely proposed (Benzian et al., 2011). Oral health needs to be considered integral to overall health for an effective fight against NCD and oral diseases. The revenue generated by SSB taxes presents an opportunity to integrate oral health prevention efforts into general health promotion (Bedi, 2018; Wordley et al., 2017).

A small number of studies estimating the effect of SSB taxes on oral health has been published in the literature. They all suggest that SSB taxes have the potential to decrease the incidence of caries; however, the majority are modelling or simulation based studies; the exception being one conducted by Hernandez and colleagues (2021) using the case of Mexico. The modelling studies commonly assume increases in SSB prices of around 20% but most of them differ in the type of tax, the products covered and the baseline SSB consumption levels.

Schwendicke and colleagues (2016) found that a 20% SSB tax would significantly reduce the number of caries, especially among low-income young male adults. Over ten years, the mean (SD) net caries increment at the population level would be 82.27 (1.15) million teeth at 20% SSB tax, compared to 83.02 (1.08) million teeth with no tax, generating treatment costs of 2.64 (0.39) billion and 2.72 (0.35) billion euro, respectively. Similarly, Sowa et al. (2019) found that a 20% ad-valorem tax would lead to a reduction of 3.9 million units of decayed, missed, filled teeth (DMFT) over ten years in the Australian adult population. The researchers also found that this tax could result in healthcare cost savings of A$666 million. Another study found that a 20% SSB tax could prevent around 1,030,163 caries lesions in the Netherlands. Additionally, the policy could result in an average of 2.13 caries-free tooth years per person and reduce caries-related dental care expenditures by 159.01 million euros (Jevdjevic et al., 2019). However, researchers suggest that the SSB tax alone is unlikely to significantly impact oral health if it is not accompanied by a comprehensive

public health strategy aiming to reduce total sugar and SSB consumption. A recent Thai study found that implementing the proposed Thai SSB tax policy was expected to decrease dental caries' prevalence by only 1% by 2040. In contrast, a comprehensive policy was projected to decrease dental caries' prevalence by 21% (Urwannachotima et al., 2020). The study based on the Mexican SSB tax is the only study published to date that estimates changes in oral health after the implementation of SSB taxes using empirical data. Their results show statistically significant reductions in outpatient visits related to caries after the policy, a reduction in the probability of having experienced dental caries for all age groups, except for children under 5 years old and in the number of teeth with caries (Hernandez et al., 2021). However, this study considered the impact of both SSB and unhealthy food taxes as they were implemented simultaneously in Mexico in January 2014.

The low number of published studies investigating the impact of SSB taxes on oral health may be explained by the relatively recent implementation of SSB tax policies, the complex association between SSB consumption and oral health or simply, the rather low importance given to oral health problems in policy research (Watt et al., 2019). Therefore, further research is needed to understand the potential SSB tax effect on oral health.

2.8 Chapter summary

In this chapter I described how increased sugar and SSB consumption is an important risk factor for people's oral health and the importance of introducing upstream interventions to reduce consumption. Chile's SSB consumption is one of the highest in Latin America and represents one of the main sources of sugar in the Chilean diet. Although health officials have committed to take prevention and promotion actions over oral diseases and inequalities at the policy level, political interventions have been historically week and have been mostly treatment-oriented. The evidence shows that SSB taxes might be effective in reducing SSB consumption and therefore the prevalence of oral diseases; however, evidence of the impact of the SSB tax on oral health outcomes is currently limited and still needs further research. Chile's Sugar Tax represents a good case study to address this research gap as although the policy was implemented within a fiscal frame, it provides a good opportunity to study its potential effect in dental public health.

Chapter 3

Mixed Methods Methodology

In this chapter I describe the design and methods I used in this PhD thesis, and it is structured as follows. I begin by describing the methodological approaches that informed the design and methods, including the rationale for choosing the research paradigm underpinning this thesis. Then, I describe the mixed methods methodology generally and specifically for this thesis, with a brief discussion about why this research design best fitted the thesis's overall aim and objectives. Next, I provide a visual representation that summarises the research strands that formed this thesis and the rationale for the approaches I took to conduct these two strands. I follow by describing the advantages and challenges that arose while conducting this PhD thesis, in particular and that are inherent to mixed methods research, in general. To finish, I provide an overview of the quality standards that I followed to conduct this thesis.

3.1 Methodology

In this section I describe the research paradigm that informed this PhD thesis and the research design and methods I used to address the overall aim and objectives.

3.1.1 Philosophical foundation

All research studies are underpinned by philosophical assumptions that guide the researcher's choices about what questions to ask and how to answer these. Philosophical assumptions are beliefs and values brought by the researcher that inform research and are known as paradigms or worldviews. These assumptions vary according to how the researcher views the nature of reality, known as ontology, and how the researcher can learn about reality and what forms the basis of our knowledge, known as epistemology (Ritchie et al., 2014; Creswell and Plano Clark, 2018).

The main worldviews that traditionally are presented in research and oppose to each other are those of positivism/postpositivism and constructivism/interpretivism (Feilzer, 2010). To put it simply, the positivism paradigm identifies a single reality that is waiting to be discovered by objective inquiry and it is associated to quantitative research methods. In contrast, the constructivism paradigm follows the idea that there is no such thing as an objective and singular reality, instead it embraces the idea that subjective inquiry is the best option to do favouring the use of qualitative research

methods (Creswell & Plano Clark, 2007). Although there have been important advances in research, these two paradigms continue to be the dominating worldviews in research (Feilzer, 2010).

Mixed methods researchers, however, advocate for an integration of quantitative and qualitative research methods, therefore the use of only one of these two worldviews does not provide an appropriate framework for mixed methods research. In consequence, researchers have proposed a series of frameworks that accommodate the diverse nature of such research; however, consensus is still needed as different perspectives or philosophical positons have been documented in the literature that relate to mixed methods research (Feilzer, 2010).

According to Creswell and Plano Clark (2018), four paradigms can inform mixed methods research: postpositivism, constructivism, transformative and pragmatism. As already described, whilst the postpositivist worldview is mostly related to quantitative research and is based on objective and measurable facts, the constructivist worldview is typically seen as an approach to qualitative research, in which people construct subjective meanings of their experiences. In mixed methods research, for example, the study might begin with a survey, where researchers may be implicitly using a postpositivist worldview to inform their study, and then move to qualitative methods to explain the survey findings and the worldview shifts to a more constructivist perspective. The transformative worldview is concerned with social justice and human rights. These studies put their central focus on specific groups, such as those with disabilities or from low-socioeconomic status. The final and fourth paradigm is pragmatism that has been largely associated with mixed methods research and embraced by many mixed methods scholars (Tashakkori and Teddlie, 2003). This latter paradigm is the worldview that underpinned my PhD thesis.

Pragmatism accepts that there are singular and multiple realities that are open to empirical enquiry and orients itself toward solving practical research issues in the real world (Feilzer, 2010). It frees the researcher of mental and practical constraints imposed by the ‘‘forced choice dichotomy between postpositivism and constructivism’’ (Creswell & Plano Clark, 2007, p. 27). It focuses on the outcome, the research question, and the use of multiple research methods best to inform our understanding of the problem under study (Morgan, 2007). The pragmatism worldview's ontological belief is concerned with 'what works' and the practical implications of the research (Patton, 1990). Its epistemological belief focuses on using different methods and varied

data collection sources, which, when combined, provide a more comprehensive understanding of the research problem (Creswell and Plano Clark, 2018). The pragmatism philosophy has been used widely to underpin applied health research (Pope and Mays, 2006). This approach best fitted the context, the aim and objectives of this thesis as the emphasis of pragmatic health research is to provide a practical and flexible foundation to find the methods, techniques, and procedures to conduct research (Creswell, 2014). Although the methodologies of each study forming part of this thesis are often associated with particular worldviews, I took a pragmatic approach in how I decided to conduct the qualitative and quantitative studies.

3.1.2 Mixed methods research design

In this subsection I first define the overall characteristics of mixed methods designs, and then I provide a description of the design I used for this PhD thesis, along with the justification of why I chose this approach and its advantages and challenges.

Research designs are procedures for data collection, analysis, interpretation and reporting in research, and are an important component of any study as they guide the methods and decisions researchers take to conduct their research (Bowling, 2009). In this PhD thesis I adopted a convergent mixed methods research design suggested by Creswell and Plano Clark (2018); a decision based on the overall aim of this thesis and the foundations of the pragmatic paradigm on 'what works' and which method would make it work.

Mixed methods design allows for choices driven by the nature of the research problem without the limitations of qualitative and quantitative paradigms (Tashakkori and Teddlie, 2003). It is a comprehensive approach to conduct research that involves varied elements in terms of methods, process philosophy and design. There are several terms regarding the same approach, such as multi-method research, mixed methodology research, multiple research, and integrating methods research. However, the term mixed methods research has gained more popularity. It is now recognised as a separate methodological perspective for conducting research, which integrates evidence from quantitative and qualitative methods into a single study to increase understanding and strengthen the research's conclusion (Creswell, 2014; Johnson, Onwuegbuzie and Turner, 2007). This approach assumes that both qualitative and quantitative data provide different but highly valuable information, and the integration of findings results in a more comprehensive account of the research problem (Tashakkori

and Teddlie, 2003). Pluye and Hong (2014) pointed out the value of this research design in public health research:

> *"Mix[ed] methods combine the power of stories and the power of numbers. In public health, stories have the power to change policies, and statistics traditionally provide a strong rationale to make changes." (p.30*)

Many definitions have been suggested for mixed methods research. However, the definition provided by Creswell and Plano Clark (2018) attempts to be a complete explanation that highlights the methods and methodological orientation, emphasises the priority of the qualitative and quantitative data and describes the intent importance of the study:

> *"[Mixed methods research is a research design in which] the researcher collects and analyses both qualitative and quantitative data rigorously in response to research questions and hypotheses, integrates (or mixes or combines) the two forms of data and their results, organizes these procedures into specific research designs that provide the logic and procedures for conducting the study, and frames these procedures within theory and philosophy." (p.5)*

Quantitative methodologies are useful to address research questions about association, magnitude of effects or causality. On the other hand, qualitative methodologies are used, for example, to explore why or how a phenomenon occurs or to develop a theory. Mixed methods research draws upon the strengths of both methodologies, and it does not favour any of the two; instead, it prioritises both (Fetters et al., 2013; Tashakkorri and Teddlie, 2003). However, the priority or weight given to qualitative approaches compared to quantitative approaches within mixed methods research varies depending on the research questions, so they may or may not have equal weights within a study (Creswell and Plano Clark, 2011).

According to Creswell and Plano Clark (2018), three core designs exist for conducting mixed methods research: convergent, explanatory sequential and exploratory sequential design. These three serve to guide methods, decisions and procedures for collecting, analysing, interpreting and reporting data. The convergent design occurs when the findings of quantitative and qualitative studies are brought together to be compared or combined. This design aims to enhance the understanding of the research problem. The second design is the explanatory sequential design that begins with collecting and analysing quantitative data and follows with the collection and analysis of qualitative data. This design allows the researcher to explain the

findings of the first study qualitatively. The final design is the exploratory sequential design that, in contrast to the previous design, starts with the qualitative study and follows with the quantitative study. This design is usually employed when researchers want to generate new variables or develop new instruments for an intervention.

These core mixed methods designs can also be intercepted with other applications in research providing scope for further designs. Creswell and Plano Clark (2018) identify four 'complex' designs apart from the three core designs already described as they recognise the complexity of mixed methods research and the flexibility needed. These are the mixed methods experimental design, the mixed methods case study design, the mixed methods participatory-social justice design, and finally, the mixed methods evaluation design. However, the authors note that further mixed methods research designs might emerge as this field is still evolving and improving.

3.1.2.1 The mixed methods design of this thesis

To conduct this PhD thesis, I followed a convergent mixed methods design (Creswell and Plano Clark, 2018). Based on this design, this thesis involved two distinct and independent research method strands in which quantitative and qualitative data were collected in parallel, analysed separately, and then integrated in a later stage which findings are described in the final chapter (Chapter 8) (see Table 2 and Figure 7). The quantitative strand included two studies: a systematic review and a quantitative analysis of survey data. The systematic review aimed to estimate the effect of sugar-sweetened beverages (SSB) on dental caries and erosion using data from the literature; and the survey data analysis aimed to compare SSB consumption levels from before and after the Sugar Tax implementation using data from waves of a Chilean national representative survey. The second strand involved semi-structured interviews with policy actors from different sectors. This qualitative case study aimed to explore the policy actors' views on the Sugar Tax policymaking process and their perceived implications of the policy with oral health. I afforded equal priority to both strands for addressing the research problem as although they have different procedures for data collection and analysis and their own methodological approach, the intent of adopting this design was "to obtain different but complementary data on the same topic" (Morse, 1991, p.122). The three studies, therefore addressed different aspects of the research problem but they built together to enhance the understanding

of the potential impact of the Sugar Tax on oral health. See section 3.1.3 for the integration process of the studies' findings.

Table 2. Thesis objectives, required data and research methods

Study	Thesis objectives	Type of data needed	Research method
1	To explore associations between the consumption of SSB, dental caries and tooth erosion, and to identify the strength of these associations in the general population.	Quantitative data: SSB consumption and dental caries and erosion rates.	Systematic review of the literature with meta-analysis and dose-response analysis.
2	To describe changes in SSB consumption levels following implementation of the Chilean Sugar Tax policy in 2014 and variation in these changes by socioeconomic status.	Quantitative data: SSB expenditure data.	Secondary analysis of survey data from before and after the policy implementation.
3	To increase understanding of Chile's Sugar Tax policymaking process and explore its oral health implications.	Qualitative data: policy actors' perspectives from academia, government and non-government organisations and beverage industry.	Qualitative case study analysis of semi-structured interview data.

3.1.2.2 The rationale for using mixed methods design

In designing this mixed method study I used an emergent approach as the original design of the thesis changed direction throughout the thesis's planning. At the beginning of my PhD journey, I aimed to estimate quantitatively the impact of the Sugar Tax on dental health under a single methodological lens. However, somewhat unexpectedly and after some thinking and long reflection, it became obvious that a single research approach would be insufficient for achieving the thesis objectives. I realised that in order to fully understand the potential effect of the policy on oral health, the thesis needed to be complemented with qualitative methods to take into account the policymaking process and the context in which the policy was implemented. Therefore, drawing on policy analysis literature and methods, varied methodologies and 'what worked' based on the pragmatism worldview, the design of this thesis evolved from a purely quantitative study to a mixed methods study combining the use of quantitative and qualitative methods pragmatically and flexibly (Creswell and Plano Clark, 2011).

Four reasons justify my decision of using both quantitative and qualitative methods under a mixed method framework. Firstly, to estimate the policy's impact on the number and severity of dental caries and erosion, I considered the use of quantitative research methods essential. However, in light of the limited availability of oral health data sources in Chile, I had to employ two research approaches to achieve this aim. These formed the quantitative strand and included a systematic review that used meta-analysis and dose-response analysis to estimate the association between SSB consumption and dental caries and erosion, and secondary analysis of survey data to explore changes in SSB consumption from before and after the implementation of the Sugar Tax in Chile.

Secondly, when I attempted to describe the policy, I realised that partial information about its policymaking process was publicly available, which revealed the need to include qualitative research methods into the thesis to increase the understanding of the policy's potential.

Thirdly, as the mixed methods approach brings together different research procedures, it allowed me to build up a more comprehensive account of the potential effect of the Sugar Tax on oral health from different perspectives, using different data sources and bringing these together to enhance the integrity of findings (Johnson and Onwuegbuzie, 2004). This approach provided me with a better understanding of the multiple aspects of consuming SSB and the development of dental diseases.

Lastly, the integration between quantitative and qualitative methods allowed me to offset their inherent weaknesses and draw on the strengths of both types of research. Using purely quantitative research methods I would have overlooked a more complete picture of the policy effect on oral health and the context and the environment in which the policy was designed, formulated and implemented. Additionally, the perspectives about the policymaking process and the implication of the policy on oral health of those involved in the process would have been omitted (Yin, 2009). In contrast, using purely qualitative research methods would have prevented me with the opportunity to analyse data sources with information about SSB consumption and dental caries and erosion, a quality that was given by quantitative research methods (Araral et al., 2013).

3.1.3 Integration of findings

Most mixed methods researchers describe that the integration point of qualitative and quantitative data is one of the most important stages of mixed methods studies, and that it can significantly increase the quality of the research (O'Cathain et al., 2007; Bryman, 2006; Fetters et al., 2013, Creswell and Plano Clark, 2018). Integration is the point where qualitative research interfaces with quantitative research. It involves looking across the results from both strands to assess how the information addresses the overall research aim of the study (Creswell and Plano Clark, 2018). Many potential gains can accrue from integrating both methodologies; however, as Creswell and Plano Clark (2018) point out, it is important to select the best approach to integrate the data from these two research strategies based on the design of the mixed methods study.

Despite that the mixed methods literature is rapidly expanding, the recommendations and guidance in the literature on the practicalities for undertaking mixed methods integration are sparse and still under development (Guettermann et al., 2015). Varied approaches and strategies have been suggested. Zhang and Creswell (2013) in the context of health services research suggest that mixing qualitative and quantitative data can be done through connection, where one approach builds upon the findings of the other; embedding, where one type of data is embedded in the other; and integration, where qualitative and quantitative data are concurrently collected and analysed separately before being integrated in the interpretation stage.

According to Johnson and colleagues (2019), there are four common techniques to data integration:

- Data transformation or conversion: this technique involves transforming one type of data into the other type of data (i.e., qualitative into quantitative or vice versa).

- Visual representation of data using a joint display or matrix: brings the data together through a visual means (Fetters et al., 2013).

- Following a thread: this is a multi-stage technique that after conducting primary analysis, it identifies key themes and questions for further exploration (Moran-Ellis et al., 2006).

- Triangulation or comparison of data sets: data are collected separately and then combined at the interpretation stage to address if the findings agree or contradict each other (O'Cathain et al., 2010).

Fetters and colleagues (2013) suggest that integration can happen at the design, methods, and interpretation and reporting levels of research. However, Creswell and Plano Clark (2018) argue that integration should be based on the type of mixed methods design. These researchers describe three main techniques for data integration and representation of the results particularly for convergent mixed methods studies: through narrative, through data transformation, and through joint displays.

When integrating through narrative, researchers describe the qualitative and quantitative findings in a single or series of reports. There are three approaches: weaving, in which both findings are written together on a theme-by-theme basis; contiguous, where both findings are reported in different sections; and staged, in which the reporting is done by stages of the mixed methods study (Fetters et al., 2013).

The transformation approach involves transforming qualitative data into quantitative data, which can be done by transforming themes or codes into numeric counts and variables using content analysis so that the data can be integrated with a quantitative database. In contrast, quantitative data can be transformed into a qualitative format, for example, by converting study outcomes with variable strengths of association into qualitative levels (Pluye et al., 2005).

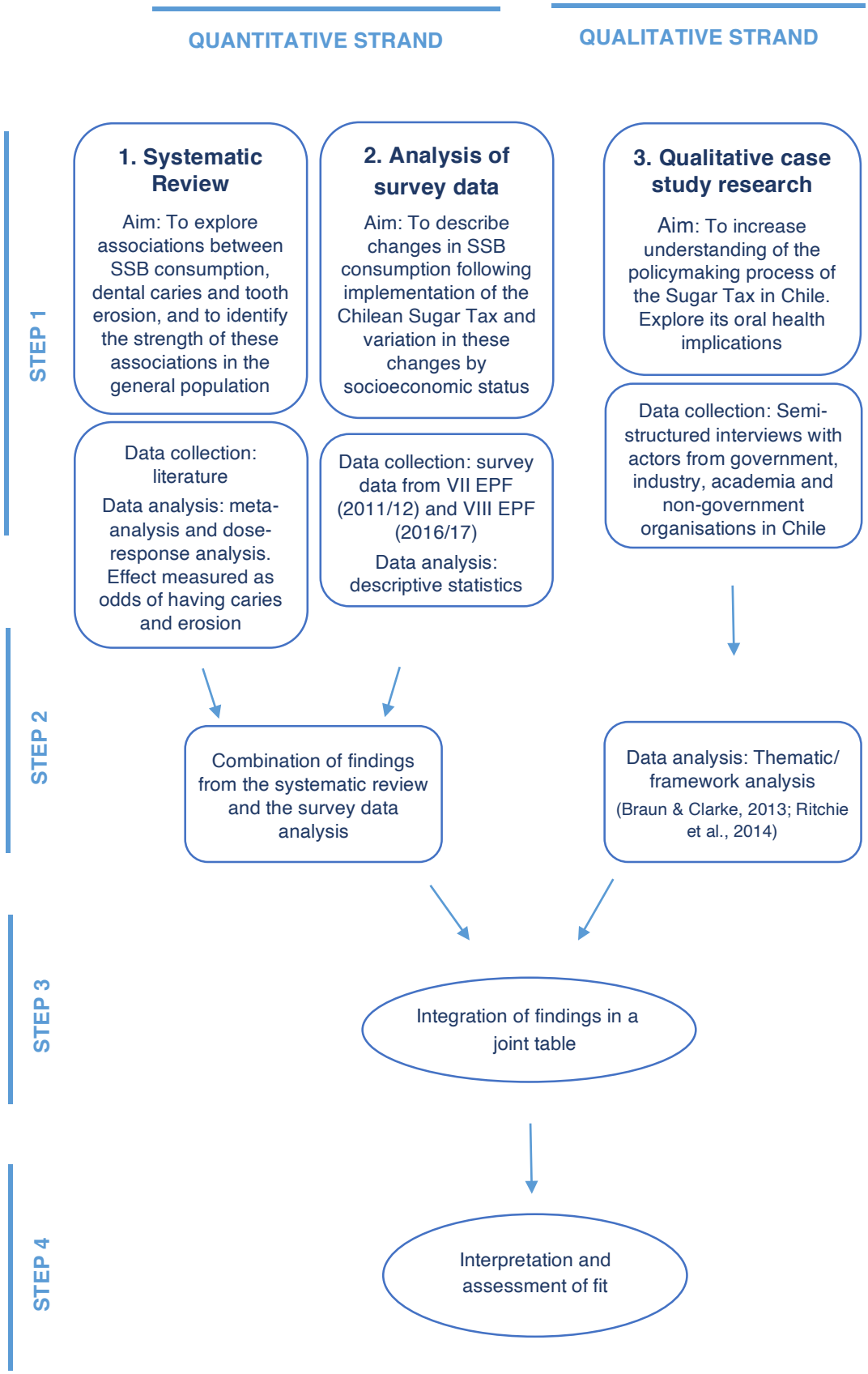
A joint display is an approach to illustrate the integration data analysis in a table or figure. It enables patterns to be drawn across the data by presenting both the qualitative and quantitative data simultaneously. This approach has been increasingly adopted by researchers conducting convergent mixed methods studies and the most common type of joint display is a table. The joint display technique can be used when qualitative and quantitative data are being integrated for the same case (O'Cathain et al., 2010). Cases are the study units and can be individuals, settings, phenomena, or data on the same topic or articles in an evidence synthesis (Johnson et al., 2019). Johnson and colleagues (2019) recently described a four-stage analytical technique to integrate qualitative and quantitative findings using a joint display, called the 'Pillar Integration Process' (PIP). The four stages are listing, matching, checking and pillar building.

Based on the design of this PhD thesis and taking a pragmatic approach, I integrated the quantitative and qualitative findings at the interpretation and reporting level through narrative and joint display techniques. The procedure I followed was mainly informed by Creswell and Plano Clark (2018) and Fetters et al. (2013) but I also borrowed from the PIP technique (Johnson et al, 2019). I first collected the quantitative

and the qualitative data concurrently and then I analysed them separately and inductively (see Chapters 4, 5 and 6 for the methods I used in each study). Next, using the first two stages of PIP, I looked for common concepts and outcomes across the findings of the three studies and I listed and matched them according to the thesis overall aim and objectives in joint display tables. This process allowed me to compare, contrast and interpret the integrated findings from a broader perspective. Having these tables also enabled me to assess whether the findings from the different studies fit together (Creswell and Plano Clark, 2018). When integrating quantitative and qualitative data, it is important to assess the coherence or fit of both types of data. Three possible outcomes can be found. First, that findings from one type confirm the findings of the other type of data. Second, the different sources of data can diverge and expand the understanding of the phenomenon under study. And third, there can be discordance when the findings from the two types of data are inconsistent or contradict to each other.

In the final chapter of this thesis (Chapter 8), I first present the findings in a written format that involves writing both quantitative and qualitative findings together and then, I bring these together in joint display tables to produce a more complete picture of the potential effect of the Sugar Tax on oral health.

Figure 7. Convergent mixed methods thesis diagram



3.1.4 Convergent mixed methods advantages and challenges

The convergent design has many strengths and advantages. It has been suggested that it is often chosen by researchers new to the mixed methods approach as it is straightforward and intuitive in its process (Creswell and Plano Clark, 2011; Tashakkorri, and Teddlie, 2003). It is efficient as both types of data can be collected and analysed concurrently, shortening the research project's timeframe. Each strand is independent of the others; therefore, the research team can include researchers with different research skills. From a personal point of view, the mixed methods research design served me best to address the thesis's aim and objectives as it was described in section 3.1.2.2, and it was also fruitful for my academic career. This approach enabled me to learn, develop and apply different research methods that contributed to my academic development (Teddlie and Tashakkori, 2009). Additionally, using the mixed methods approach helped me to communicate and disseminate the research findings to a broader community with quantitative, qualitative and mixed methods backgrounds.

However, some challenges that are inherent to this design arose when conducting this thesis. First, since equal weight was given to both strands, it was challenging to balance their importance in the integration and interpretation of findings. However, this is usually addressed by forming a group of researchers with different method expertise to assess and provide recommendations on this matter. For my PhD thesis I asked for advice from my supervisors and Thesis Advisory Panel members to better integrate the findings from the two research strands. Second, it was particularly challenging to integrate the quantitative and qualitative findings into one meaningful interpretation of the Sugar Tax potential effect on oral health given the different data formats. However, several strategies are suggested in the literature, particularly by Fetters and colleagues (2013) which guided me in this process. Finally, I found some contradictions between the findings from both strands, which made the interpretation stage quite difficult. However, I took this as a strength rather than a weakness of my thesis as it is inherent in this design. Integrating the findings from both strands involved comparing similar findings and contrasting deviant results, which resulted in a more meaningful and insightful understanding of the effect of the policy on oral health.

3.2 Quality in mixed methods

Quality assessment in mixed methods research has been documented in the literature as complex and controversial (Fabregues and Molina-Azorin, 2017). Many authors have attempted to provide standards and frameworks for evaluating quality in mixed methods; however, consensus in these areas has yet to be reached (Onwuegbuzie and Johnson, 2006). Another contentious feature of mixed methods design relates to the language used to address the concept of quality (O'Cathain, 2010). Many terms have been used, such as validity (Creswell and Plano Clark, 2007), inference quality (Teddlie and Tashakkori, 2009) and legitimation (Onwuegbuzie and Johnson, 2006). I use the term quality as O'Cathain (2010) described it, "the term quality might be more helpful for those wishing to assess a mixed methods study as either good or poor" (p.9).

Focusing on the research approach rather than the topic of study, Creswell and Poth (2018) identify five elements to look for in good mixed methods studies: the use of both qualitative and quantitative methods, the presence of a detailed description of the methods, an appropriate explanation of how the findings were integrated, the use of mixed methods terms, and whether the elements fit together logically. I drew on these quality standards when I planned and conducted this PhD thesis. To provide evidence of these standards, in this chapter I offered a rich description of the convergent mixed methods design that I used to achieve the aim and objectives of this thesis. I also explained how and why I used different types of data sources and quantitative and qualitative methods to build together a common understanding of the potential effect of the Sugar Tax on oral health. I provided a description of the procedures I followed to making rigorous analyses and integration of findings. As I described in section 3.1.3, I integrated the findings from the three studies at a later stage after collecting and analysing the data from the two research strands concurrently and independently. In this process I also carefully analysed how the integrated findings fitted together (see Chapter 8, section 8.2). A more detailed description of the quality standards followed for each study in relation to their research methods can be found in Chapters 4, 5 and 6.

Use of the good reporting of a mixed method study (GRAMMS) framework (Table 3; O'Cathain et al., 2008) has also been recommended to demonstrate rigour in mixed method studies (Equator Network, 2013). Therefore, I also followed this

framework for the reporting of this mixed methods thesis to provide a transparent account of the decisions I made in order to demonstrate quality and rigour (Table 3).

Table 3. Good reporting of a mixed methods study (GRAMMS) (O'Cathain et al., 2008)

Good reporting of a mixed method study (GRAMMS)		Corresponding thesis chapter and section
1	Describe the justification for using a mixed methods approach to the research question.	Chapter 3, section 3.1.2.2
2	Describe the design in terms of the purpose, priority, and sequence of methods.	Chapter 3, section 3.1.2.1
3	Describe each method in terms of sampling, data collection, and analysis.	Chapter 4, section 4.2; Chapter 5, section 5.3; Chapter 6, section 6.3
4	Describe where integration has occurred, how it has occurred, and who has participated in it.	Chapter 3, section 3.1.3
5	Describe any limitation of one method associated with the presence of the other method.	Chapter 3, sections 3.1.2.1 and 3.1.4
6	Describe any insights gained from mixing or integrating methods.	Chapter 8

3.3 Chapter summary

In this chapter I described the convergent mixed methods design that I used in this PhD thesis to understand the complex and multifactorial phenomenon of the potential effect of the Sugar Tax policy on oral health. I offered the rationale for considering the mixed methods design the most appropriate approach for the thesis purpose given the available data sources and the pragmatic worldview that underpinned this thesis and each of the three studies forming part of the thesis. I briefly discussed the strengths and challenges that arose while I conducted this thesis and I outlined the quality standards that I followed in the doing and reporting of this thesis. The specific description of the methodological procedures and findings of the three studies are presented in Chapters 4-7.

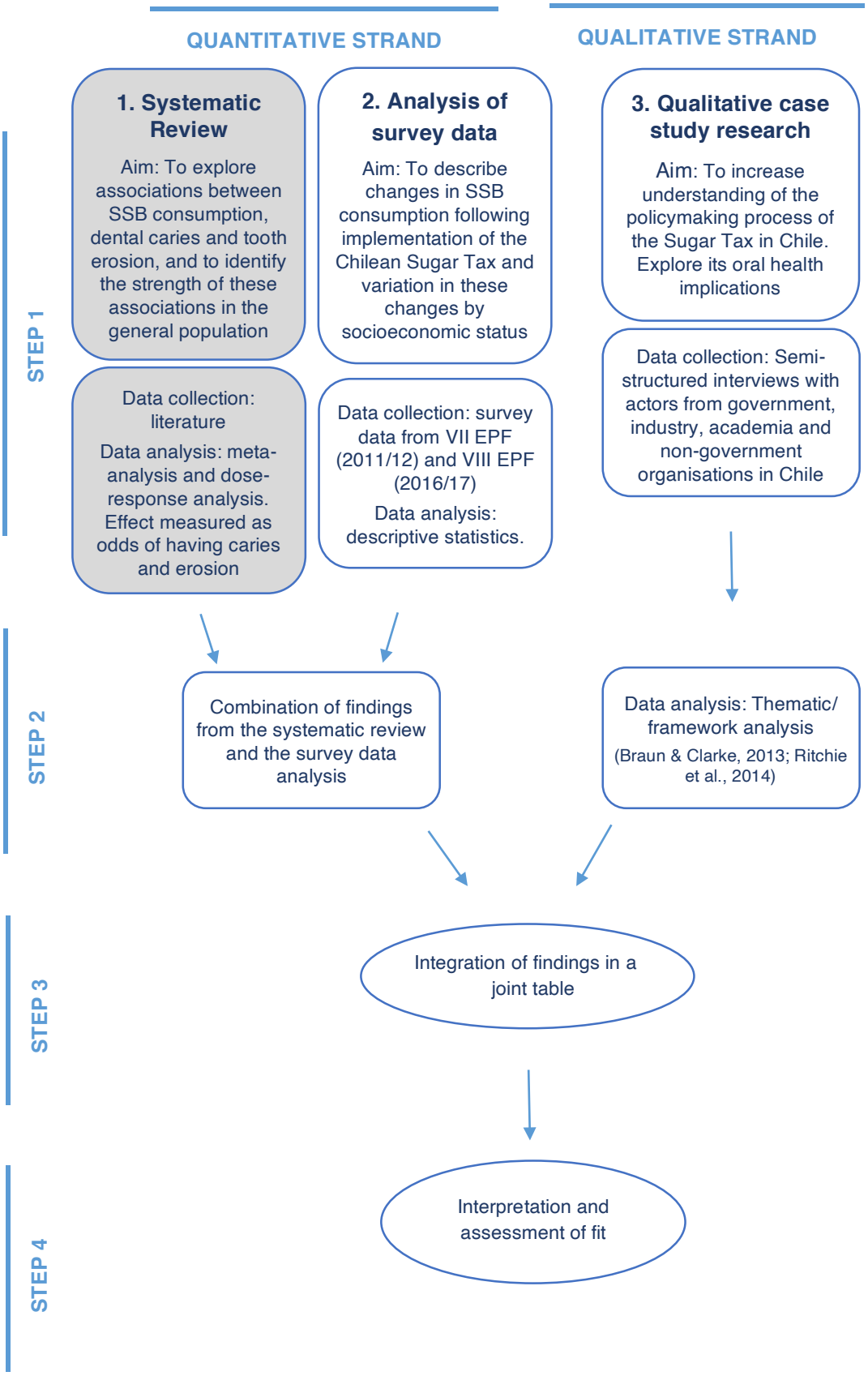
Chapter 4

The effect of sugar-sweetened beverages on oral health: A systematic review

In this chapter I begin describing and justifying the methods I used to identify relevant studies and the strategy I followed to synthesise and analyse the data for this systematic review (Figure 8). Next, I provide a detailed description of the findings following two approaches. First, I synthesise the data according to study characteristics and secondly, I pool the quantitative data using meta-analysis and dose-response analysis methods. I finish the chapter with a summary of findings.

The study described in this chapter was published in the European Journal of Public Health on 23rd August 2020 (Valenzuela et al., 2021). After the study publication, I updated the search, therefore some of the results in this chapter are slightly different to the published article.

Figure 8. Convergent mixed methods thesis diagram



4.1 Study aim

This systematic review aims to explore associations between the consumption of sugar-sweetened beverages (SSB), dental caries and tooth erosion, to identify the strength of these associations in the general population, and to evaluate the quality of the available evidence.

4.2 Methods

4.2.1 Protocol and registration

I undertook this systematic review and meta-analysis following PRISMA and the Centre for Reviews and Dissemination's guidelines for systematic reviews (Moher et al., 2009; Centre for Reviews and Dissemination, 2009). The methods I used are documented in a protocol registered in the PROSPERO database, registration number: CRD42018088720 (PROSPERO, 2018). The study protocol is available in the following link: https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=88720

4.2.2 Eligibility criteria

I set out the inclusion and exclusion criteria using the PICOS strategy for the eligibility of studies. This strategy provides a framework to increase the comprehensiveness of the searching process focusing on the Participant (or population or patient), Intervention (or exposure), Comparison, Outcomes and Study design (Methley et al, 2014).

4.2.2.1 Population

Participants from general populations with no age, gender and nationality limits were eligible for inclusion. Specific or minority groups not representative to the general population were excluded.

4.2.2.2 Exposure

Consumption of any type of SSB were included. These included flavoured and not flavoured carbonated beverages.

4.2.2.3 Comparisons

High SSB consumers compared to a lower consumption group including non-consumers.

4.2.2.4 Outcomes

The outcomes that I considered for this review were dental caries measured as decayed, missed and filled teeth or surface in permanent dentition (DMFT/DMFS), decayed, missed and filled teeth or surface in primary dentition (dmft/dmfs) and early childhood caries (ECC), and tooth erosion with no restriction to measurement (Table 4). These measurement methods are widely used to assess dental caries' severity and have been recommended by the WHO to standardise measurements of oral diseases and allow international comparability in dental epidemiology (WHO, 2013; Daly et al., 2013). For tooth erosion, I did not limit the outcome measure by the method of measurement as there are a great number of indices and researchers have not yet reached consensus for an internationally accepted and standardised index (Joshi et al., 2016). Studies were included if they reported caries and/or erosion and at least two SSB consumption levels.

Table 4. Definitions of dental indexes

Dental caries index	**Definition**
DMFT/dmft and DMFS/dmfs index	Index to measure the prevalence and severity of dental caries. It stands for Decayed due to caries (D), Missed due to caries (M), Filled due to caries (F) Teeth (T) or Surface (S). The index in upper-case letters (DMFT) is used for the permanent dentition and lower-case letters (dmft) for the primary dentition. The last "T" stands for teeth and it can be replaced for an "S" depending whether the count is made on the total number of teeth or surfaces (Klein et al., 1938).
ECC index	Early Childhood Caries is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing teeth (due to caries), or filled tooth surfaces in any primary tooth in a 72 months of age child or younger (Colak et al., 2013; Drury et al., 1999).

4.2.2.5 Type of studies

I considered evidence from various study designs: randomised controlled trials (RCTs), quasi-experimental studies (non-randomised controlled trials, before-and-after and interrupted time series studies), observational studies (cross-sectional, cohort and case-control studies), and natural experiments. However, I excluded single case-studies, qualitative studies, in-vitro studies, animal studies, reviews, editorials, opinion letters and conference abstracts or posters.

I limited the inclusion criteria to articles published in English and Spanish as I am native in Spanish and the second researcher (B.W.) who helped me to undertake this review is native in English. I did not exclude studies on the basis of setting and publication date as the purpose was to include as many studies as possible. I excluded studies on the basis of publication type or status, if they were conference abstracts or posters.

4.2.3 Information sources

I combined two approaches to search for studies. Firstly, I identified them through electronic searches, and secondly, I screened reference lists of eligible studies and I retrieved the citation of papers that seemed to meet the inclusion criteria and then I screened the full text.

4.2.3.1 Electronic sources

I undertook a preliminary search in Web of Science (a scientific citation indexing service that incorporates multiple databases) to avoid duplication of reviews, where I did not find similar studies.

I run the searches on 17th October 2017 and updated them on 7th April 2021 in seven databases accessed via the E-resources guide link in the University of York Library's webpage https://subjectguides.york.ac.uk/az.php?s=102489, apart from LILACS which I accessed through Google:

- MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present (Ovid)
- Embase 1974 to present (Ovid)
- The Cochrane Library (Wiley)
- Scientific Electronic Library Online - SciELO (Web of Science)
- Latin American and Caribbean Health Sciences Literature LILACS 1982 onwards (VHL)
- Health Management Information Consortium (1979 to April 2021) (Ovid)
- Open Grey

I included the latter two to search for grey literature to minimise the risk for publication bias.

4.2.3.2 Other sources

I scanned the reference lists of all eligible studies in order to identify further eligible studies that might have been missed in the electronic search. I then entered the identified citations into Google search engine (selected because it is a large database that was not included in the main electronic search) and retrieved the full texts for screening.

4.2.4 Search strategy

I used terms related to SSB (for example, soft drink$) and oral health (for example, dental caries OR dental erosion) in the electronic searches. All terms were generated based on general knowledge and from words commonly used in the related literature. I also outlined synonyms, abbreviations and alternative spellings and then I discussed the appropriateness of the selected terms with other researchers from my supervision team and a systematic review specialist (S. G.).

I used different techniques to obtain an appropriate trade-off between sensitivity and specificity in the search strategy (Higgins and Green, 2011). Search terms for study type was considered for inclusion in the search strategy; however, I decided not to include them to increase search sensitivity. The Boolean operators 'OR' and 'AND' were used to combine similar terms within and between each group. I used truncation and wildcards to expand terms to include different versions of words with a common root, for example the term erosi$ expands to erosion, erosive and erosions. I used the proximity operator 'adj3' to specify that two search terms should be adjacent to each other within three words. I also used MeSH terms in combination with free text terms to identify as many relevant records as possible. I exploded most MeSH terms, although not all of them as some were too general and when I exploded them a great number of ineligible studies were yield. I did not apply restrictions on publication date, country setting, publication type/status and language. I adapted all terms for each database and I piloted the searches prior to the definitive search. For an example of the search strategy used in MEDLINE, see Table 5. The detailed search strategy for the rest of the databases alongside the total number of studies identified are presented in Appendix 1.

Table 5. Example of search strategy in Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily and Ovid MEDLINE(R) 1946 to Present

Searches		Results	
		Original (2017)	**Update (2021)**
1.	exp Carbonated Beverages/	2616	3020
2.	(fruit$ adj3 juice$).ab,ti	3869	4850
3.	((carbonated or calori$ or fizzy or soft or soda or energy or sugar$ or sweet$) adj3 (beverage$ or drink$)).ab,ti.	9360	12487
4.	SSB$.ab,ti.	5723	6840
5.	soda.ab,ti.	3624	4351
6.	exp Oral Health/	13575	17486
7.	oral health.ab,ti.	20809	27480
8.	dental caries.ab,ti.	16650	19041
9.	dental health.ab,ti.	7706	8457
10.	(dmf or dmft or dmfs or dft or deft or defs).ab,ti.	43569	60653
11.	exp DMF index/	9257	9505
12.	exp Tooth Diseases/	167239	176712
13.	(tooth or teeth or dental).ab,ti.	302948	346862
14.	exp Tooth Erosion/	2608	2924
15.	tooth erosi$.ab,ti.	160	178
16.	(erosi$ adj3 wear).ab,ti.	316	503
17.	or/1-5	21821	26969
18.	or/6-16	428134	491421
19.	17 and 18	**1504**	**1838**

‘$ = truncation; ‘adj3’ = adjacent within three words; ‘exp’ = exploded; ‘ab’ = abstract; ‘ti’ = title.

4.2.5 Study selection

I exported all references into the reference management software EndNote version X8.0.1, where I identified and removed duplicated records. Then, I exported titles and abstracts to Microsoft Excel 2016 for screening. The study selection was carried out in two stages. First, two researchers (B. W. and I) independently screened titles and abstracts against the inclusion and exclusion criteria. Then, the full texts of potentially

relevant studies were retrieved and examined to determine their inclusion. If we had disagreements, we resolved them through discussion and consensus.

I assessed our level of agreement through proportion of agreement and Kappa Cohen statistic. The interrater proportion of agreement is a basic method that represents the percentage of agreement between two reviewers from the total number of citations. However, a more reliable method of assessing overall agreement is the Kappa Cohen's Statistic (Orwin, 1994). This method relates the actual measure of agreement with the degree of agreement, which would have occurred by chance (Fleiss et al., 2003). I calculated both tests using the statistical package software STATA version 15.1.

We kept a screening log to record all screened, excluded and included studies and then I used a flow diagram to illustrate the selection process. This flow diagram follows recommendations of the PRISMA group (Moher et al., 2009) and can be found in section 4.3.1 in this chapter (Figure 9).

4.2.6 Data collection

I developed a data extraction form based on the Centre for Reviews and Dissemination guidance (CRD, 2009), and I tailored it to fit the topic area of this review and the relevant data needed for the subsequent analyses (Appendix 2). I first extracted the data from the included studies, and then a second researcher checked this data extraction. We resolved disagreements through discussion and consensus.

The information extracted from each study included: main author(s) name(s), year and journal of publication; study design; country; population and participants' characteristics (including age, type of dentition and gender); sample size; type of drink, and measure of consumption (including level of consumption and portion size); and type of outcome and method of measurement.

4.2.7 Risk of bias assessment in individual studies

Two reviewers assessed the risk of bias in the included studies independently. We resolved disagreements through discussion and consensus; however, if we did not achieve consensus, then we consulted a third reviewer.

4.2.7.1 Quality assessment tool

The risk of bias was assessed using a modified version of the NIH Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies, which I chose in relation to the observational cross-sectional design of the majority of included studies as stated in the protocol (see Appendix 3 for the tool) (NHLBI, 2014). This tool was developed by the National Institutes for Health in conjunction with the Research Triangle Institute International (NHLBI, 2014). Rather than providing a numeric score, this tool was designed to critically appraise the internal validity of studies by focusing on the sample characteristics, recruitment process, and the level of in-depth reported information of the exposure and outcome measures. The tool allows to assess each study individually and rate them as 'Good', 'Fair' or 'Poor' quality. A study rated as 'Good', has low risk of bias and its results are highly reliable. A 'Fair' rated study presents some degree of bias, but its results are still reliable. A 'Poor' rated study means that there is significant risk of bias, and one needs to be cautious when interpreting its results. In this review, and in line with recommendations from the Centre for Reviews and Dissemination and the Cochrane handbook for systematic reviews, I did not exclude studies based on their rating (CRD, 2009; Higgins and Green, 2011). Instead, I explored the results of the review against the level of risk of bias.

I adapted the tool by removing four irrelevant questions for cross-sectional studies:

1. "For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?"
2. "Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?"
3. "Was the exposure(s) assessed more than once over time?"
4. "Was loss to follow-up after baseline 20% or less?"

4.2.8 Synthesis of results and effect measures

Following the recommendations given by the PRISMA group, I conducted the data synthesis in two ways (Moher et al., 2009). First, I summarised the characteristics of each study in a table including general information about the study and its design, methodological approach and exposure and outcome measures (see section 4.3.3). This process served me to assess the feasibility of synthesising the findings quantitatively. After this step, I synthesised the data using meta-analysis and dose-response analysis as the included studies presented the evidence of effect in a

quantitative and comparative format. In order to undertake these analyses, I included studies if they reported a binary or continuous outcome among SSB consumers compared to a sample with a lower level of consumption or no consumption. When the raw data in any of the groups (exposed or not exposed, or with outcome presence or not) were not reported, I calculated them from the available information, e.g., proportions.

4.2.8.1 Levels of SSB consumption

To date, researchers have not found consensus on a standardised measure of SSB consumption. Authors tend to develop their surveys tailored to their own study objectives resulting in a great variability of portion sizes, frequency of consumption and time of consumption measures (Weed et al., 2011). For example, one study asked their participants if they usually consumed SSB twice a week or less, three to six times a week or at least daily (Amin and Al-Abad, 2008); whereas another study asked their participants if they consumed SSB at least once every two days or less than once every two days (Zhang et al., 2014). The same variability can be found in the portion size as some studies measured it as a can (Damle et al., 2011), others described the portion as a cup or a glass (Skinner et al., 2015), and the majority did not report this information.

As every study measured SSB consumption differently, I took three decisions based on what has been reported in the related literature to standardise the varied levels of consumption across the included studies into Low, Moderate and High level (Table 6). First, I applied a common portion size (250ml) to all studies based on the average portion size reported in some of the included studies and converted them to millilitres per day (ml/day) (Imamura et al, 2015). Second, for the studies that reported consumption as “three times a week”, I assumed that “times” were equal to servings of 250ml; therefore, this was considered as 750ml consumed in a week (3 x 250ml) (Berlin et al., 1993; Xi et al., 2015). Finally, for the studies that presented the SSB consumption in categories with intervals, I estimated the median of each interval by using the midpoint of the lower and upper boundaries. For the lowest categories with open ended intervals I assigned zero consumption as the lower boundary, and for upper categories with open ended intervals, I added the lowest boundary 20% more to assign the upper boundary (Liu et al., 2009; Orsini et al., 2006).

Table 6. Assigned levels of SSB consumption

Levels	SSB consumption
Never/Low	≤ 2 portions/ week or ≤ 71 ml/day
Moderate	2 portions/ week – 1 portion/day or 71 – 250ml/day
High	> 1 portion/ day or > 250ml/day

4.2.8.2 Meta-analyses

I conducted the meta-analyses separately for each oral health outcome using a random-effects model (DerSimonian and Laird 1986). I took this decision based on the large heterogeneity expected to be found across studies and later corroborated in the analyses. For the binary and the continuous outcomes, I computed odds-ratios (OR) and weighted mean differences (WMD) respectively, with their corresponding 95% confidence intervals (CI), to estimate the effect of SSB consumption on oral health. There is an ongoing debate on the best effect size measure to analyse binary data. In this study, I estimated the effect for binary outcomes using OR as it provides a more comprehensive estimate of effect and it can be easily applied to further analyses (Walter, 2000). The OR is interpreted as the odds of having the outcome in group A compared to the odds of having the same outcome in group B (Littell et al., 2008). I pooled the data in four different meta-analyses comparing none/low with moderate consumption, none/low with high consumption, moderate with high consumption and none/low with moderate/high levels of consumption.

I undertook subgroup analyses by type of dentition (primary, mixed or permanent) to examine effect size changes from early ages to adulthood. If the studies did not report the type of dentition, I inferred this information from the age of the study sample. On average, the primary dentition is present in children up to 6 years-old, the mixed dentition (both primary and permanent teeth) is found in 6 to 12-year-olds and permanent dentition is present in adolescents and adults older than 12 years-old (Lynch, 2013).

I explored the between-studies heterogeneity using the chi-squared Cochran's Q test of heterogeneity and I^2 statistic ($P < 0.05$) (Borenstein et al., 2009; Higgins et al., 2003). The Cochran's Q test is widely used; however, it has low power when the number of studies is small and excessive power when the sample is large. Therefore, I

complemented it with the I^2 statistic that quantifies the amount of variation due to heterogeneity rather than to chance (Liberati et al., 2009).

4.2.8.3 Dose-Response Analysis

Dose–response analysis is a statistical procedure that combines and compares evidence on the association between a continuous exposure and the risk of a health outcome (Crippa and Orsini, 2016). I used (Risk-ratios) RR and its corresponding 95% CI as the effect size in the dose-response analysis between SSB and dental caries. I measured it using generalised least squares trend estimation, according to methods developed by Berlin et al. (1993), Greenland and Longnecker (1992) and Orsini et al. (2006). I used the two-stage generalised least-squares trend estimation method. In the first stage, I calculated the regression coefficient for every study and in the second stage, I pooled them together in a multivariate random effects model to estimate the average slope. The first stage examined whether the relationship was linear and the second stage if it was non-linear. For the latter, I modelled the levels of SSB consumption using the restricted cubic splines with four knots at 5%, 35%, 65%, and 95% percentiles of the distribution (a standard approach in similar studies, such as Jayedi et al., 2018 and Orsini et al., 2006). I used other knots in the analysis to investigate if they had an impact on the dose-response relationship; however, I found no variations. I performed a likelihood ratio test to compare the difference between the linear and non-linear models. Only studies reporting three or more categories of SSB consumption were included in this analysis. This is because in studies with less than three categories the quadratic models cannot be identified. I could not undertake a dose-response analysis for the erosion outcome as not enough studies met the inclusion criteria for this type of analysis.

All these analyses were conducted with the Stata software, version 15 (Stata Corp, College Station, Texas, USA). P value < 0.05 was considered statistically significant for all analyses.

4.2.8.4 Interpretation

The meta- and dose-response analyses should be interpreted with caution due to the assumptions taken with regards to the levels of consumption and assigned portion size. In addition, the data extracted from the studies were not adjusted for potential confounders. Furthermore, as there are a variety of sample sizes across- the included studies, the results should also be interpreted with caution as sometimes the random-

effects model gives more weight to smaller studies and less weight to larger studies (Borenstein et al., 2009).

4.2.9 Risk of bias across studies

I examined the publication bias visually using funnel plot asymmetry and formally using Egger's asymmetry test ($P < 0.05$) (Egger et al., 1997). Publication bias may occur when studies with negative results are not published in the literature or when negative data are not published within the studies (also known as selective reporting bias) (Liberati et al., 2009). This assessment is important as the absence of information from some studies may pose a serious threat to the validity of the review.

To examine the potential effect of each study on the pooled effect sizes, I conducted influence analyses with one study removed at a time.

4.2.10 Additional analyses

I undertook two sensitivity analyses. The first explored variation in the estimates of the meta-analyses and dose-response analyses assuming a portion size of 330 ml rather that 250 ml as this is the amount of SSB contained in a regular sized SSB can. The second was undertaken for the dose-response analysis to evaluate the robustness of the pooled dose-response curve against the assumptions and decisions taken *a priory*. In the spline model, sensitivity analyses assessed the effect of alternative knot locations on the shape of the dose-response curve.

4.2.11 Quality of evidence

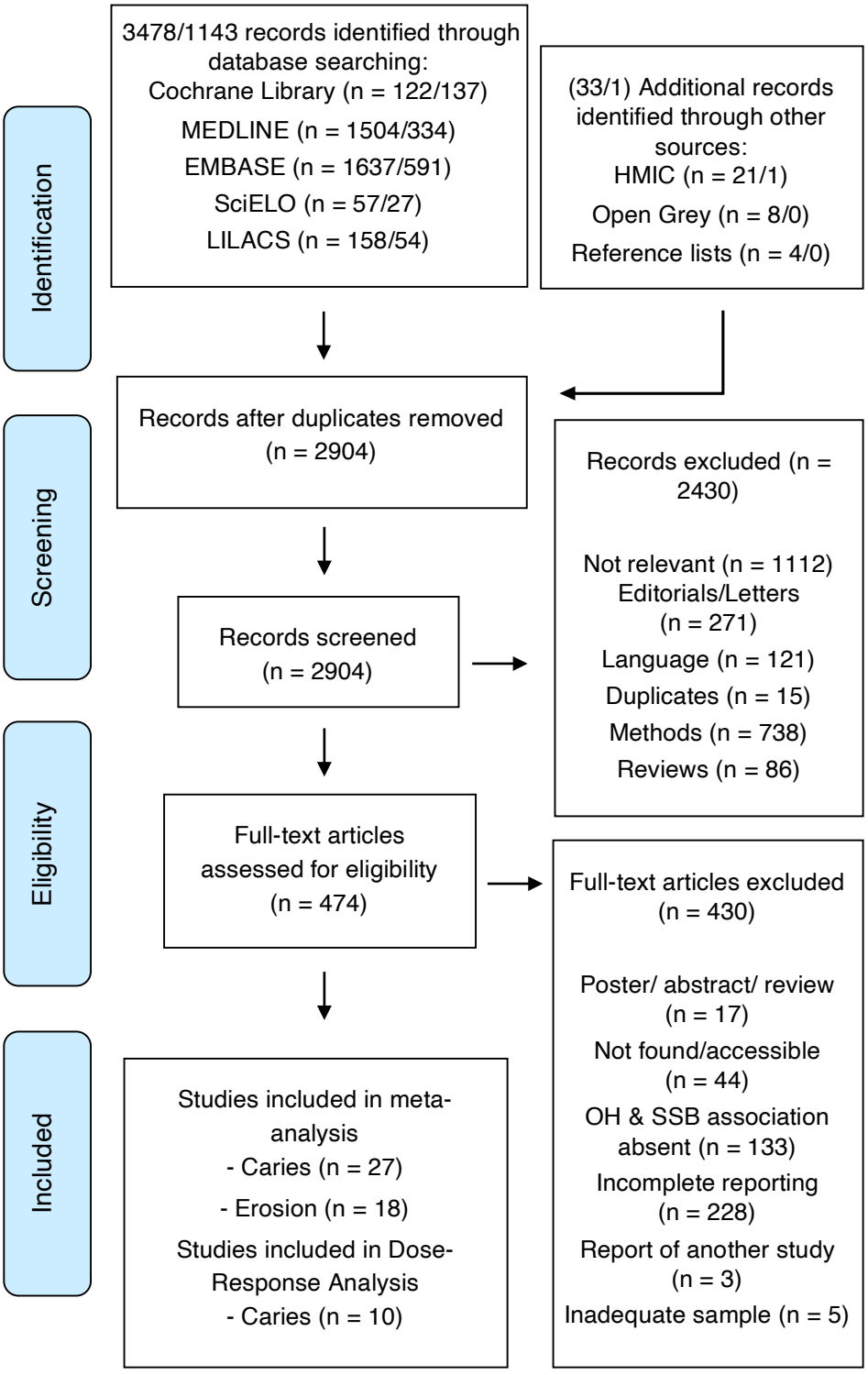
I assessed the quality and certainty of the body of evidence using the Grading of Recommendation Assessment Development and Evaluation (GRADE) tool (Higgins and Green, 2011). I used the programme GRADEpro GDT 2015 to generate a certainty of evidence table (section 4.3.7). Starting for a high quality level, it was downgraded according to presence of limitations in the risk of bias, consistency, and/or precision of the pooled estimate. I then rated the quality level as high, moderate, low or very low according to the limitations.

4.3 Results

4.3.1 Study selection

I identified a total of 4655 studies. Searches in Cochrane Library, Medline, Embase, SciELO and LILACS databases yield 3,478 citations in 2017 and further 1143 in the updated search. I identified an additional 33 studies from other sources including Open Grey, HMIC and reference lists in 2017 and one more in the updated search. Combining the citations identified from the original and the updated search, after identifying and excluding duplicates, 2904 citations remained. Of these, I excluded 2,430 titles because they did not meet the eligibility criteria. I then retrieved the full text of 474 citations and examined against the inclusion and exclusion criteria in detail. I excluded further 361 studies at this stage because they did not assess the relationship between SSB consumption and oral health and/or did not report sufficient data for the analyses. Seventeen studies were posters, conference abstracts or reviews. Forty-four studies were not accessible. For these, I contacted the authors of those more likely to meet the inclusion criteria via email to gain access to the studies, but only three of them replied. Three were reports of other studies, and five involved a non-representative sample. Finally, forty-four studies met the inclusion criteria. I included twenty-seven studies in the meta-analyses to assess the effect of SSB consumption on dental caries, 18 on tooth erosion, and ten in the dose-response analysis for caries (Figure 9).

Figure 9. PRISMA flow chart for systematic reviews (Moher et al., 2009)[a]



[a]The first two boxes show the original (2017) and the updated (2021) number of records identified through the electronic searches.

4.3.2 Interrater agreement

I assessed the interrater reliability twice. For the first title and abstract screening attempt there was a low agreement level, and the eligibility criteria were therefore reviewed and screening attempted a second time. In the second attempt the agreement improved (Cohen's kappa=0.8) (Table 7).

Table 7. Level of interrater agreement

	Interrater proportion of agreement	**Interrater reliability Kappa Cohen's**
First screening attempt	61.8%	0.34
Second screening attempt	96.5%	0.8

4.3.3 Study characteristics

The majority of studies were undertaken in Asia (27 studies) followed by North and South America (six studies), Europe (five studies), Australia (four studies) and Africa (two studies). Most studies used a cross-sectional design with the exception of three that used baseline and final records of cohort studies (Jamieson et al., 2010; Mello et al., 2008; Perinetti et al., 2005). With respect to the age of the sample and type of dentition, a greater proportion of studies involved adults with permanent dentition (23 studies), and a smaller number of studies included young children with primary dentition (ten studies), and young adolescents with mixed dentition (eleven studies). SSB consumption was assessed through structured questionnaires. Most studies included sweetened carbonated drinks as the exposure; however, one assessed consumption of only sport drinks (Kawashita et al., 2011) and two pooled carbonated drinks with juices or sparkling water (Skinner et al, 2015 and Manaf et al., 2012). A greater number of studies measured dental caries (27 studies) as oral health outcome compared to erosion (18 studies). Twenty-three out of 27 studies used the DMFT/dmft index where participants with a score equal to zero were categorised as caries free and greater or equal to one, were categorised as having caries. The other four did not report any specific index when measuring presence of caries. For erosion, various indexes were used across the studies. These included the Smith and Knight Tooth Wear Index (TWI), and its modified version, O'Sullivan index, Basic Erosive Wear Examination (BEWE), and Visual Erosion Dental Examination (VEDE). As with caries, when the index was equal to zero, participants were categorised as erosion free and with the presence of the outcome otherwise (Table 8).

Table 8. Study characteristics

Author, year	Study type	Country	Year	Sample age	N	Type of beverage	Assessment of beverage consumption	Outcome variable	Outcome measure
Abu-Ghazaleh et al. (2013)	Cross-sectional	Jordan	2009-2010	15-16 year-olds	1,602	Fizzy drinks	Self-completed questionnaire: – never; – ≥ once/day	Erosion	Modified Tooth Wear Index on labial and lingual/palatal surfaces of incisor teeth/canines and occlusal surfaces of first molars and then dichotomised as TWI=0 and TWI>1
Alhabdan et al. (2018)	Cross-sectional	Saudi Arabia	2015	6-8 year-olds	578	Soft drinks	Questionnaire completed by parents: – less than twice a week – more than twice a week	Caries	dmft index measured and then dichotomised as dmft=0 and dmft>1.
Al-Malik et al. (2001)	Cross-sectional	Saudi Arabia	N/A	2-5 year-olds	987	Fizzy drinks	Questionnaire completed by parents: – < once/day – ≥ once/day	Caries & Erosion	Caries presence/absence in all teeth using BASCD criteria & Erosion presence/absence in primary maxillary incisors.
Alvarez et al. (2015)	Cross-sectional	Uruguay	2011-2012	12 year-olds	1,136	Soft drinks	Questionnaire completed by parents or legal guardians: – ≤ once/day – ≥ 3 times/day	Erosion	BEWE recorder on labial, palatal/lingual and occlusal surfaces of all erupted permanent teeth and then dichotomised as TW=0 and TW>1.
Amin & Al-Abad (2008)	Cross-sectional	Saudi Arabia	2007	10-14 year-olds	1,208	Carbonated soft drink	Interview + self-reported questionnaire: – < twice / week; – 3–6 times / week; – daily or several / day	Caries	Presence/ absence of any level of caries lesion.
Araujo et al. (2009)	Cross-sectional	Brazil	2006	5-12 year-olds	970	Soft drinks	Interview to parents: – consumption asked as yes or no.	Erosion	Presence/absence of cervical lesions on vestibular surfaces in both primary and permanent teeth.
Chen et al. (2014)	Cross-sectional	China	2012-2013	21-58 year-olds	545	Sugary beverages	Self-reported questionnaire: – once /day; – once /week; – hardly ever	Caries	DMFT index (continuous and dichotomised as DMFT=0 and DMFT>1).

Author, year	Study type	Country	Year	Sample age	N	Type of beverage	Assessment of beverage consumption	Outcome variable	Outcome measure
Dahal et al. (2020)	Cross-sectional	Nepal	2018-2019	2-12 year-olds	425	Soft drinks/fresh juices	Questionnaire completed by parents: – never – sometimes – often	Erosion	Smith and Knight Tooth Wear Index measured on all surfaces of deciduous teeth.
Damle et al. (2011)	Cross-sectional	India	N/A	12-13 year-olds	200	Carbonated beverage	Self-reported questionnaire: No. of cans (125ml) per week: – none; – 1-10; – 11-20; – >20	Caries	Mean DMFT index and dichotomised as DMFT=0 and DMFT>1.
El Karim et al. (2007)	Cross-sectional	Sudan	N/A	12-14 year-olds	157	Carbonated drinks	Self-completed questionnaire: – never; – 7 times/ week; – 8-21 times/ week; > 21 times/ week	Erosion	Tooth Wear Index of Smith and Knight and then dichotomised as TWI=0 and TWI>1.
Fung & Messer (2013)	Cross-sectional	Australia	2008-2009	6-12 year-olds	154	Soft drinks	Questionnaire completed by parents: – never; – 1-2/week; – ≥ 1/day	Erosion	Modified Tooth Wear Index of O'Brien and then dichotomised as TW=0 and TW>1.
Hamasha et al. (2014)	Cross-sectional	Jordan	N/A	12-14 year-olds	3,812	Carbonated drinks	Self-completed questionnaire: – never; – once/ week; – 2-4 times/ week; – once/ day; – ≥ 2 times/day	Erosion	Smith and Knight Tooth Wear Index on permanent teeth and then dichotomised as TWI=0 and TWI>1.
Hashim et al. (2009)	Cross-sectional	United Arab Emirates	2002-2003	5-6 year-olds	908	Soft drinks	Questionnaire completed by parents: – < 2 times/week; – otherwise; – ≥ 3 times/day	Caries	Mean dmft index

Author, year	Study type	Country	Year	Sample age	N	Type of beverage	Assessment of beverage consumption	Outcome variable	Outcome measure
Hasieh et al. (2014)	Cross-sectional	Taiwan	2007-2008	6-9 year-olds	256	Sweetened beverages	Questionnaire completed by caretaker: – often; – sometimes or never	Caries	Mean deft index
Huew et al. (2012)	Cross-sectional	Libya	N/A	12 year-olds	791	Sugared carbonated drinks	Self-reported questionnaire: – never; – < 1 / day; – > 1 / day	Caries	DMFT index
Jamieson et al. (2010)	Cohort	Australia	N/A	16-20 year-olds	442	Soft drinks	Face-to-face interviews: – once/week or less often – every day or few times a week;	Caries	Mean DMFT index and dichotomised as DMFT=0 and DMFT>1.
Khan et al. (1990)	Cross-sectional	Saudi Arabia	1987	0-12 year-olds	321	Sweet/soft drinks	Interview to head of family: – do not drink daily; – drink daily	Caries	DMFT index and then dichotomised as DMFT=0 and DMFT>1.
Kirthiga et al. (2015)	Cross-sectional	India	N/A	11-16 year-olds	2000	Soft drinks	Self-completed questionnaire: – occasionally; – once/ week; – twice/ week; – daily	Erosion	O'Sullivan index and then dichotomised as TW=0 and TW>1.
Krisdapong et al. (2013)	Cross-sectional	Thailand	N/A	12 & 15 year-olds	1,063 & 811	Fizzy drinks	Self-administered questionnaires: – rarely/never; – sometimes/every day	Caries	Mean DMFT index
Kruger et al. (2005)	Cross-sectional	Australia	N/A	2 - 5 year-olds	70	Soft drinks	Questionnaire completed by parents. – consumption asked as yes or no	Caries	Mean dmft index and dichotomised as dmft=0 and dmft>1.
Li et al. (2010)	Cross-sectional	China	N/A	3-6 year-olds	1523	Carbonated drinks	Questionnaire completed by parents: – > 3; – 1-3 times/week; – seldom	Caries	Caries presence/absence with visual–tactile method.

Author, year	Study type	Country	Year	Sample age	N	Type of beverage	Assessment of beverage consumption	Outcome variable	Outcome measure
Maharani et al. (2019)	Cross-sectional	Indonesia	2016	12 year-olds	696	Soft drinks	Questionnaire completed by parents: – less than once per week; – at least once per week	Caries and erosion	Mean DMFT index, dichotomised as DMFT=0 and DMFT>1, and the BEWE index.
Maharani et al. (2019b)	Cross-sectional	Indonesia	2017	5 year-olds	691	Soft drinks	Questionnaire completed by parents: – less than once every two days; – at least once every two days	Erosion	BEWE used to examine the buccal, lingual, and occlusal/incisal surfaces of all primary teeth.
Manaf et al. (2012)	Cross-sectional	Malaysia	N/A	19-24 year-olds	150	Sugared carbonated drinks (carbonated drinks and sparkling water)	Self-completed questionnaire: – 1–3 times/ week or never; 4–5 times/week or ≥ 1/ day	Erosion	Basic Erosive Wear Examination on buccal/facial, occlusal, and lingual/palatal surfaces and then dichotomised as TW=0 and TW>1.
Mello et al. (2008)	CC (Baseline data of a cohort study)	Portugal	2003	13 year-olds	500	Soft drinks irrespective of sugared or diet	Questionnaires completed by parents and adolescents: – < 2 or – ≥ 2 times/ week	Caries	Mean DMFT index and dichotomised as DMFT=0 and DMFT>1.
Milosevic et al. (2004)	Cross-sectional	England	1999	14 year-olds	2,348	Fizzy drinks	Self-completed questionnaire: – never; – once/ week – 2-4 times/ week; – once/day; – ≥ 2 times/ day	Erosion	Presence/absence dental erosion on labial, incisal and lingual/palatal surfaces of the 12 anterior teeth and the occlusal surface of all four first molars and then dichotomised as TWI=0 and TWI>1.
Mulic et al. (2012)	Cross-sectional	Norway	2008	18 year-olds	1,456	Soft drinks	Self-completed questionnaire: – < once/week; – 1-2 times/week; – 3-5 times/week; – once/day;	Erosion	Visual Erosion Dental Examination (VEDE) scoring system on all teeth and surfaces and then dichotomised as TW=0 and TW>1.

Author, year	Study type	Country	Year	Sample age	N	Type of beverage	Assessment of beverage consumption	Outcome variable	Outcome measure
							– several times daily		
Murakami et al. (2011)	Cross-sectional	Brazil	N/A	3-4 year-olds	967	Soft drink	Questionnaire completed by parents: – never; – once daily; – twice daily; – > 3 times/day	Erosion	Modified O'Brien index on palatal surface of upper incisors and the occlusal surface of lower molars and then dichotomised as ETW=0 and ETW>1.
Nakayama & Mori (2015)	Cross-sectional	Japan	2012-2013	1.5-2 year-olds	1675	Soda	Questionnaire completed by parents or guardians. – < 4 days a week – ≥ 4 days a week	Caries	dmft index measured and then dichotomised as dmf>=1 and dmf=0.
Nakayama & Mori (2015b)	Cross-sectional	Japan	2012-2013	3 year-olds	1780	Soda	Questionnaire completed by parents or guardians: – < 4 days a week – ≥ 4 days a week	Caries	dmft index measured and then dichotomised as dmf>=1 and dmf=0.
Perinetti et al. (2005)	Cross-sectional (Last record of a cohort study)	Italy	2003	7, 9 & **11 year-olds**	5,801	Sweet drinks	Questionnaire completed by parents or guardians. – none/< 1/ week; – ≥ 1/ week; – ≥ 1/ daily	Caries	DMFT index and then dichotomised as DMFT=0 and DMFT>1.
Punitha et al. (2015)	Cross-sectional	India	N/A	13-19 year-olds	916	Carbonated drinks	Self-completed questionnaire: – no intake; – occasionally; – 1-3 times/ day; – ≥ 4 times/ day	Caries	DMFT index
Salas et al. (2014)	Cross-sectional	Brazil	2010	8-12 year-olds	1,208	Soft drinks	Self-completed questionnaire: – never or 1-2 times/ week; – > 3 times/ week	Caries	DMFT index
Senesombath. et al (2010)	Cross-sectional	Laos	2008	36-47 month-olds	400	Sweet beverages	Questionnaire + interview: – never; – < 2 times/ day – ≥ 2 times/ day	Caries	Mean dmft index

Author, year	Study type	Country	Year	Sample age	N	Type of beverage	Assessment of beverage consumption	Outcome variable	Outcome measure
Shahbaz et al. (2016)	Cross-sectional	Pakistan	2010	12-14 year-olds	385	Soft drinks	Exposure measure not specified: – 1 - 7 times/ week: – 8 - 21 times/ week	Erosion	Presence/absence of dental erosion in all teeth.
Skinner et al. (2015)	Cross-sectional	Australia	2010	14-15 year-olds	1,187	Sugary drinks (combines soft drinks, fruit juice, energy and sports drinks)	Questionnaire completed by teenagers and parents or guardians: – no intake; – 1 drink/ day; – ≥ 2/ day	Caries	Mean DMFT index and dichotomised as DMFT=0 and DMFT>1 on permanent dentition.
Su et al. (2018)	Cross-sectional	China	2016	3-6-year-olds	11,153	Sweetened beverages	Questionnaire completed by parents or grandparents: – < 1 times/week; – 1-2 times/week; – 3-4 times/week; – 5-6 times/week; – 7-8 times/week; – > 8 times/week	Caries	dmft index in primary dentition.
Tudoroniu et al. (2020)	Cross-sectional	Romania	2017	10-19-year-olds	650	Sugary sweetened beverages	Questionnaire completed by parents or legal guardians: – never-rare; – frequent	Caries	Mean DMFT index
Wakashita et al. (2011)	Cross-sectional	Japan	2005-2006	3-year-olds	522	Sport drinks	Questionnaire completed by parents: – no drinking; – < once/ month; – < twice/ week; – > 3 times/ week	Caries	dmft index measured and then dichotomised as dmft=0 and dmft>1.
Wang et al. (2010)	Cross-sectional	China	N/A	12-13-year-olds	1,499	Carbonated drinks	Self-completed questionnaire: – < once/ week; – ≥ once/ week	Erosion	O'Sullivan index on central incisors, lateral incisors, and first molars in the upper and lower jaws and then dichotomised as TW=0 and TW>1.

Author, year	Study type	Country	Year	Sample age	N	Type of beverage	Assessment of beverage consumption	Outcome variable	Outcome measure
Waterhouse et al. (2018)	Cross-sectional	Brazil	N/A	13-14-year-olds	458	Sugared carbonated drinks	Self-completed questionnaire: – never + ≤ 1/week + 2-4 times/week; – 1/day + ≥2/day	Erosion	Presence/absence of dental erosion.
Wilder et al. (2016)	Cross-sectional	United States	2010-2011	8-9-year-olds	2,944	Sugar-sweetened beverage	Questionnaire completed by parents or caregivers: – 0; 1; 2; 3; 4; ≥ 5 servings/ day.	Caries	Presence/ absence of untreated and/or treated caries in accordance with the diagnostic criteria of the ASTDD BSS.
Wulaerhan et al. (2014)	Cross-sectional	China	2013	3-5-year-olds	670	Sugar containing soft drink	Questionnaire completed by parents or caregivers: – ≤ once; – ≥ twice *per day?*	Caries	dmft index measured and then dichotomised as dmft=0 and dmft>1.
Zhang et al. (2014)	Cross-sectional	Hong Kong	2011-2012	12-year-olds	600	Soft drinks	Questionnaire completed by parents: – At least once every 2 days; – < once every 2 days	Caries	DMFT index on permanent dentition and then dichotomised as DMFT=0 and DMFT>1.

DMFT/dmft= decayed, missed, filled teeth; TW= tooth wear; TWI= Tooth Wear Index; VEDE= Visual Erosion Dental Examination; ASTDD= Association of State and Territorial Dental Directors; BSS= Basic Screening Survey Tool; BASCD= British Association for the Study of Community Dentistry.

Shaded rows highlight the included articles in the updated search.

4.3.4 Risk of bias within studies

Overall, the evidence of the relationship between SSB consumption and the oral health outcomes was found to have a good quality level. I rated thirty-one studies as 'Good', ten as 'Fair' and three as 'Poor'. In general, 'Poor' studies failed to provide an appropriate description of the sample, eligibility criteria and size, and they did not explore different levels of SSB consumption (Araujo et al., 2009; Senesombath et al., 2010; Shahbaz et al., 2016). However, even though the majority of studies showed a 'Good' quality level, the design of these studies needs to be taken into consideration as observational studies are at the bottom in the hierarchical scale of quality of evidence (Petrisor and Bhandari, 2007). Table 9 provides a summary of the quality assessment undertaken for each study.

All studies included in this review had at least one 'NR' (not reported) item as it is shown in Table 9 below. This introduces some risk of bias as there is valuable information that is missing and that could be affecting the quality of the results and the generalisability of this review's findings.

4.3.4.1 Aim

All authors explicitly described their aims or research questions. Some included this information in the full text, whereas in others this was found only in the abstract.

4.3.4.2 Sample

The majority of studies described, defined and specified adequately their study population; however, there were a few (n=5) that failed to provide this information. This is of great relevance as if we wanted to conduct the study again, we would want to know who to recruit and from where.

4.3.4.3 Participation rate

This information was greatly missed in almost half of the included studies. Twenty-two studies mentioned the participation rate, where only sixteen reported to have included a sample that represented more than 50% of the eligible population. This increases the risk of bias as when fewer than 50% of eligible subjects participates in the study, the study sample does not adequate represents the target population.

4.3.4.4 Eligibility criteria

Most studies pre-specified the inclusion and exclusion criteria for their participants in the methods section. Only one study failed to describe this information in detail (Senesombath et al., 2010). This may introduce some risk of selection bias.

4.3.4.5 Sample size justification

Less than half of the included studies provided a justification for the number of selected and recruited participants. Varied methods of sample size calculation were used across the studies, e.g. statistical power, variance or effect estimations. This component is of relevance as only the studies with a justified number of participants are able to detect if the hypothesized effect size is statistically true or not. However, some studies were exploratory, thus this information was not stated. In these cases, the lack of the sample size justification was not considered as a “fatal flaw” (NHLBI, 2014).

4.3.4.6 Exposure levels and measures

Most studies examined different levels of SSB consumption, with the exception of eleven studies that measured whether the participants ever consumed SSB or not. Multiple levels of exposure allowed the assessment of the existence of a dose-response relationship with dental caries. To collect this exposure information, authors used either a self-completed questionnaire or interviews introducing some potential recall bias. Most authors reported to use their own questionnaires according to the objectives of their research, which resulted in a great variety of questions adding great difficulty to the comparison. There was limited information on their accuracy, validity and reliability with only a few reporting to have pre-tested their tools. This is important as it influences the confidence in the reported exposures that may introduce some information bias to the results.

4.3.4.7 Outcome measures

The vast majority of studies provided an internationally accepted method of outcome data collection, and most of them followed recommendations from the WHO. However, there were a few studies that did not report having used a validated method, introducing measurement bias to their results and limiting the generalizability of this review.

4.3.4.8 Blinding of outcome assessors

Almost all studies failed to report whether the outcome assessors were blinded to the participant's level of exposure. Only one study described that the researcher who undertook the oral health examination was blinded to the exposure (Waterhouse et al., 2018). The lack of blinding could introduce some bias as the assessor may influence (either subconsciously or not) on the participant and the subsequent results (Petrisor and Bhandari, 2007).

4.3.4.9 Adjustment for confounders

Around half of the studies provided the relationship between SSB consumption and the oral health outcomes adjusted for potential confounders in their analyses. These confounders were age, gender and consumption of other acidic food items.

Table 9. Quality assessment summary

Author, year	Clear aim	Sample defined	Participation rate > 50%	Inc/excl criteria	Sample size justification	Levels of exposure	Exposure measures	Outcome measures	Assessors blinding	Adjusted for confounders	Quality rating
Abu-Ghazaleh et al. (2013)	✓	✓	NR	✓	✓	×	✓	✓	NR	×	Good
Alhabdan et al. (2018)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Al-Malik et al. (2001)	✓	✓	NR	✓	×	×	✓	✓	NR	×	Fair
Alvarez et al. (2015)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Amin & Al-Abad (2008)	✓	✓	×	✓	✓	✓	✓	×	NR	×	Good
Araujo et al. (2009)	✓	×	×	✓	×	×	CD	CD	NR	×	Poor
Chen et al. (2014)	✓	✓	NR	✓	×	✓	✓	✓	NR	×	Good
Dahal et al. (2020)	✓	✓	NR	✓	×	✓	✓	✓	NR	×	Fair
Damle et al. (2011)	✓	×	NR	✓	×	✓	✓	✓	NR	×	Fair
El Karim et al. (2007)	✓	✓	×	✓	×	✓	✓	✓	NR	×	Fair
Fung & Messer (2013)	✓	✓	NR	✓	×	✓	✓	✓	×	×	Good
Hamasha et al. (2014)	✓	✓	NR	✓	×	✓	✓	✓	×	×	Good
Hashim et al. (2009)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Hasieh et al. (2014)	✓	×	NR	✓	×	×	✓	✓	NR	×	Fair
Huew et al. (2012)	✓	✓	×	✓	✓	✓	✓	✓	NR	×	Good
Jamieson et al. (2010)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Khan et al. (1990)	✓	✓	×	✓	×	×	×	✓	NR	×	Fair
Kirthiga et al. (2015)	✓	✓	×	✓	×	✓	×	✓	NR	✓	Fair
Krisdapong et al. (2013)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Kruger et al. (2005)	✓	✓	NR	✓	×	×	✓	✓	NR	×	Fair
Li et al. (2010)	✓	✓	NR	✓	×	✓	CD	✓	NR	✓	Good
Maharani et al. (2019)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Maharani et al. (2019b)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Manaf et al. (2012)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Mello et al. (2008)	✓	✓	✓	✓	×	✓	✓	✓	NR	✓	Good
Milosevic et al. (2004)	✓	✓	NR	✓	✓	✓	✓	✓	NR	×	Good
Mulic et al. (2012)	✓	✓	×	✓	×	✓	✓	✓	NR	×	Good
Murakami et al. (2011)	✓	✓	NR	✓	✓	✓	✓	✓	NR	✓	Good
Nakayama & Mori (2015)	✓	✓	✓	✓	×	✓	✓	✓	NR	✓	Good
Nakayama & Mori (2015b)	✓	✓	✓	✓	×	✓	✓	✓	NR	✓	Good
Perinetti et al. (2005)	✓	✓	×	✓	×	✓	✓	✓	NR	✓	Good

Author, year	Clear aim	Sample defined	Participation rate > 50%	Inc/excl criteria	Sample size justification	Levels of exposure	Exposure measures	Outcome measures	Assessors blinding	Adjusted for confounders	Quality rating
Punitha et al. (2015)	✓	✓	×	✓	✓	✓	✓	✓	NR	×	Good
Salas et al. (2014)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Senesombath et al. (2010)	✓	×	NR	×	×	×	✓	✓	NR	×	Poor
Shahbaz et al. (2016)	✓	×	NR	✓	×	×	✓	×	NR	×	Poor
Skinner et al. (2015)	✓	✓	NR	✓	×	✓	✓	✓	NR	×	Fair
Su et al. (2018)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Tudoroniu et al. (2020)	✓	✓	✓	✓	✓	✓	✓	✓	NR	✓	Good
Wakashita et al. (2011)	✓	✓	✓	✓	×	✓	✓	✓	NR	✓	Good
Wang et al. (2010)	✓	✓	NR	✓	✓	✓	✓	✓	NR	✓	Good
Waterhouse et al. (2018)	✓	✓	NR	✓	×	✓	✓	✓	✓	×	Good
Wilder et al. (2016)	✓	✓	×	✓	×	✓	✓	CD	NR	✓	Fair
Wulaerhan et al. (2014)	✓	✓	✓	✓	✓	×	✓	✓	NR	×	Good
Zhang et al. (2014)	✓	✓	×	✓	✓	×	✓	✓	NR	×	Good

NR= not reported; CD=cannot determine

Shaded rows highlight the included articles in the updated search.

4.3.5 Findings

Table 10 provides a summary of the estimated OR of having caries, the OR of having erosion, and the DMFT/dmft mean difference comparing different levels of SSB consumption – Low, Moderate, High and Any level - by oral health outcome and type of dentition. Figure 14 illustrates the summary of findings.

Table 10. Summary of the effect of SSB consumption on caries and erosion using random- effects model

SSB levels comparison	Outcome	Overall estimation/ Type of dentition	No. of studies	N	Effect size (95% CI)	I^2 (%)
Never/Low vs Mod	Caries	Overall OR	17	23077	**1.52 (1.29-1.79)**	**72.7**
		Primary dentition	5	14657	**2.20 (1.41-3.44)**	**82.8**
		Mixed dentition	2	2618	1.15 (0.59-2.27)	**93.7**
		Permanent dentition	10	5801	**1.44 (1.20-1.73)**	42.2
		Overall WMD	9	6131	**0.82 (0.38-1.26)**	**83**
		Primary dentition	3	2687	**0.98 (0.44-1.52)**	0
		Mixed dentition	1	1063	0.20 (-0.05-0.45)	NA
		Permanent dentition	5	2381	**0.93 (0.29-1.58)**	**83**
	Erosion	Overall OR	10	10865	**1.70 (1.24-2.35)**	**83.9**
		Primary dentition	2	1528	**1.23 (0.44-3.47)**	62.6
		Mixed dentition	1	367	**4.10 (2.12-7.92)**	NA
		Permanent dentition	7	8871	**1.65 (1.16-2.34)**	**85.9**
Mod vs High	Caries	Overall OR	12	13422	**1.48 (1.17-1.86)**	**85.9**
		Primary dentition	3	5369	2.15 (0.90-5.09)	**96.2**
		Mixed dentition	2	2855	1.31 (0.95-1.80)	**46.5**
		Permanent dentition	7	5198	**1.34 (1.03-1.75)**	**73.5**
		Overall WMD	4	1820	1.16 (-0.59-2.91)	**95.7**
		Primary dentition	2	701	0.57 (-0.18-1.67)	0
		Permanent dentition	2	1119	**1.57 (-1.08-4.22)**	**98.6**
	Erosion	Overall OR	8	7493	**2.67 (1.26-5.64)**	**97.0**
		Primary dentition	2	1164	**1.93 (1.49-2.49)**	0
		Mixed dentition	1	382	**0.98 (0.52-1.83)**	NA
		Permanent dentition	5	5947	**3.80 (1.19-12.13)**	**98.2**
Never/Low vs High	Caries	Overall OR	9	12482	**1.86 (1.53-2.27)**	**67.3**
		Primary dentition	1	6739	**1.50 (1.27-1.76)**	NA
		Mixed dentition	1	1944	**2.36 (1.89-2.95)**	NA
		Permanent dentition	7	3799	**1.86 (1.46-2.38)**	**56.5**
		Overall WMD	4	1778	1.91 (-0.94-4.75)	**97.6**
		Primary dentition	2	751	1.09 (-0.40-2.58)	0
		Permanent dentition	2	1027	2.59 (-1.58-6.77)	**99.2**
	Erosion	Overall OR	11	9665	**2.99 (1.42-6.29)**	**97.2**
		Primary dentition	1	916	**1.77 (1.20-2.61)**	NA
		Mixed dentition	2	255	**2.20 (0.66-7.32)**	**73.5**
		Permanent dentition	8	8494	**3.48 (1.35-9.0)**	**98**
Never/Low vs Mod/High	**Caries**	Overall OR	20	28970	**1.90 (1.55-2.33)**	**86.8**
		Primary dentition	6	15374	**2.22 (1.48-3.32)**	**78.6**
		Mixed dentition	3	4730	2.77 (0.86-8.91)	**97.9**
		Permanent dentition	11	8866	**1.63 (1.39-1.91)**	**46.5**
		Overall WMD	13	8706	**1.06 (0.48-1.65)**	**94.3**
		Primary dentition	4	2901	**1.16 (0.62-1.70)**	0
		Mixed dentition	2	1319	0.76 (-0.46-1.98)	**87.6**
		Permanent dentition	7	4486	**1.07 (0.17-1.98)**	**96.7**
	Erosion	Overall OR	16	17739	**1.93 (1.44-2.60)**	**89.2**
		Primary dentition	2	1656	**1.47 (1.07-2.03)**	0
		Mixed dentition	3	1549	2.67 (1.27-5.60)	60.0
		Permanent dentition	11	14534	**1.84 (1.28-2.65)**	**92.2**

In bold=P value<0.05; CI = confidence interval; N = number of participants; I^2 = test of heterogeneity; OR = odds ratio; WMD = weighted mean difference

4.3.5.1 Effect of SSB consumption on dental caries

A) Meta-analyses

I included twenty-three studies in the meta-analyses that estimate the OR of having caries and thirteen studies were included to estimate the difference in mean DMFT/dmft. Most OR and WMD random-effects meta-analyses revealed a statistically significant association between SSB consumption and caries. The overall estimates in all meta-analyses showed a high level of heterogeneity ($I^2 > 46.5\%$) as expected, which confirms that the random-effects model was the best approach to pool the data.

Never/low level compared to moderate/high levels of SSB consumption

Figures 10 and 11 show the forest plots for the OR of having dental caries and the weighted mean DMFT/dmft difference among never/low level SSB consumers compared to moderate/high level consumers. With the exception of three studies (Huew et al., 2012; Mello et al., 2008; Salas et al., 2014), most studies found a positive association between SSB and dental caries.

The graphs illustrate that moderate/high consumers have significantly higher odds of caries (OR=1.90, 95%CI: 1.55-2.33), and have mean 1.06 more decayed, missed or filled teeth than never/low level consumers. There is a clear effect difference between types of dentition. The OR is higher in the primary dentition compared to the permanent dentition; however, it improves during the mixed dentition phase, which is expected as it is when the primary dentition is replaced by permanent teeth. By contrast, the WMD is slightly lower in the primary dentition compared to the permanent dentition, but decreases during the mixed dentition phase. The WMD refers to the severity of the disease, so the results suggest that towards adulthood the severity of caries increases as this is a cumulative disease.

Never/low, Moderate and High SSB consumption levels comparisons

The OR of having caries and the WMD is similar between never/low to moderate level and moderate level to high level consumers (OR=1.52, 95%CI: 1.29-1.79 and WMD=0.82, 95%CI: 0.38-1.26; OR=1.48, 95%CI: 1.17-1.86 and WMD=1.16, 95%CI: -0.59-2.91, respectively). However, the odds of having caries and the WMD among high-level consumers is twice the odds and the WMD among never/low level consumers (OR=1.86, 95%CI: 1.53-2.27; WMD=1.91, 95%CI: -0.94-4.75). Overall, the OR in the mixed dentition group is higher than the permanent dentition group, and in

contrast, the WMD is more severe during adulthood compared to early years. The forest and funnel plots of all meta-analyses are presented in Appendix 4 (A-D).

Figure 10. Forest plot of odds-ratios of having dental caries

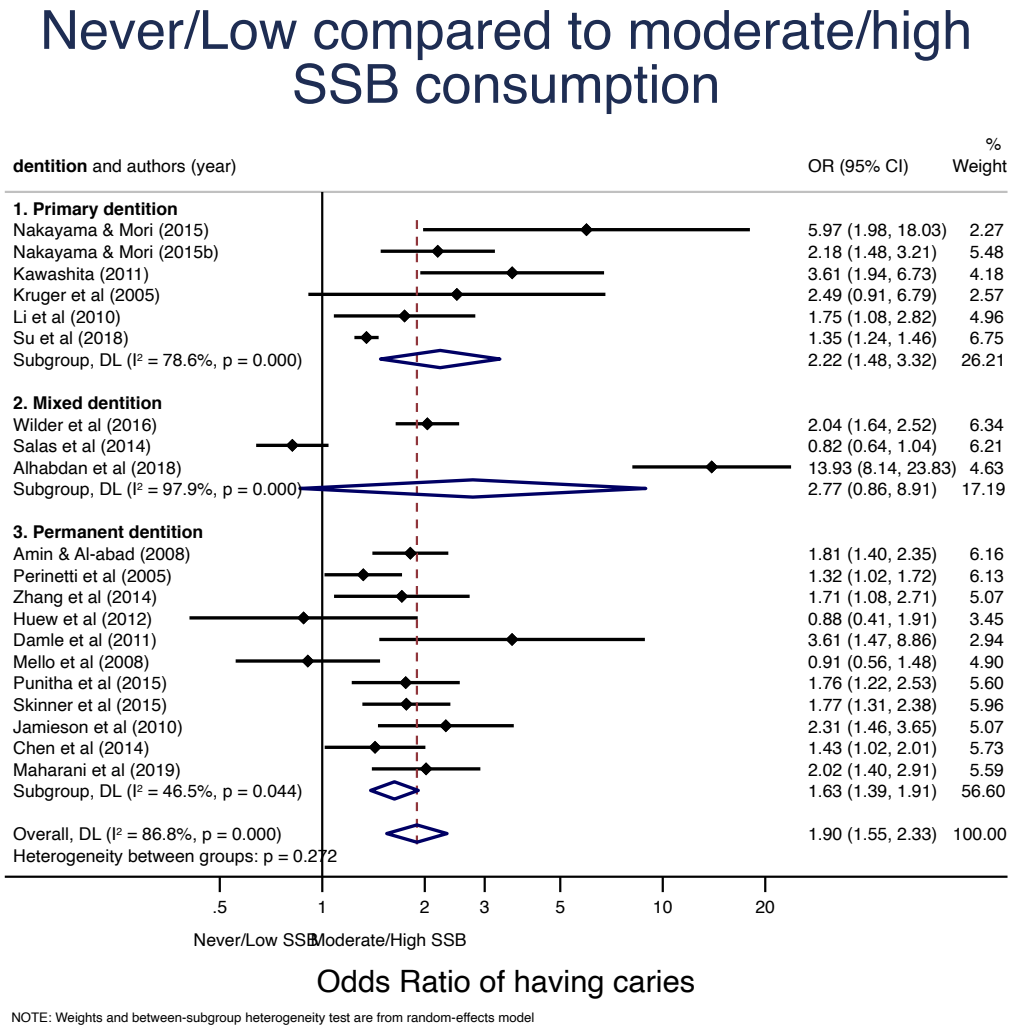
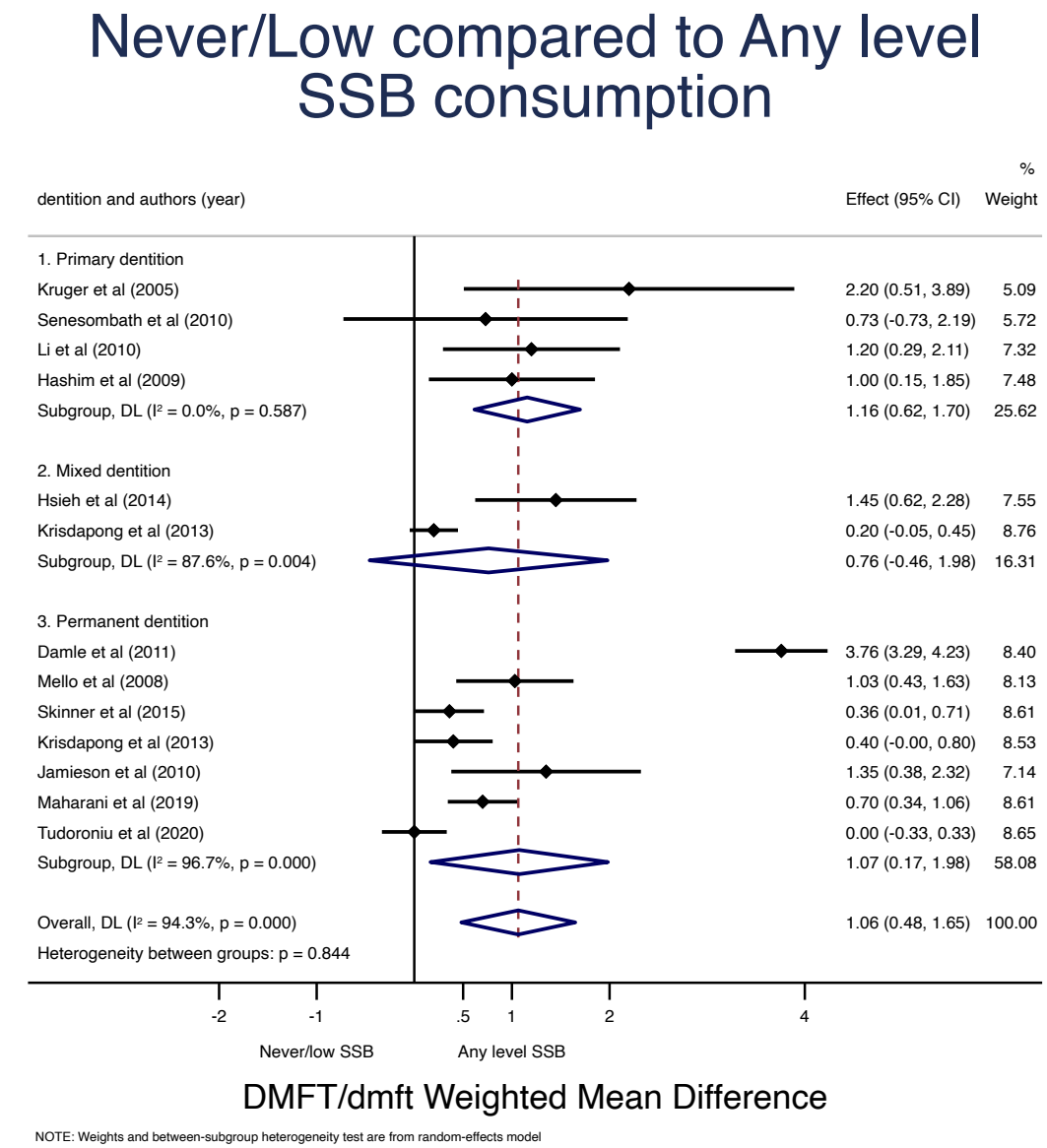


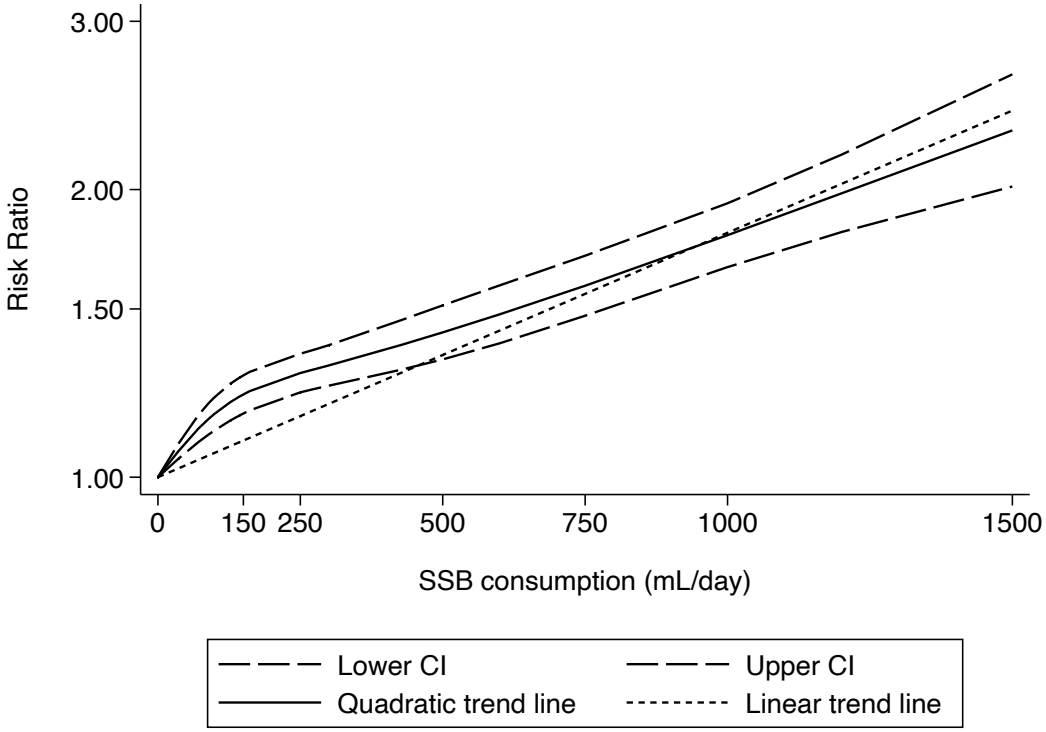
Figure 11. Forest plot of weighted DMFT/dmft mean difference



B) Dose-response analysis

I included ten studies in the dose-response analysis. I explored linear and non-linear dose-response associations between the amount of SSB consumption and the risk of dental caries; however, the likelihood test revealed that the relationship is clearly non-linear. Figure 12 shows that the risk of caries is steeper as the amount of SSB increases up to 150ml/day, and then levels off to continue in an apparent linear line to 1500 ml/day. Appendix 4 (C) shows the risk estimate with the 95% CI for each amount of SSB in detail.

Figure 12. Linear and non-linear dose-response curve between amount of daily SSB consumption and the risk of having dental caries



4.3.5.2 Effect of SSB consumption on dental erosion

A) Meta-analysis

I included eighteen studies in the meta-analyses that estimate the OR effect of SSB consumption on dental erosion. Overall, the OR random-effects meta-analyses revealed statistically significant effects of SSB consumption on erosion (Table 10). The overall estimates of all meta-analyses showed high level of heterogeneity ($I^2 > 60.0\%$), thus the random effects model was the best approach to pool the data.

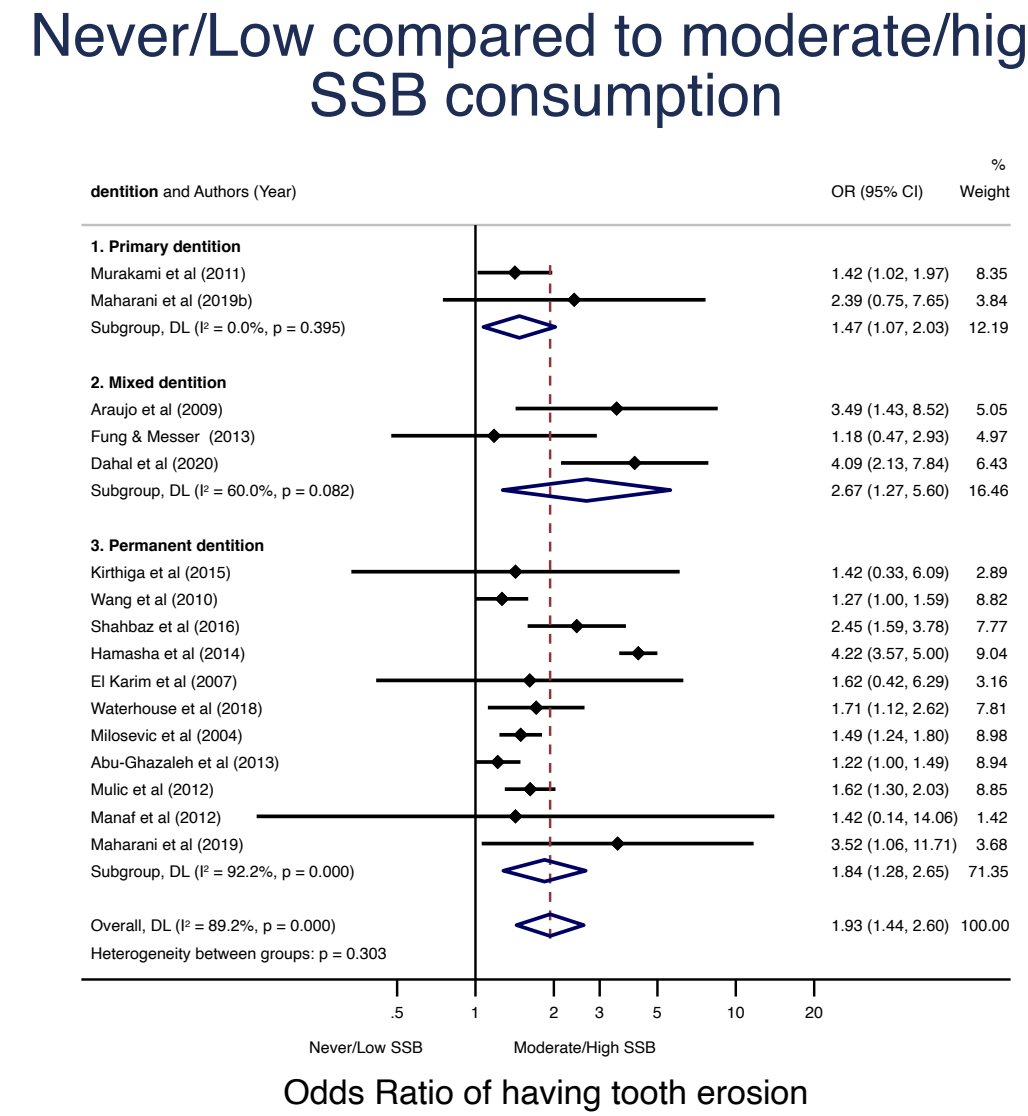
Never/low level compared to moderate/high levels of SSB consumption

The meta-analyses show that moderate and high SSB consumers have a higher risk of erosion than low-level consumers. The odds of having erosion for those who drink more than two portions of SSB a week almost double the odds of that for those who do not consume or drink less than that amount (OR 1.93, 95%CI 1.44-2.60). Similar to caries, there is a clear effect difference across types of dentition; however, for erosion, the OR is lower in the primary compared to permanent dentition (Figure 13).

Never/low, Moderate and High SSB consumption levels comparisons

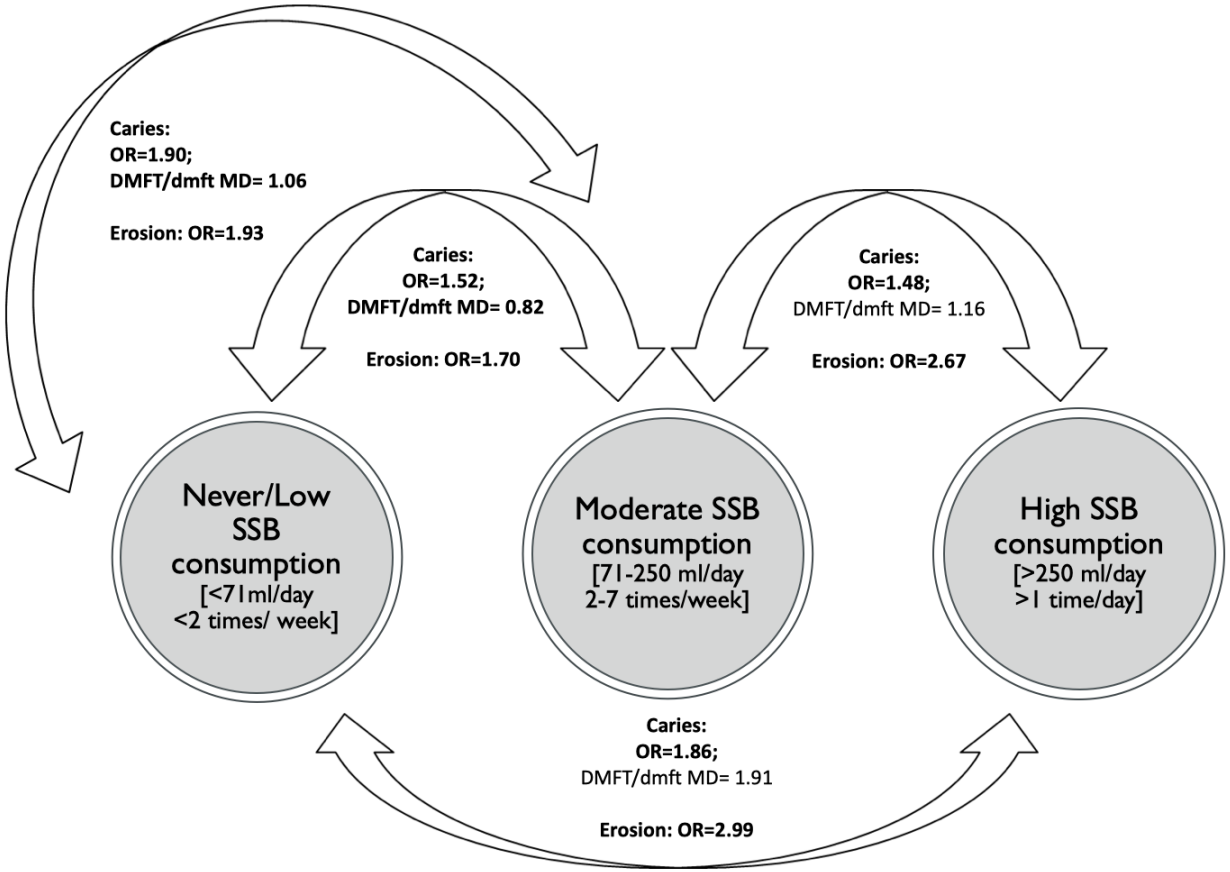
The odds-ratio of having erosion between the different levels of SSB consumption differ with caries as for erosion the effect is larger. The odds of having erosion among high SSB consumers are almost three times the odds of both moderate and never/low level consumers (OR=2.67, 95%CI 1.26-5.64; OR=2.99, 95%CI 1.42-6.29), whereas between never/low and moderate level consumers this estimate is lower, but still significant (OR=1.70, 95%CI 1.24-2.34). See Appendix 4 (D) for the forest and funnel plots of these comparisons.

Figure 13. Forest plot of odds-ratios of having dental erosion



NOTE: Weights and between-subgroup heterogeneity test are from random-effects model

Figure 14. Summary of findings



SSB= sugar-sweetened beverages; ml= millilitres; OR= odds-ratio; MD= mean difference; DMFT/dmft: decayed, missed and filled teeth; Estimates in bold are statistically significant p<0.05.

4.3.6 Risk of bias across studies and additional analyses

I drew funnel plots for each meta-analysis and although visual inspection of some funnel plots suggest some publication bias, this was not found to be statistically significant by Egger's test of bias as I only found p values greater than 0.05 (See Appendix 4 (A-D). To account for this heterogeneity, I undertook all meta-analyses using a random-effects model. In other words, there is no major threat to the validity of this review. No study demonstrated a large effect on the influence analyses (Appendix 4 (A-D). The sensitivity analyses showed no substantial variation in the estimates.

4.3.7 Certainty of evidence

The certainty of evidence was assessed high for the caries outcome measured as OR and for some of the erosion outcome using GRADE criteria (Table 11). For the rest of the outcomes, the certainty was assessed as Moderate given the design of the included studies. The main reason for upgrading was the presence of a dose-response gradient for the dichotomous caries outcome and the presence of a large effect for the erosion outcome.

Table 11. GRADE assessment for evidence certainty

Outcomes	№ of participants (studies) Follow-up	Certainty of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Never/Low level SSB consumption	Risk difference with Moderate level SSB consumption
Moderate level compared to Never/Low level SSB consumption in the general population					
Dental caries assessed with: Presence/absence (DMFT/dmft>=1 or 0)	23077 (17 observational studies)	⊕⊕⊕⊕ HIGH [a]	**OR 1.52** (1.29 to 1.79)	228 per 1,000	**82 more per 1,000** (48 more to 118 more)
Dental caries assessed with: Mean DMFT/dmft Scale from: 0 to 32	6131 (9 observational studies)	⊕⊕⊕◯ MODERATE	**WMD 0.82** (0.38 to 1.26)	-	WMD **0.82 DMFT/dmft higher** (0.38 higher to 1.26 higher)
Erosion assessed with: Presence/absence (various indices)	10865 (10 observational studies)	⊕⊕⊕◯ MODERATE	**OR 1.43** (1.01 to 2.03)	263 per 1,000	**115 more per 1,000** (44 more to 193 more)
High level SSB consumption compared to Moderate level SSB consumption in the general population					
Dental Caries assessed with: Presence/absence (DMFT/dmft>=1 or 0)	13422 (12 observational studies)	⊕⊕⊕⊕ HIGH [a]	**OR 1.48** (1.17 to 1.86)	436 per 1,000	**98 more per 1,000** (39 more to 154 more)
Dental Caries assessed with: Mean DMFT/dmft Scale from: 0 to 32	1820 (4 observational studies)	⊕⊕⊕◯ MODERATE	**WMD 1.16** (0.59 to 2.91)	-	WMD **1.16 DMFT/dmft higher** (0.59 lower to 2.91 higher)
Erosion assessed with: Presence/absence (various indices)	7493 (8 observational studies)	⊕⊕⊕⊕ HIGH [b]	**OR 2.67** (1.26 to 5.64)	543 per 1,000	**217 more per 1,000** (57 more to 327 more)

Table 8. GRADE assessment for evidence certainty (continues…)

Outcomes	№ of participants (studies) Follow-up	Certainty of the evidence (GRADE)	Relative effect (95% CI)	Anticipated absolute effects	
				Risk with Never/Low level SSB consumption	Risk difference with Moderate level SSB consumption
High level SSB consumption compared to Never/Low level SSB consumption in the general population					
Dental caries assessed with: Presence/absence (DMFT/dmft>=1 or 0)	12482 (9 observational studies)	⊕⊕⊕⊕ HIGH [a]	**OR 1.86** (1.53 to 2.27)	125 per 1,000	**85 more per 1,000** (54 more to 120 more)
Dental caries assessed with: Mean DMFT/dmft Scale from: 0 to 32	1778 (4 observational studies)	⊕⊕⊕◯ MODERATE	**WMD 1.91** (0.94 to 4.75)	-	WMD **1.91 DMFT/dmft higher** (0.94 lower to 4.75 higher)
Erosion assessed with: Presence/absence (various indices)	9665 (11 observational studies)	⊕⊕⊕⊕ HIGH [b]	**OR 2.99** (1.42 to 6.29)	316 per 1,000	**264 more per 1,000** (80 more to 428 more)
Moderate/High level SSB consumption compared to Never/Low level SSB consumption in the general population					
Dental caries assessed with: Presence/absence (DMFT/dmft>=1 or 0)	28970 (20 observational studies)	⊕⊕⊕⊕ HIGH [a]	**OR 1.90** (1.55 to 2.33)	205 per 1,000	**124 more per 1,000** (81 more to 170 more)
Dental caries assessed with: Mean DMFT/dmft Scale from: 0 to 32	8706 (13 observational studies)	⊕⊕⊕◯ MODERATE	**WMD 1.06** (0.48 to 1.65)	-	WMD **1.06 DMFT/dmft higher** (0.48 higher to 1.65 higher)
Erosion assessed with: Presence/absence (various indices)	17739 (16 observational studies)	⊕⊕⊕◯ MODERATE	**OR 1.93** (1.44 to 2.60)	208 per 1,000	**128 more per 1,000** (66 more to 198 more)

The risk in the intervention group (and its 95% confidence interval) is based on the assumed risk in the comparison group and the relative effect of the intervention (and its 95% CI).

a. Outcome upgraded by one increment due to presence of dose-response gradient.

b. Outcome upgraded by one increment due to presence of a large effect.

CI: Confidence interval; **OR:** Odds ratio; **MD:** Mean difference

4.4 Summary of findings

Although other reviews have found an association between SSB and caries and erosion, to my knowledge, this study is the first to quantify this relationship using different levels of consumption. I found not only a positive association but also a dose-response gradient between SSB consumption and caries. My analyses show that people who consume larger quantities of SSB (daily or several times a week) have greater odds of having dental caries and erosion, and higher caries rates than people who consume smaller amounts (less than twice a week). The evidence was robust in establishing these relationships given the lack of publication bias, quality of studies, the strength of the effect and the dose-response relationship found between SSB and caries. This evidence suggests that reducing the exposure to SSB in the population would improve the oral health of the next generations and for this, better public health strategies should be developed.

My findings are consistent with other reviews (Bleich and Vercammen, 2018; Du, 2014; Vartanian et al., 2007; Li et al., 2012; Salas et al., 2015). Previous studies have reported the effect of SSB on either caries or erosion; however, they are unclear on the amounts of SSB used, only compare the effect of no consumption with absolute consumption of SSB, or provide a narrative analysis. While the majority conclude that there is substantial evidence supporting an association between SSB consumption and caries and erosion (Bleich and Vercammen, 2018; Du, 2014; Li et al., 2012; Salas et al., 2015) there is uncertainty regarding the strength with one study (Vartanian et al., 2007) claiming (based on results from only four studies) that although this association is positive, it is small (r=0.03). Existing reviews lack clarity about the amount of SSB considered in their analyses. Salas and colleagues (2015) for example, report that higher consumption levels of SSB are associated with erosion, but the authors do not define ‘high’ levels of consumption. Similarly, while Li et al. (2012) report that the OR for SSB consumption and erosion is 2.41 (similar to our findings) they do not clarify the amounts of SSB being compared. The findings of my study corroborate these positive associations, but go further by quantifying the relationship more precisely, based on amounts of SSB consumed, thereby increasing the robustness of the evidence.

Although the studies included in this systematic review were cross-sectional, and therefore cannot inform temporal relationships as longitudinal studies would (Bowling, 2009), the established biological plausibility of the relationship between sugar

consumption and caries (Moynihan and Kelly, 2014), along with the strength of association and dose-response relationship observed in the review, suggest that the relationship between SSB consumption and dental carries is likely to be causal.

4.5 Chapter summary

In this chapter I described the methods that I used to conduct this systematic review and explore if the consumption of higher levels of sugar-sweetened beverages compared with lower levels is associated with dental caries and/or tooth erosion, the strength of the association in the general population and to investigate whether this association follows a dose-response relationship. I provided a rich description of the procedures and the quality criteria that I used to perform the analyses and the risk of bias assessment of the included studies and the evidence. Forty-four studies met the inclusion criteria and I pooled them using meta-analysis and dose-response analysis methods. The findings showed that SSB are a significant risk factor for dental caries and erosion and that the strength of the relationship between these outcomes and the exposure depends on the level of consumption with a clear dose-response relationship between SSB consumption and dental caries. The current body of evidence surrounding the effect of SSB consumption on oral health is consistent with the literature, of good quality and certainty and provides a timely opportunity to inform future public health policies to reduce SSB consumption, including sugar taxation.

Chapter 5

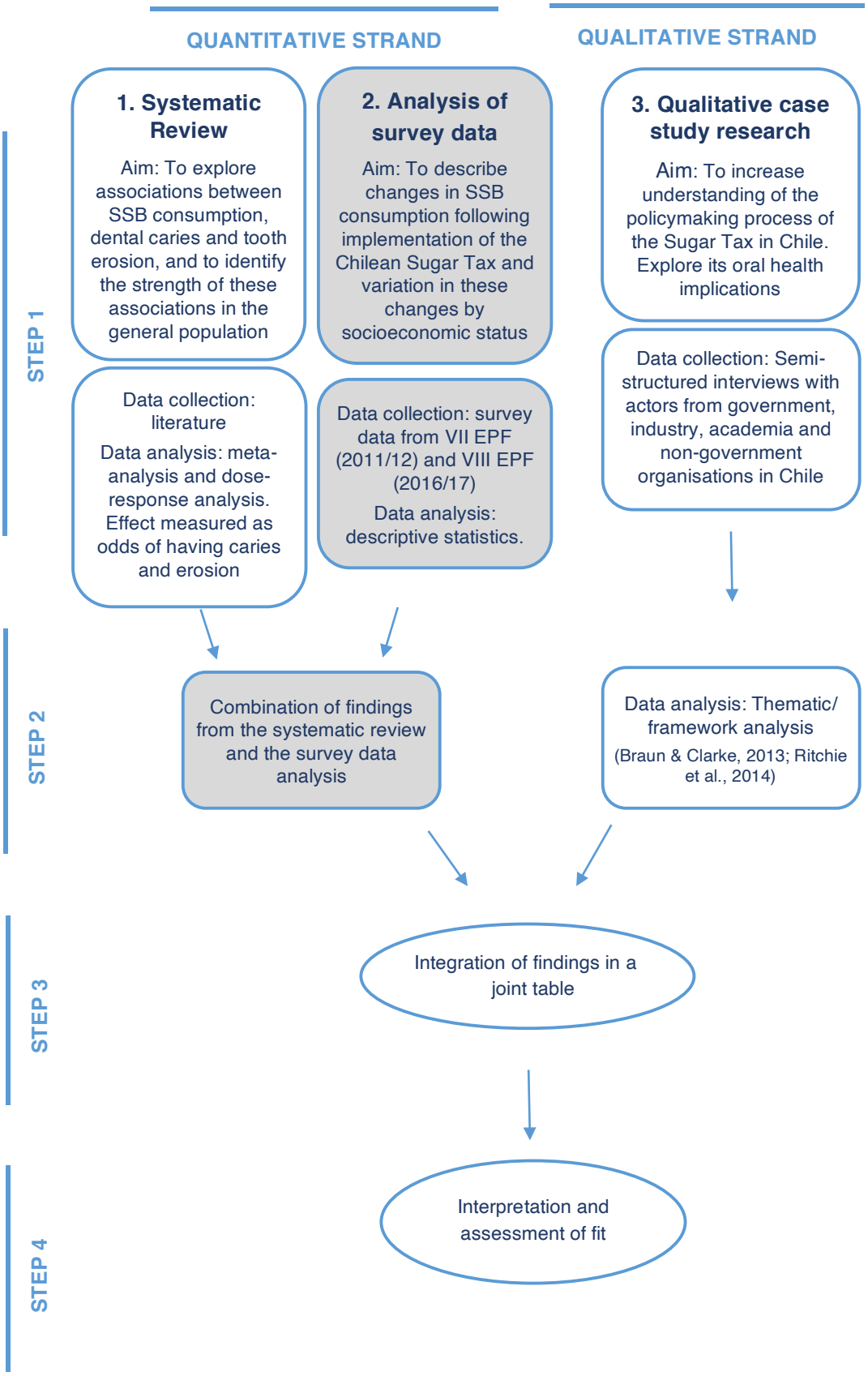
Quantitative analysis of two waves of the Household Budget Survey in Chile

---

After describing the association between the consumption of SSB and dental caries and tooth erosion (Chapter 4, section 4.3), in this chapter I describe SSB consumption expenditures from two waves of the Chilean Household Budget Survey (Encuesta de Presupuestos Familiares - EPF), one before and one after the implementation of the Sugar Tax policy in October 2014. The analysis also combines the survey data with findings from the systematic review in Chapter 4 to provide a more comprehensive account of SSB consumption changes resulting from the policy and to estimate the potential effect of the policy on oral health (Figure 15).

I begin this chapter by explaining the rationale for this study and the aim and objectives. Then, I describe the methods, type of study, outcomes and variables I selected from the EPF surveys with emphasis on the survey methodology. In this section I also describe the steps I followed in preparing and analysing the datasets. Next, I present the study results, and I finish with a chapter summary.

Figure 15. Convergent mixed methods thesis diagram



5.1 Rationale for conducting this study

To evaluate fully the effect implementation of the national Sugar Tax policy had on the oral health of the population requires data on SSB consumption levels and oral health status from before and after the policy's implementation. Unfortunately, such detailed information does not exist in Chile. Small-scale studies have measured the oral health status of specific age groups, but these are not representative of the total population nor repeated over time, and data on SSB consumption is similarly lacking. There is therefore a substantial gap in knowledge about the impact of government policies and programmes on population oral health, including variation across population groups. Household surveys, however, may fill this gap to some degree as they can be used to estimate how household behaviour changes in response to new policies (UN, 2005).

The EPF survey is a repeated household survey containing information about consumption expenditure data of many items, including non-alcoholic beverages from a representative sample. One wave of the survey was conducted in 2011/12 – two years before implementation of the Sugar Tax in 2014 – and another wave was conducted in 2016/17. Data from these surveys therefore provide an opportunity to explore the impacts of the policy on SSB consumption.

5.2 Aim and objectives

This study aims to describe changes in SSB consumption levels following implementation of the Chilean Sugar Tax policy in 2014 and variation in these changes by socioeconomic status. A second aim is to project the possible effect of the policy on oral health.

The study objectives are:

1) For both the 2011/12 and 2016/7 EPF survey waves:

a) To describe the sociodemographic characteristics of the Chilean population.

b) To describe household and per capita total expenditures and disposable incomes.

c) To describe variation in household and per capita beverage consumption expenditure by socio-economic status.

2) To compare household and per capita SSB expenditure and implied consumption before and after implementation of the Chilean Sugar Tax policy.

3) To estimate the possible effect of the Sugar Tax policy on oral health.

5.3 Methods

5.3.1 Type of study

This study is a secondary data analysis of two waves of the anonymous national representative and cross-sectional EPF survey conducted in Chile between November 2011 – October 2012 (VII EPF) and July 2016 – June 2017 (VIII EPF).

5.3.2 Overview of the Chilean Household Budget Survey (EPF, in Spanish)

There are two main sources of information on SSB consumption expenditure in the Chilean population: independent market research data and national surveys. The first provides robust longitudinal data collected by Euromonitor and Kantar Worldpanel, but access comes at a significant cost. Among the national surveys in Chile, the EPF survey is the richest data source including data on SSB consumption expenditure, and datasets are openly available for researchers. Despite limitations that I further describe and explore in the discussion chapter (Chapter 8), particularly relating to the cross-sectional design and the classification of SSB that makes impossible to distinguish between sugary and non-sugary beverages, it is a valuable source of information and was used in this study.

The EPF survey is a national population-based survey conducted in Chile by the National Institute of Statistics (INE), the body responsible for producing and disseminating the country's official statistics. The first EPF survey was conducted in 1956/57 and repeated every ten years until the sixth version in 2006/07. Under the country's commitment to the Organization for Economic Cooperation and Development (OECD), the EPF survey started to be conducted on a five-year basis. The covered geographic area was expanded beyond Santiago's urban area, Chile's capital city, to the rest of the country, increasing its representativeness of the urban areas at the national level.

The EPF survey provides a picture of the economic and social living conditions of private households and individuals over time. It collects detailed information on household consumption expenditure on items used to produce the weights for the basket of goods to construct the Consumer Price Index (CPI). It reports data about income, housing, possession of consumer durable goods, including foods and

beverages, and households' socio-economic and demographic information. The survey has two main objectives (INE, 2021):

1. To identify the structure and characteristics of the final consumption expenditure of urban households, in the regional capitals of Chile and some of its metropolitan areas, with one year's reference period.

2. To identify the structure of total disposable income of urban households in Chile's regional capitals and some of its metropolitan areas, with a reference period of one year.

However, the wealth of information captured in the survey makes it useful for secondary purposes, such as monitoring aspects of standard of living, consumption trends, eating patterns, poverty rates, and getting information on individual household income, wealth and expenditure (INE, 2018).

The survey methodology, questionnaires and procedures are publicly available at https://www.ine.cl/estadisticas/sociales/ingresos-y-gastos/encuesta-de-presupuestos-familiares. The data are presented in two separate files linked by a unique identifier assigned to each household. The first is the member file that contains personal and demographic information, employment status, education, household ownerships, total household expenditure and income for the head of the household and the rest of the members. The second is the household file that contains information about the household expenditure in detail per product based on an adapted version of the United Nations' (UN) Classification of Individual Consumption by Purpose (COICOP), a reference classification of the purpose of individual consumption expenditures. I describe this classification system in more detail in section 5.3.4.4.

5.3.3 Sample

5.3.3.1 Sample design

The sampling frame for the EPF survey covers Santiago (the capital city and its wider metropolitan area) and the country's regional capitals and principal conurbations. The sampling frame covered 70.5% and 72.1% of all urban households in the VII EPF and the VIII EPF, respectively (INE, 2013).

The inclusion criteria include persons residing in private households, but the actual sample unit is the household. Dwellings with more than five households were excluded, as well as collective or institutional households, such as care homes,

hospitals, hostels and prisons, and persons without a fixed place of residence and buildings identified as businesses, collective homes, uninhabited homes, summer homes, destroyed homes, among others. These represented 5.9% and 9% of the total household sample in the VII and VIII EPF surveys, respectively (INE, 2019).

5.3.3.2 Sampling strategy

The complex sampling strategy used in the EPF surveys involves a probabilistic, stratified, and two-stage selection of households. The first stage sampling units corresponds to delimited geographical areas called *manzanas* (blocks). Each *manzana* is stratified within the city *comunas* (communes) according to socio-economic status and number of households based on the 2002 population and dwellings national census. The second stage sampling corresponds to the selection of private dwellings within each *manzana*. There is an equal probabilistic selection of *manzanas* and dwellings; however, small *manzanas*, i.e. with seven or fewer households and hard to reach *manzanas* due to their difficult geographical access or in dangerous neighbourhoods are excluded.

5.3.3.3 Sample size and non-response rate

The VII EPF (2011/12) survey included 10,528 households, and the VIII EPF (2016/17) 15,239 households. The number of households included in the surveys was representative of the total population in each region living in urban settings. Table 12 shows the household samples and their national representation (after weighting the sample).

Table 12. Total number of households and their national representation by survey wave

	VII EPF (2011/12)	**VIII EPF (2016/17)**
Surveyed	10,528	15,239
National representation	3,009,720	3,373,786

Household budget surveys are known for having a low response rate due to the household's fatigue after repeated visits by the interviewer or the level of detail about income and expenditure that needs to be submitted (Groves and Couper, 1998). However, the reported response rate was relatively high at 64.4% for the VII EPF survey and 71.5% for the VIII EPF survey (INE, 2019). These rates are much higher

than those experienced in household budget surveys in Western Europe, for example, where the response rate levels have been around 50% (UN, 2005).

5.3.4 Data collection

The data collection involved a combination of face-to-face interviews and self-recorded notebooks. The interviews were conducted in four visits and recorded substantive information on household sociodemographic characteristics. In contrast, the notebooks maintained by households and their 15 years-old or older members, contained information about the household's consumption expenditure at a detailed level. Household members submitted expenditure information about high-frequency items daily for two weeks, and low-frequency items were retrospectively recorded based on three recall periods: 3, 6 and 12 months. The total data collection period lasted 12 months to incorporate seasonal variations in the household spending data (INE, 2021).

The following notebooks were used for the data collection, all partially administered by the surveyor and self-recorded by the head or other household members. They all differ in the type of items covered, the responding unit, the recording mode, and the recording period.

1. **Household basic information questionnaire:** this instrument captured sociodemographic characteristics of the household. This information included the household's housing situation, household members' relationships, and demographic data, such as occupation, employment, and education. A surveyor collected the data through an interview during the first visit immediately before the recording period.

2. **Individual-level expenditure notebook**: this notebook recorded the expenditure on goods and services by each member of the household aged 15 or over who were in physical and mental conditions suitable to answer the instrument. The surveyor delivered this notebook in the first visit and involved daily recordings of all expenditures and receipts irrespective of the amounts for 14 days. This notebook was the only self-recording instrument in the survey at the individual level.

3. **Household-level expenditure notebook**: this notebook covered periodic household expenditure on goods and services common to the household. The household head recorded the data, including expenses paid or owing in the previous month.

4. **Retrospective recording questionnaire**: this notebook captured irregular expenditure of goods and services in the household from three recording periods: 3, 6 and 12 months before the month in which the household survey was conducted. The

data was provided by the head of the household in an interview and self-recorded in a diary.

5. **Financial assets and premiums expenditure questionnaire**: these data were provided by the household head in an interview and self-recorded in a notebook.

6. **Income questionnaire**: this notebook recorded monetary and non-monetary incomes that each member aged 15 or over received. The reference period was the previous month from the time of the interview. The data were provided by the household head in an interview and self-recorded in a diary.

5.3.4.1 Household definition

The household definition has great importance as it is the basic unit of data collection and analysis in the EPF surveys. It was used to select the sample as the objective was that each person in the study population belonged to only one household so that a sample of households provides coverage for the entire population. In the EPF, the concept of household considers the following:

- A household is constituted by one or more people who benefit from the same budget, mainly food.

- To be part of a household, it is not necessary to be related to other members. In some cases, households may consist of friends or students.

- Persons from the same household need to be usual residents[1] of a shared accommodation or part of it. This means that they spend most of their daily night-rest there.

- People forming a household, regardless of whether they contribute to the household expenses or not, benefit from a shared budget.

5.3.4.2 Members of a household

It is important to specify who is considered a member of a household as including or excluding people may affect the average household size, composition and sociodemographic characteristics. The EPF defines a household member as a person who has habited regularly for at least four days a week in the last six months in the same address (INE, 2018). Additionally, members needed to have shared the food

[1] "The place of usual residence is the geographical place where the enumerated person usually resides" (OECD, 2001).

budget, which excludes lodgers, boarders, long-term visitors, live-in domestic servants or other persons with no close ties to the rest of the members residing at the address. Persons joining an existing household were considered members of the new location if they intended to stay in the accommodation for six months or more at the new place of residence.

The definition is extended to include specific categories of persons who were absent from the household at the interview time. A person was still considered a member of the household if they: a) were temporarily absent for work reasons and did not have permanent residence in another private home; b) resided in a collective dwelling[2]; or c) were students with no other permanent residence.

5.3.4.3 Household head definition

In the EPF, the household head was a particular individual designated by the household members regardless of being or not the person contributing most to the household's total income. The household head was used as a reference person whose personal characteristics were used in household classification and analysis.

5.3.4.4 Classification of Individual Consumption According to Purpose (COICOP)

The Classification of Individual Consumption According to Purpose (COICOP) is an international reference classification of household expenditure issued by the United Nations. COICOP is an integral part of the System of National Accounts (SNA). It is used in several statistical areas, including household budget surveys, international comparisons of gross domestic product and consumer price indices (UN, 2018).

This classification system aims to provide a framework of homogeneous categories of goods and services that are considered a purpose of household consumption expenditure, which is made to benefit individual persons or households. It enables comparison in a variety of analytical applications in different domains between countries over time. A critical advantage of this system is that it allows for data collection on expenditure and food consumption, which accounts for a considerable share of household expenditure. Chile incorporated this classification system in the

[2] Collective dwelling is a dwelling occupied by a group of people subject to a standard system or authority not based on family or cohabiting ties. They correspond to hotels, residential, hospitals, barracks, and jails (INE, 2018).

EPF survey after entering the OECD in 2010; therefore, it is included in the two EPF waves considered in this study.

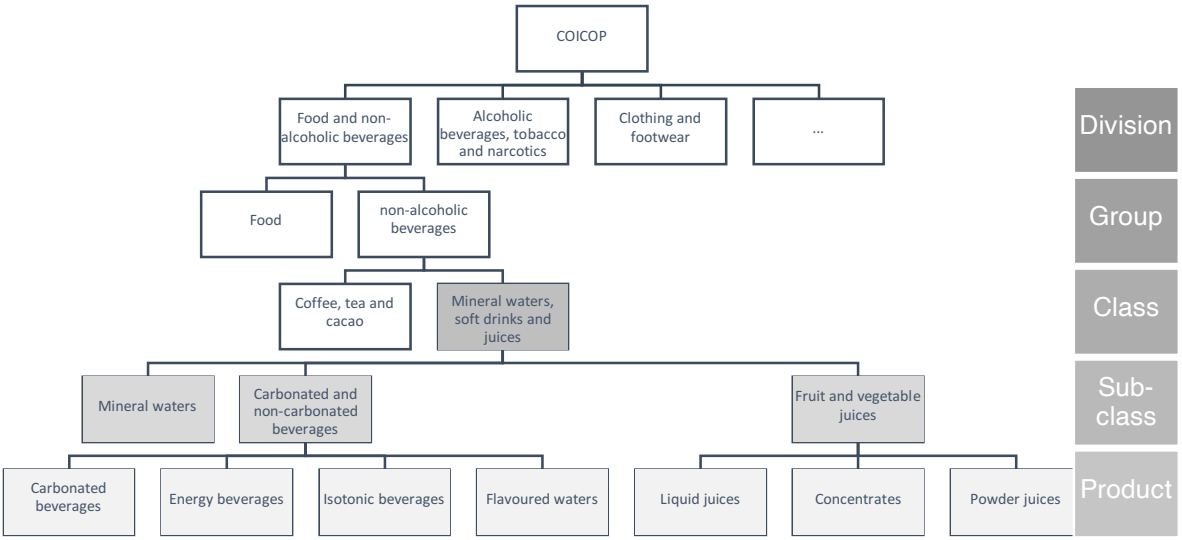
COICOP classifies individual consumption into 14 divisions (UN, 2018). The first twelve correspond to households' consumption expenditure, while the rest cover the individual expenditure of non-profit institutions serving households (NPISH) and general government. The EPF survey, however, considers only the first twelve divisions (Table 13).

Table 13. COICOP divisions

Divisions	Definition
1.	Food and non-alcoholic beverages
2.	Alcoholic beverages, tobacco and narcotics
3.	Clothing and footwear
4.	Housing, water, electricity, gas and other fuels
5.	Furnishings, household equipment and routine household maintenance
6.	Health
7.	Transport
8.	Information and communication
9.	Recreation, sport and culture
10.	Education services
11.	Restaurants and accommodation services
12.	Miscellaneous goods and services
13.	Individual consumption expenditure of NPISHs
14.	Individual consumption expenditure of general government

COICOP has a hierarchical structure consisting of five levels. The first level is subdivided into groups, which are subdivided into classes and then sub-classes. The subclasses are the result of the aggregation of the products. The subclasses and products were adapted in the EPF survey to the national situation to cover a greater variety of goods and services as the COICOP only standardises the classification until the class level for international comparisons. The EPF survey also included a ‘residual products’ category for products that did not have a defined category. Figure 16 illustrates the five levels of non-alcoholic beverages.

Figure 16. Five levels of ‘food and non-alcoholic beverages’ division (COICOP)



This study's main domain of interest is the first division of the COICOP that covers foods and non-alcoholic beverages with a particular focus on the class ‘mineral waters, soft drinks, and juices’ (highlighted grey in Figure 16). The foods and non-alcoholic beverages division includes items purchased by the household mainly for consumption or preparation at home, regardless of where these were consumed. It excluded food and non-alcoholic beverages provided as part of a food serving service or sold for immediate consumption away from home by restaurants, bars or vending machines. Non-alcoholic beverages included drinks that do not contain any alcohol. It excluded milk-based beverages, and those that would normally be alcoholic, such as non-alcoholic wine, beer and others for immediate consumption provided by a serving service. The class ‘mineral waters, soft drinks and juices’ was the primary domain used for analysis in this study. It is important to note, that this classification system does not differentiate sugar and non-sugar SSB, therefore the analysis in this study considers both as one type of SSB. As Table 14 shows, this class is divided into three subclasses, which contain a total of seven different products.

Table 14. Breakdown of the class 'mineral waters, soft drinks and juices'

Mineral waters	**Carbonated and non-carbonated beverages**	**Fruit and vegetable juices**
Mineral waters	Carbonated beverages	Liquid juices
Unflavoured waters	Energy beverages	Concentrates
	Isotonic beverages	Powder juices
	Flavoured waters	

5.3.5 Primary and secondary outcomes of this study

5.3.5.1 Primary outcomes:

- Change in SSB consumption levels following implementation of the policy.

- Potential impact of the policy on oral health.

5.3.5.2 Secondary outcomes:

- Description of sociodemographic characteristics of the Chilean population.

- Description of household and per capita total expenditure and disposable income.

- Description of household and per capita beverage consumption expenditure according to socio-economic status.

- Change in household and per capita SSB expenditure and consumption following implementation of the policy.

5.3.6 Variables selected from the EPF survey

In this section I describe the variables that I identified relevant to analyse changes in SSB consumption levels after the implementation of the Sugar Tax policy and the estimations of the likely impact of this on oral health. First, I provide a brief description of the selected variables in Table 15 and then I explain in more detail the more complex variables, such as expenditure and income.

Table 15. Brief description and source of the included variables[a]

Variable group	Variable name	Description [measurement]	Location of data
Consumption expenditure	Total household expenditure	Continuous variable [Chilean pesos]	EPF surveys
	Total per capita expenditure	Continuous variable [Chilean pesos]	EPF surveys
	Household SSB expenditure	Continuous variable [Chilean pesos]	EPF surveys
	SSB expenditure per capita	Continuous variable [Chilean pesos]	EPF surveys
Disposable income	Total household disposable income (without rent imputed)	Continuous variable [Chilean pesos]	EPF surveys
	Total disposable income per capita (without rent imputed)	Continuous variable [Chilean pesos]	EPF surveys
Sociodemographics	Marital status	Categorical variable [Married; separated; divorced; widowed; single]	EPF surveys
	Sex	Dichotomous variable [Male/female]	EPF surveys
	Age	Continuous variable [Years]	EPF surveys
	Educational level	Categorical [Nursery; primary; secondary; tertiary; other]	EPF surveys
	Employment status[b]	Categorical [Employer; own-account worker; private sector employee; public sector employee; domestic employee; non-remunerated employee]	EPF surveys
	Occupation[c]	Categorical [Skilled; unskilled; other]	EPF surveys
SSB consumption level	SSB level consumption	Categorical [Low; moderate; high daily ml]	Systematic Review (Chapter 4)
Oral health status	Dental caries	Odds-ratio	Systematic Review
	Erosion	Odds-ratio	Systematic Review

[a] I re-classified some of these variables as recommended by investigators of the EPF surveys in their original document. I describe them fully in Appendix 5.

[b] This variable was recorded according to the International Classification of Status in Employment (CISE-93) and only included respondents aged 15 years or older.

[c] This variable was recorded according to the International Standard Classification of Occupations (ISCO-88) and only included respondents aged 15 years or older.

5.3.6.1 Consumption expenditure

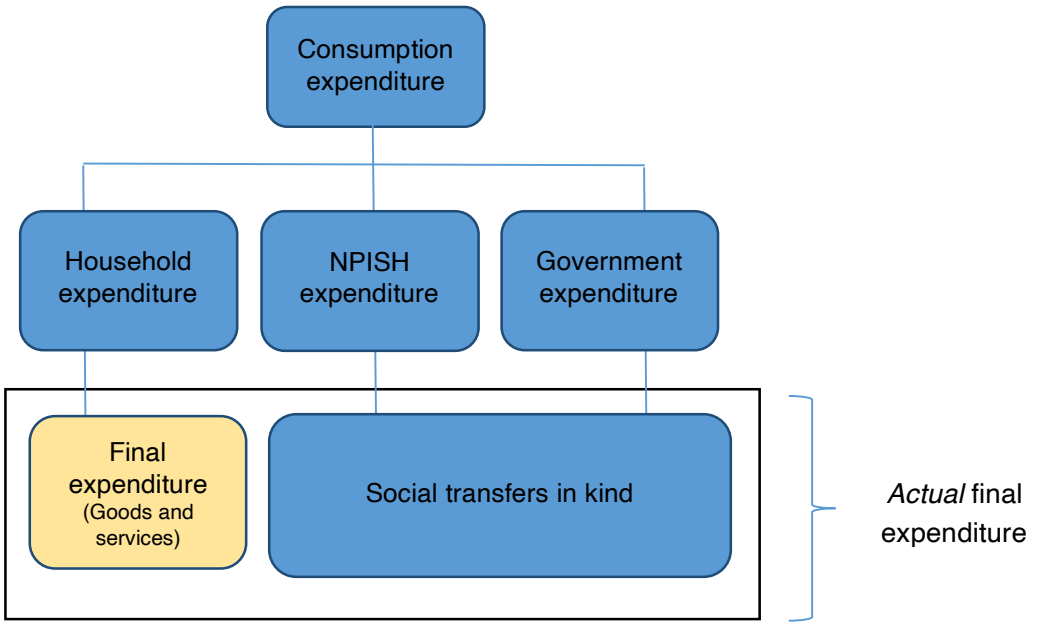
One of the main variables I used in this analysis was household consumption expenditure. There are two relevant conceptual definitions associated with household expenditure, which can give different results: household *actual final* consumption expenditure and household *final* consumption expenditure. As I show in Figure 17 below, the first relates to the acquisitions households obtain through their spending on consumption goods and services in Chile or abroad plus acquisitions from the government and NPISH, which are essentially social transfers in kind[3] to the households (INE, 2018). The second considers only the household consumption expenditure on goods and services[4].

The EPF surveys used *final* household consumption expenditure as its conceptual base for expenditure. While the concept of household *actual final* consumption expenditure would be more suitable since it is based on acquisition, there are practical difficulties implementing it. For example, for items such as health and education, actual use cannot be recorded at the individual household level as these are public for some part of the population and are financed through taxes and premiums.

[3] "The social transfers in kind consist of individual goods and services provided as transfers in kind to individual households by government units and NPISH, whether purchased in the market or produced as non-market output by government unit or NPISH. They may be financed out of taxation, other government income or social security contributions, or out of donations and property income in the case of NPISH" (EUROSTAT, 2013).

[4] Goods or services for consumption correspond to those used by households for the direct satisfaction of their needs, where spending is defined as the amount that buyers pay, or agree to pay, to sellers in exchange of goods or services that they supply to buyers (INE, 2013). On the other hand, additions to savings, amounts invested or loaned, repayments of loans (e.g. interest on mortgages), outlays, gambling losses, cash grants and donations (exempt small contributions of a recurrent nature to churches and charitable institutions) for other financial transactions are non-consumption expenditures.

Figure 17. Household expenditure diagram



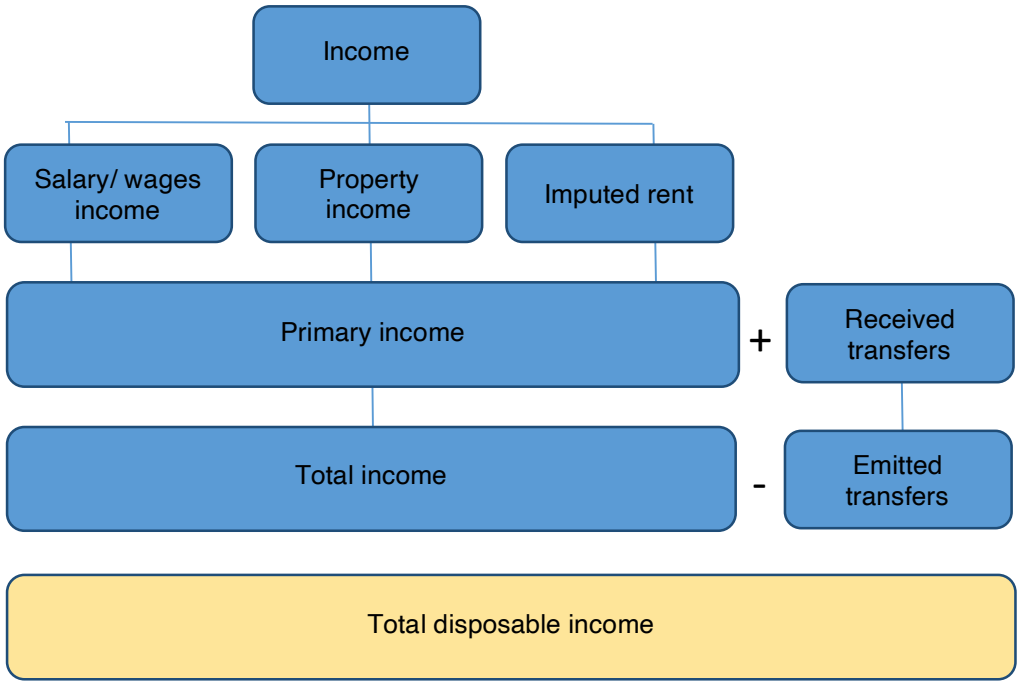
* Own construction based on INE, 2018. See Appendix 5 for a more detailed description of the variable.

5.3.6.2 Total disposable income

Household income corresponds to a flow variable that impacts household wealth or net worth, contributing to final consumption expenditure. Household income represents the resources available to households for consumption and savings in a given period. This measurement is relevant as it allows us to identify a household's financial well-being, one of the most critical and accessible indicators of well-being (INE, 2018). I used disposable income in this study to analyse consumption expenditure patterns across different household income quintiles.

There are two conceptual definitions associated with household income. First, total *household income* and second, *total household disposable income*. Total household income is conceptually defined as "all receipts, whether monetary or in-kind (goods and services), that are received by the household or by individual members of the household…" (OECD, 2013). As I show in Figure 18, the household's total income is constructed by the primary income that corresponds to the salary/wages income, property income, income derived from the self-provision of goods produced by the household; and money transfers received.

Figure 18. Household income diagram



* Own construction based on INE, 2018. See Appendix 5 for a more detailed description of the variable.

Salary/wages income corresponds to any type of income generated by economic work activity. Property income refers to resources generated from financial assets. It includes the return of such assets (interests earned from deposits), receipts of investment income and other regular payments of life insurance and private pension funds, in addition to the net income received by the lease of non-financial assets, such as natural resources, land, buildings, equipment, patents or copyrights. Rents received by property owners, the net income is recorded in the survey, i.e. after deduction of tax, repayment of interest and costs for the maintenance and repair of rented dwelling. The imputed rent corresponds to the estimated value of the accommodation in the homes occupied by their owners.

The second definition is the *total disposable household income*, which is used in the EPF survey and this study. This concept adds up all primary incomes and payments received excluding taxes, compulsory social contributions (i.e. pension and healthcare), emitted money transfers, payments with a social origin and bank payments. The SNA defines total disposable income as “the maximum amount that a household or other unit can afford to spend on consumption goods or services during the accounting period without having to finance its expenditures by reducing its cash,

by disposing of other financial or non-financial assets or by increasing its liabilities." (SNA, 2009, p.160).

5.3.6.3 Sociodemographic variables

I selected seven sociodemographic variables to characterise the samples. Apart from the disposable income, these included age, sex, marital status, employment status, occupation, and education. The variables are briefly described in Table 15.

5.3.6.4 Oral health-related variables

In order to estimate the effect of the policy, I took information on oral health from the review study described in Chapter 4. The information used was the levels of SSB consumption (ml/day), categorised as Low, Moderate and High, and oral health status as odds of having dental caries or erosion comparing the different levels of SSB consumption.

5.3.7 Data preparation

Preparing and cleaning data before conducting statistical analyses is essential for studies based on household surveys due to the potential for errors in data entry, spelling or missing values (Mitchell, 2020). Consequently, before conducting further data analysis, I explored the variables in both sets of data files. For this, I followed guidance on data management and cleaning from 'A Toolkit on Using Household Expenditure Surveys for Research in Economics of Tobacco Control' by Chelwa et al. (2019) and the data management handbook by Mitchell (2020) to ensure the analysis was tailored to the aims of this study. Table 16 shows an overview of the sequence of steps that I undertook and the Stata commands used in this process (Stata Version 15).

Table 16. Data preparation strategy (adapted from https://tobacconomics.org/wp-content/uploads/2019/03/UIC_HES-Tool-Kit_Eng_final.pdf - page 25) (Chelwa et al, 2019)

Action	How	Stata commands used
Identification of variables of interest and fixing incorrect codes	Labelling and recoding variables and their values	label; recode
Identification of unique observations to merge datasets	Understanding unique identifiers from surveys to extract/export data	egen group(); codebook; inspect
Change and transform variables to make data uniform and comparable between datasets	Correcting string variables and transforming variables	gen; destring; drop; keep; egen; rename; bysort; encode; recode; replace; label
Ensure logical data distributions	Consistency checks	tab; sum; tabstat; count
Create a single data file to work with	Merging the individual and household data files and appending data from both waves	merge 1:1; merge m:1; merge 1:m; append
Create a logical observation to organise the data file	Reshaping data to wide or long format	reshape
Identify the importance and influence of missing values	Decide if missing observations need to be removed or imputed	sum; hist; drop; keep
Identification of outliers	Removing outliers if necessary	sum; hist; stem; graph box; scatter; drop
Keep a record of all commands to facilitate replication and collaboration	Documenting every step with comments and commands	using do-file editor to organise

5.3.7.1 Missing data and outliers

A careful look at the datasets gave me a preliminary understanding of the data's meaning and distributional patterns. It also allowed me to identify missing values and outliers (data points that differ from other observations) in some variables.

There are different ways to deal with missing data. One approach is to impute missing values. Imputation methods assign values to unknown or not reported observations (Mitchell, 2020). In the EPF surveys, the following codes were used to record missing data: -99: do not know; -88: do not answer; -77: does not apply.

However, given the very low rate of missing values (≤0.5%), I did not use data imputation for this study. The variable that reported the highest rate of missing values was the educational level in the VIII EPF survey, which had 0.2% of missing values. The percentage of missing values is indicated in the relevant tables in section 5.4. For

clarity, I excluded them from the visual representation in some graphs (due to the small number of missing observations).

For the consumption expenditure and disposable income variables, extreme values and outliers – including possibly erroneous observations - created distributions that were heavily right skewed. I therefore, dropped the upper 1% of observations from the final analysis (see sections 5.4.2 and 5.4.3 for a visual representation).

5.3.7.2 Inflation and per capita adjustments

I inflation-adjusted the product consumption expenditure data of the VII EPF survey (2011/2012) to the 2017 prices using the Consumer Price Index (CPI) for foods and non-alcoholic beverages (OECD, 2021). From the dataset, it was impossible to know each household's day of the interview; therefore, I used the CPI of 2017 (Table 17).

Table 17. CPI values from 2012 to 2017 (OECD, 2021)[a]

	2012	2013	2014	2015	2016	2017
CPI[b]: All items	89.9	91.5	95.8	100	103.8	106.1
CPI: Food and non-alcoholic beverages	83.6	87.3	93.4	100	103.8	105.9

[a] Index, 2015=100
[b] Consumer Price Index

Household composition varied within and between the survey samples. Households had a different number of members and ages; therefore, I used an adult equivalence scale (AES) to standardise per capita estimations. A simple per capita approach would have ignored the fact that households have different consumption and expenditure needs according to their demographic characteristics; instead, it would have assumed that resources were uniformly distributed across households. Per capita calculations adjusted by an AES allowed me to standardise expenditure estimates, allowing for comparisons between households of different composition and structure in a more realistic manner (Deaton and Paxson, 1998). This was particularly important in this study, as the two surveys' samples were not the same.

I calculated per capita expenditure estimates by allocating weighting coefficients to the household's members according to their age group by adult equivalence. As there are no adult equivalence scales for the Chilean population to date, I took these coefficients from a study based on food and beverage consumption expenditure data of the Mexican population conducted by Teruel et al. (2005) that have been used in other

studies that estimate SSB consumption per capita in Chile (Guerrero-Lopez et al., 2017). As shown in Table 18, I assigned a value of 1 to adults and a fraction of 1 to the other age groups. Therefore, the size and age structure of the household determined the *equivalent household* SSB consumption expenditure.

Table 18. Adult equivalence scale values from Teruel et al. (2005)

Age group	Weighting coefficient (adult equivalence)
≤ 5 years-old	0.77
6 to 12 years-old	0.80
13-18 years-old	0.74
≥ 19 years-old (Adult)	1.00

5.3.8 Data analysis

In this section I describe the methods I used for data analysis. I describe the rationale behind the data analyses and the sensitivity analyses I carried out to assess the estimates' quality and accuracy.

The first part of the data analysis consists of descriptive statistics that characterise and compare the two samples. The second part estimates and compares household and per capita SSB consumption expenditures between the two surveys. The third part combines these estimations with findings from the systematic review (described in Chapter 4).

5.3.8.1 Exploratory analysis

I obtained the EPF surveys' datasets from the official website of the Chilean National Institute of Statistics (INE), the institution responsible for conducting the survey (INE, 2021). I retrieved the datasets in STATA format in March 2018 to ensure data quality. It is essential to explore the datasets and read the accompanying documentation thoroughly before starting any analysis. This allows mapping of relevant methodological differences between the surveys and assess their potential impact on the analysis (Rafferty et al., 2015). Therefore, before conducting any analysis, I explored the data in detail using summary statistics. This allowed me to gain insight into data patterns, classifications and distributions. At this point, I followed the data

preparation and cleaning strategy already described above in this chapter in sub-section 5.3.7.

5.3.8.2 Descriptive analysis

I conducted descriptive analyses of each variable included in the study through summary statistics. For continuous variables, I explored their frequency and distribution using histograms, and I estimated means, medians and standard deviations. I explored and described categorical variables using cross-tabulations and bar charts, and by estimating proportions and percentages of households and people (population) with the corresponding 95% confidence intervals.

5.3.8.3 Weighted sample

When analysing household survey data, assigning weights to the responding units depends on the sampling strategy. It is necessary to compensate for unequal selection probabilities, unit non-response, and allow for population-based estimations (UN, 2005). In this study, I conducted the analyses with a weighted sample as the surveys had a complex multistage sampling strategy. Weighting the data allowed a population size of 10,516,225 individuals in the VII EPF and 11,095,466 individuals in the VIII EPF. According to estimates based on the last two Census (INE, 2021b), these figures corresponded approximately to three-quarters of the country's national urban population of the country (Table 19).

Table 19. Number of people in the survey and in the population

No. of respondents	Weighted no. of respondents	Urban population estimates in Chile
35,669	10,516,225	15,015,959 (2011)
48,308	11,095,466	16,159,787 (2016)

To ensure that the sampling weights and the survey design characteristics were the correct ones, I performed a cross-examination of the official survey documentation and published reports. One way to analyse survey data is by declaring the survey design through the command *svyset* in Stata; however, the VII EPF dataset did not contain the necessary information for this command and so I used sampling weights for each data estimation. Results using both methods in the VIII EPF data were almost identical.

5.3.8.4 Descriptive analysis by income quantiles

I stratified most of the descriptive analyses by household income quintiles. The purpose of this was to explore socio-economic variations across income groups using the disposable income variable.

5.3.8.5 Descriptive analysis of a typical household

Household structure and complexity have significant impacts on the well-being of families (Brown et al., 2015). Consumption of goods and services are also influenced by the number of people and the proportion of adults and children living in the same dwelling. Environmental factors have also been found to influence SSB consumption (Schneider et al., 2020; Van Ansem et al., 2014). For these reasons, I identified the most common household composition in the surveys and compared the whole sample's results with the most prevalent household type. I categorised households into 20 different composition types ranging from households with a single occupant to a large family of six adults and five children. The results section (section 5.4) shows these types and their frequency in more detail.

5.3.8.6 Estimating the volume of consumption from expenditure data and the use of systematic review findings

To estimate the volume of SSB consumption from expenditure data, I used values from a peer-reviewed study conducted by Caro and colleagues (2018). Using longitudinal data of household food purchases from January 2013 to December 2015 from Kantar WorldPanel Chile, the authors reported information about the price per litre of SSB in Chile during this period which corresponded to the implementation of the tax policy. However, the authors used a different classification for SSB to the one used in the EPF surveys:

- Untaxed beverages: plain water, plain and flavoured or sweetened milk, dairy-based ready-to-drink beverages, milk powders and modifiers (such as cocoa), coffee, and tea.

- 10%–taxed beverages: this category includes ready-to-drink low or no sugar SSB and low or no sugar concentrates.

- 18%–taxed beverages: this category includes carbonated and non-carbonated high sugar level-SSB.

Given that the EPF surveys categorise SSB based on COICOP as described previously (section 5.3.4.4), I analysed carbonated beverages, liquid juices and

flavoured waters as a single group of SSB. This enabled me to estimate the volume consumption levels per capita in millilitres per day (ml/day). The authors estimated that the mean price of ready-to-drink low or no sugar SSB and carbonated and non-carbonated high sugar level SSB per litre was $767 Chilean pesos (Caro et al., 2018). I adjusted this value for the foods and non-alcoholic beverages CPI of 2017 before estimating the volume of consumption from the expenditure.

Next, I categorised the ml/day of SSB into the consumption levels described in the systematic review (Chapter 4) shown in the table below (Table 20). I also added a zero consumption category to explore the effect of non-consumers on the estimations.

Table 20. SSB consumption levels used in Chapter 4

Level	Amount
Zero	0 ml/day
Low	1 – 71 ml/day
Moderate	71 – 250 ml/day
High	> 250 ml/day

5.3.9 Statistical software and level of confidence

I used the statistical package StataSE v.16 to analyse the data, and I considered the estimates statistically significant at the 0.05 level.

5.4 Results

In this section I provide descriptive statistics for the samples of the two EPF surveys (VII EPF survey 2011/12 and VIII EPF survey 2016/17). I combine the findings with the Systematic Review results described in Chapter 4 to estimate the possible effect of the Sugar Tax policy on dental caries and erosion.

Table 21 and Table 22 summarise the demographic characteristics of the samples. Table 21 provides information at the household level and shows data for the household head, and Table 22 reports information per capita.

The populations represented in this study correspond to households and their members. 35,669 individuals from the VII EPF survey and 48,308 individuals from the VIII EPF survey were included in the analysis, from a random sample of 10,528 and

15,239 households, respectively. These households represented 70.5% and 72,1% urban households in the country.

The average household size was just over 3 (VII EPF: 3.38 ± 1.6; VIII EPF: 3.17 ± 1.62) in both samples. The household head's age was also similar between the two, at around 51 years-old (VII EPF: 51.38 ± 15.65; VIII EPF: 51.2 ± 15.7). There was a higher proportion of households with a male, married, completed secondary education, employed in the private sector and skilled head in both samples.

Around 47% of respondents were men and 53% women in both surveys. The average age in the VII EPF sample was 34.4 ± 21.9, whilst in the VIII EPF was slightly higher (35.7 ± 21.6). After classifying the samples into four age groups, the vast majority corresponded to people aged 19 years and over. Around 60% of the individuals were single, 30% married, and the rest separated, divorced or widowed. Less than half of the respondents reported having completed secondary education and around one fourth completed primary education. The majority were employed in the private sector (VII EPF: 60.9%, 95%CI: 60.2-61.7; VIII EPF: 57.9%, 95%CI: 57.2-58.5) or were self-employed (VII EPF: 20.8%, 95%CI: 20.2-21.5; VIII EPF: 24.1%, 95%CI: 23.6-24.7). Three-quarters of the 15-years-old or older sample reported being skilled (VII EPF: 76.1%, 95%CI: 75.4-76.8; VIII EPF: 77.5%, 95%CI: 77.0-78.1) and around one fifth unskilled (VII EPF: 23.1%, 95%CI: 22.4-23.7; VIII EPF: 22.0%, 95%CI: 21.5-22.5).

Table 21. Demographic characteristics of households and household head

Demographic variables	VII EPF 2011/12 (n=10,528)		VIII EPF 2016/17 (n=15,239)	
	Mean ± SD	**Median**	**Mean ± SD**	**Median**
Household size[a]	3.38 ± 1.67	3	3.17 ± 1.62	3
Age of household head	51.4 ± 15.6	51	51.2 ± 15.7	52
Missing values	*0%*		*0%*	
	Count (%)	**95% CI**	**Count (%)**	**95% CI**
Sex of household head				
Male	6,236 (59.2)	58.3 - 60.1	8,567 (56.2)	55.4-57.0
Female	4,292 (40.7)	39.8 - 41.7	6,672 (43.8)	42.9-44.5
Missing values	*0%*		*0%*	
Marital status of the household head				
Married	4,975 (47.2)	46.3-48.2	7,893 (51.8)	51.0-52.6
Separated/divorced	1,252 (11.9)	11.3-12.5	1,104 (7.2)	6.8-7.6
Widowed	1,063 (10.1)	9.5-10.7	1,525 (10.0)	9.5-10.5
Single	3,237 (30.7)	29.8-31.6	4,716 (30.9)	30.2-31.7
Missing values	*0.0%*		*0.0%*	
Educational level of the household head				
Primary	2,121 (20.1)	19.4-20.9	3,313 (21.7)	21.1-22.4
Secondary	5,014 (47.6)	46.6-48.6	7,900 (51.8)	51.0-52.6
Tertiary	3,246 (30.8)	29.9-31.7	3,789 (24.8)	24.2-25.5
Other	135 (1.3)	1.1-1.5	209 (1.3)	1.2-1.5
Missing values	*0.1%)*		*0.2%*	
Employment status household head				
Employer	255 (3.4)	3.0-3.8	364 (3.3)	2.9-3.6
Own-account workers	1,722 (23.1)	22.2-24.1	2,811 (25.5)	24.7-26.3
Private sector employee	4,255 (57.1)	56.0-58.2	6,011 (54.5)	53.5-55.4
Public sector employee	907 (12.3)	11.4-12.9	1,455 (13.2)	12.5-13.8
Domestic employee	287 (3.8)	3.4-4.3	380 (3.4)	3.1-3.8
Non-remunerated employee	20 (0.2)	0.1-0.4	8 (0.1)	0.0-0.1
Missing values	*0%*		*0%*	
Occupation of the household head				
Skilled	5,847 (78.5)	77.5-79.4	8,687 (78.8)	78.0-79.6
Unskilled	1,512 (20.3)	19.4-21.2	2,267 (20.6)	19.8-21.3
Other	87 (1.1)	0.9-1.4	64 (0.6)	0.4-0.7
Missing values	*0%*		*0.1%*	

[a] Table 22 below provides the household sizes in more detail.

Table 22. Demographic characteristics of respondents in the EPF surveys (weighted values)

Demographic variables	VII EPF 2011/12 (n=35,669)		VIII EPF 2016/17 (n=48,308)	
	Mean ± SD	**Median**	**Mean ± SD**	**Median**
Age of total sample	34.4 ± 21.9	32	35.7 ± 21.6	34
Missing values	*0%*		*0%*	
	Count (%)	**95% CI**	**Count (%)**	**95% CI**
Age (years-old)				
≤ 5	3,151 (8.8)	8.5-9.1	3,855 (7.9)	7.7-8.2
6 to 12	3,511 (9.8)	9.5-10.1	4,620 (9.5)	9.3-9.8
13-18	3,639 (10.2)	9.9-10.5	4,193 (8.7)	8.4-8.9
≥ 19	25,368 (71.1)	70.6-71.6	35,640 (73.8)	73.4-74.1
Sex				
Male	16,731 (46.9)	46.4-47.4	22,693 (46.9)	46.5-47.4
Female	18,938 (53.0)	52.5-53.6	25,615 (53.0)	52.5-53.4
Missing values	*0%*		*0%*	
Marital status				
Married	10,405 (29.1)	28.7-29.6	15,659 (32.4)	31.9-32.8
Separated/divorced	1.902 (5.3)	5.1-5.5	1,669 (3.4)	3.3-3.6
Widowed	1.521 (4.2)	4.0-4.4	2,177 (4.5)	4.3-4.7
Single	21,840 (61.2)	60.7-61.7	28,792 (59.6)	59.1-60.0
Missing values	*0%*		*0.0%*	
Educational level				
Nursery	3,158 (8.8)	8.5-9.1	2,750 (5.7)	5.5-5.9
Primary	9,269 (25.9)	25.5-26.4	12,019 (24.9)	24.5-25.2
Secondary	14,374 (40.3)	39.8-40.8	21,698 (44.9)	44.4-45.3
Tertiary	8,262 (23.1)	22.7-23.6	9,178 (19.0)	18.6-19.3
Other	546 (1.5)	1.4-1.6	2,565 (5.3)	5.1-5.5
Missing values	*0.1%*		*0.2%*	
Employment status[a]				
Employer	352 (2.2)	2.0-2.5	505 (2.2)	2.0-2.4
Own-account workers	3,225 (20.8)	20.2-21.5	5,453 (24.1)	23.6-24.7
Private sector employee	9,421 (60.9)	60.1-61.7	13,078 (57.9)	57.2-58.5
Public sector employee	1,717 (11.1)	10.6-11.6	2,716 (12.0)	11.6-12.4
Domestic employee	669 (4.3)	4.0-4.6	761 (3.3)	3.1-3.6
Non-remunerated employee	71 (0.4)	0.3-0.5	72 (0.3)	0.2-0.4
Missing values	*0%*		*0.0%*	
Occupation[a]				
Skilled	11,769 (76.1)	75.4-76.8	17,483 (77.5)	77.0-78.1
Unskilled	3,567 (23.1)	22.4-23.7	4,965 (22.0)	21.5-22.5
Other	119 (0.7)	0.6-0.9	91 (0.4)	0.3-0.5
Missing values	*0%*		*0.1%*	

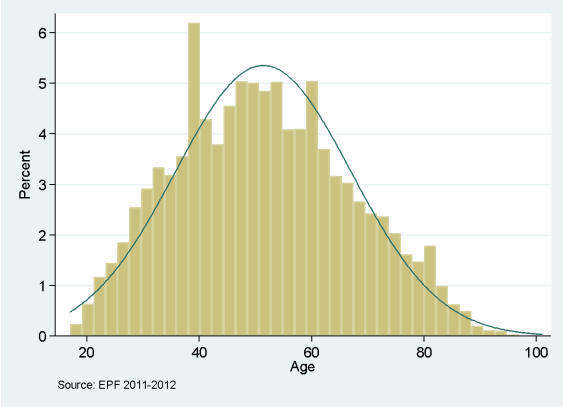
[a] Includes only population older than 15 years old

The following graphs (Figure 19. A-F) visually compare Table 21 and Table 22 demographics.

Figure 19. (A-F) Visual comparison of demographic characteristics between the samples

VII EPF 2011/2012	VII EPF 2016/2017

Figure 19.A Age distribution of the household head



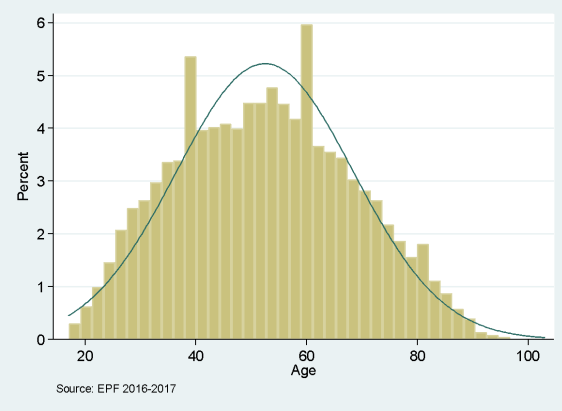
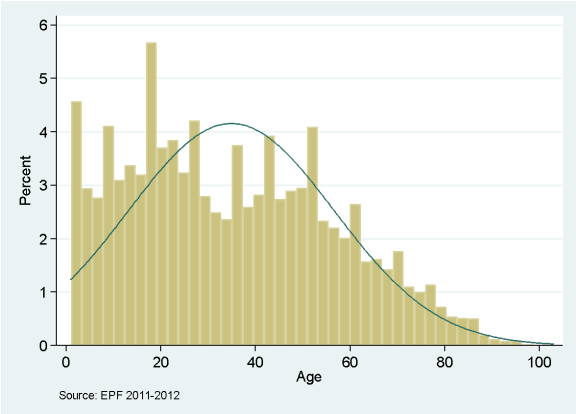


Figure 19.B Age distribution of the total sample



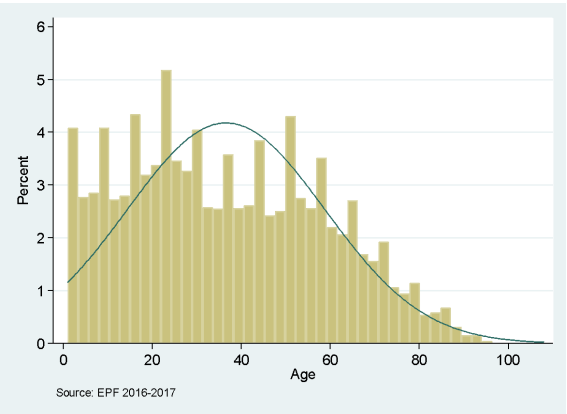
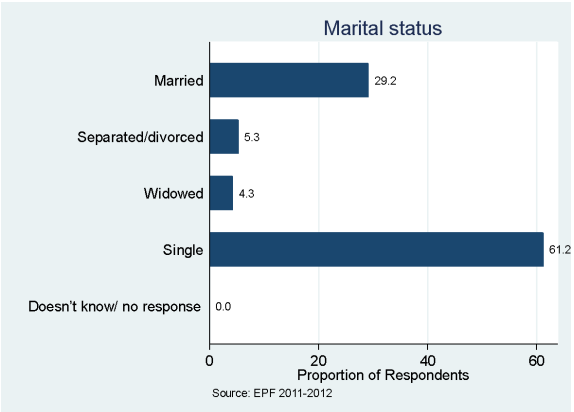


Figure 19.C Marital status of the total sample



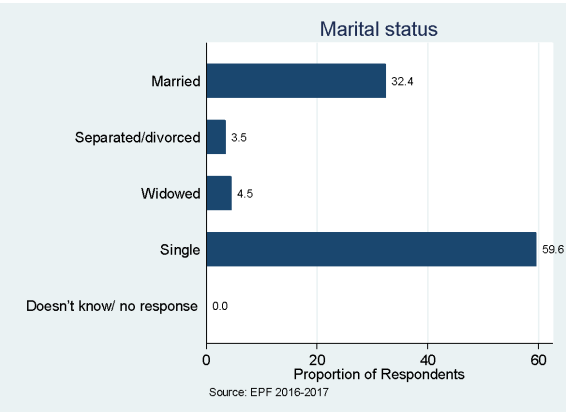
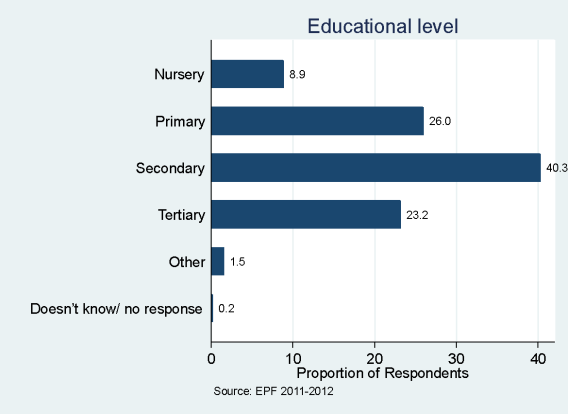


Figure 19.D The educational level in the total sample



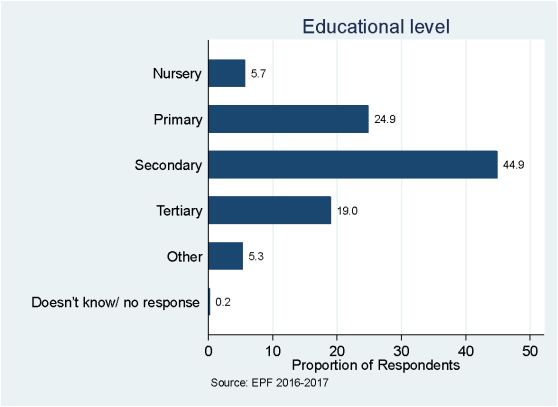
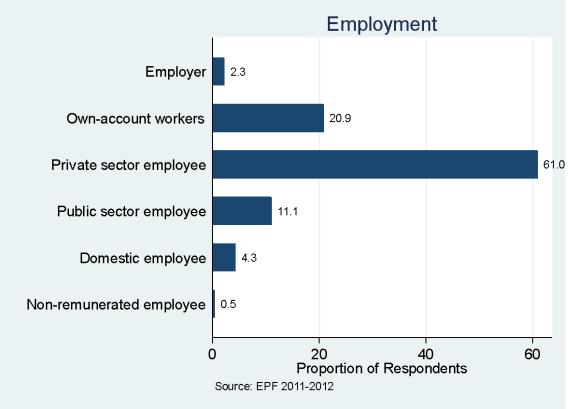


Figure 19.E Employment status distribution according to the International Classification of Status in Employment (CISE-93) in the total sample[a]



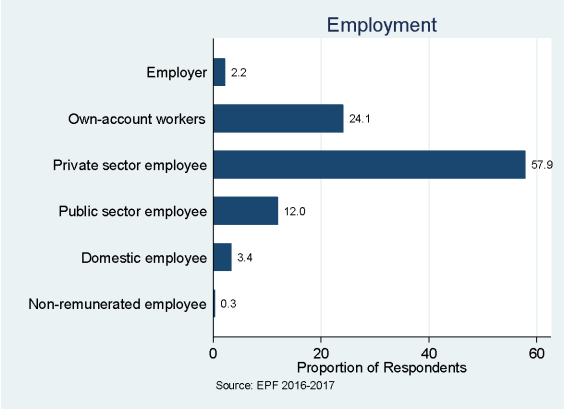
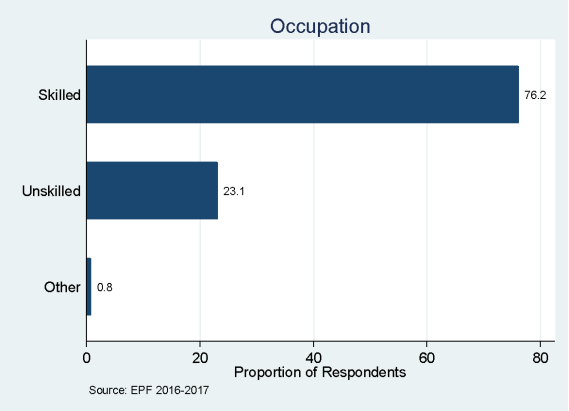


Figure 19.F Occupation status according to the International Standard Classification of Occupations (ISCO-88) in the total sample [a]



[a] Only includes the population older than 15 years old

5.4.1 Description of household size and composition

As the household size and composition may be a determinant of the amount of income and expenditure earned and spent by households, I explored these features in more detail. Overall, I found similar household structures in both surveys with slight differences.

Households were of one-person up to 17 people (Table 23). There was a greater proportion of families with two, three and four members (shown in light grey). As the dark grey rows show, in 2011/12, the most prevalent household was formed by four people (22.6%, 95%CI: 21.8-23.4), whilst in 2016/17 there was a higher percentage of households with only two members (24.1%, 95%CI: 23.4-24.7).

Table 23. Household size in detail

Household size (no. members)	**VII EPF Survey (2011/12)**			**VIII EPF Survey (2016/17)**		
	Count	**%**	**95%CI**	**Count**	**%**	**95%CI**
1	1,239	11.7	11.1-12.4	2,219	14.5	14.0-15.1
2	**2,245**	**21.3**	**20.5-22.1**	**3,666**	**24.0**	**23.4-24.7**
3	**2,368**	**22.5**	**21.7-23.3**	**3,479**	**22.8**	**22.1-23.5**
4	**2,378**	**22.6**	**21.8-23.4**	**3,110**	**20.4**	**19.7-21.0**
5	1,301	12.3	11.7-13.0	1,627	10.7	10.2-11.1
6	560	5.3	4.9-5.7	662	4.3	4.0-4.6
7	229	2.2	1.9-2.4	249	1.6	1.4-1.8
8	103	0.9	0.8-1.2	123	0.8	0.6-0.9
9	54	0.5	0.4-0.6	55	0.3	0.2-0.4
10	31	0.3	0.2-0.4	24	0.1	0.1-0.2
11	12	0.1	0.0-0.2	8	0.0	0.0-0.1
12	3	0.0	0.0-0.1	7	0.0	0.0-0.1
13	3	0.0	0.0-0.1	6	0.0	0.0-0.1
14	1	0.0	0.0-0.0	1	0.0	0.0-0.0
15	1	0.0	0.0-0.0	2	0.0	0.0-0.0
17	-	-	-	1	0.01	0.0-0.0
Total number of households	**10,528**	**100**		**15,239**	**100**	

In both surveys, 2 adult families were most common, followed by one and three, as Table 24 shows in light grey. Amongst families with children, in the two surveys, the

most common household structure was two adults and one child (VII EPF: 11.4% 95%CI: 10.8-12.0**;** VII EPF: 10.8% 95%CI: 10.3-11.3; shown in dark grey).

Table 24. The most prevalent household compositions in the surveys

Household composition	VII EPF Survey (2011/12)			VIII EPF Survey (2016/17)		
	Count	%	95% CI	Count	%	95% CI
One adult	1,238	11.7	11.1-12.4	2,213	14.5	13.9-15.1
1 adult, 1 child[a]	306	2.9	2.6-3.2	442	2.9	2.6-3.1
1 adult, 2 children	213	2.0	1.7-2.3	300	1.9	1.7-2.2
1 adult, 3 children	94	0.9	0.7-1.1	124	0.8	0.7-0.9
1 adult, 4 children	20	0.2	0.1-0.3	22	0.1	0.1-0.2
1 adult, 5 children	3	0.0	0.0-0.1	1	0.0	0.0-0.0
2 adults	1,935	18.4	17.6-19.1	3,220	21.1	20.5-21.8
2 adults, 1 child	1,195	11.3	10.7-11.9	1,640	10.7	10.2-11.2
2 adults, 2 children	1,149	10.9	10.3-11.5	1,348	8.8	8.4-9.3
2 adults, 3 children	383	3.6	3.3-4.0	498	3.2	2.9-3.5
2 adults, 4 children	96	0.9	0.7-1.1	88	0.6	0.4-0.7
2 adults, 5 children	16	0.1	0.1-0.2	14	0.1	0.0-0.1
3 adults	960	9.1	8.6-9.7	1,538	10.1	9.6-10.6
3 adults, 1 child	700	6.6	6.2-7.1	959	6.3	5.9-6.6
3 adults, 2 children	403	3.8	3.4-4.2	500	3.3	3.0-3.5
3 adults, 3 children	151	1.4	1.2-1.7	163	1.0	0.9-1.2
3 adults, 4 children	28	0.2	0.2-0.4	39	0.2	0.2-0.3
3 adults, 5 children	8	0.1	0.0-0.1	10	0.0	0.0-0.1
4 adults	435	4.1	3.7-4.5	679	4.4	4.1-4.8
4 adults, 1 child	374	3.5	3.2-3.9	431	2.8	2.5-3.1
4 adults, 2 children	193	1.8	1.6-2.1	232	1.5	1.3-1.7
4 adults, 3 children	84	0.	0.6-0.9	85	0.5	0.4-0.7
4 adults, 4 children	16	0.1	0.1-0.2	34	0.2	0.1-0.3
4 adults, 5 children	6	0.0	0.0-0.1	8	0.0	0.0-0.1
5 adults	121	1.1	0.9-0.1	176	1.1	0.9-1.3
5 adults, 1 child	102	0.9	0.8-1.1	149	0.9	0.8-1.1
5 adults, 2 children	64	0.6	0.4-0.7	79	0.5	0.4-0.6
5 adults, 3 children	38	0.3	0.2-0.5	41	0.2	0.2-0.3
5 adults, 4 children	10	0.1	0.0-0.1	16	0.1	0.0-0.1
5 adults, 5 children	9	0.1	0.0-0.1	5	0.0	0.0-0.0
6 adults	15	0.1	0.1-0.2	29	0.2	0.1-0.2
6 adults, 1 child	27	0.2	0.1-0.3	30	0.2	0.1-0.3
6 adults, 2 children	31	0.3	0.2-0.4	20	0.1	0.1-0.2
6 adults, 3 children	20	0.2	0.1-0.3	18	0.1	0.0-0.2
6 adults, 4 children	6	0.0	0.0-0.1	7	0.0	0.0-0.1
6 adults, 5 children	4	0.0	0.0-0.1	1	0.0	0.0-0.0
Rest of households	75	0.7	0.5-0.9	80	0.5	0.4-0.6
Total number of households	**10,528**	**100**		**15,239**	**100**	

[a] Members categorised as children were those younger than 18 years old.

Table 25 shows the household members' relationship to the head in the family structure of two adults and one child mentioned above. Both surveys showed that the adults were likely to be a couple and the child their son/daughter or grandchild (shown in light grey).

Table 25. Relationship of household members to the household head in a typical Chilean family

Two adults and 1 child family	**VII EPF Survey (2011/12)**			**VIII EPF Survey (2016/17)**		
Relationship to the household head	**Count**	**%**	**95% CI**	**Count**	**%**	**95% CI**
Household head	1,195	33.3	31.8-34.9	1,639	33.3	32.0-34.6
Spouse	555	15.5	14.3-16.7	592	12.0	11.1-12.9
Partner	374	10.4	9.4-11.4	609	12.4	11.5-13.3
Son/daughter	1,174	32.7	31.2-34.3	1,633	33.2	31.9-34.5
Partner's son/daughter	40	1.1	0.8-1.5	86	1.7	1.4-2.1
Brother/sister	20	0.5	0.3-0.8	31	0.6	0.4-0.9
Father/mother	28	0.8	0.5-1.1	44	0.9	0.6-1.2
Brother/sister in law	1	0.0	0.0-0.2	3	0.0	0.0-0.2
Father/mother in law	0	0	-	0	0	-
Son/daughter in law	3	0.1	0.0-0.2	1	0.0	0.0-0.1
Grandchild	150	4.2	3.5-4.9	212	4.3	3.7-4.9
Grandparent	0	0	-	4	0.1	0.0-0.2
Another relative	27	0.7	0.5-1.1	39	0.8	0.5-1.1
Another non-relative	18	0.5	0.3-0.8	24	0.5	0.3-0.7
TOTAL	**3,585**	**100**		**4,917**	**100**	

In summary, the demographics and household structures of the two samples were quite similar. Exploring the datasets' potential similarities and differences was important as although the samples were from the same population, households were randomly selected. As there was little change in household composition between the surveys, I could draw reliable comparisons between them.

5.4.2 Total household and per capita disposable income

The mean (standard deviation) total household disposable income was 819,189 (807,952) Chilean pesos in 2011/12 and 1,104,348 (1,046,639) pesos in 2016/17 (the difference corresponds to around US$400[5]). The median total household disposable income, however, was considerably lower (around US$400 less) in both samples, showing a highly skewed distribution to the right.

A similar tendency was seen for the total disposable income per capita, which was 288,556 ± 309,934 Chilean pesos in 2011/12, whilst it was also higher at 411,040 ± 420,368 pesos in 2016/17, a difference of around US$140 of difference (Table 26). Figure 20 illustrates how skewed the distributions were and shows that this characteristic did not differ between the two surveys.

The fact that the mean income was higher than the median income is not surprising, since some households earned significantly higher wages and derived higher income from other sources. Given the extent of skewness of this variable, I explored the observations at the tail's top side. As there were many extreme values, for example, some incomes were 44 times higher than the mean, the top 1% of observations were dropped. Despite this, the extremely positive skewed distribution remained, suggesting that only a few have very high incomes.

Table 26. Total household and disposable income per capita in both surveys (in Chilean pesos, data weighted, bottom 99% of the sample)

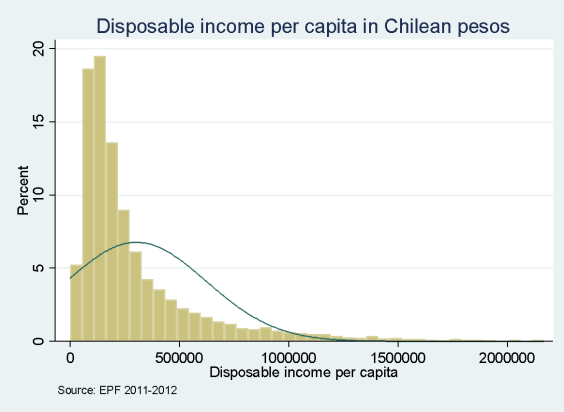
	VII EPF 2011/12 (n=10,427) [a]		**VIII EPF 2016/17 (n= 14,856) [a]**	
	Mean ± SD	**Median**	**Mean ± SD**	**Median**
Total household disposable income	819,189 ± 807,952	553,090	1,104,348 ± 1,046,639	772,575
Missing values	*0%*		*0%*	
Total disposable income per capita	288,556 ± 309,934	175,903	411,040 ± 420,368	265,000
Missing values	*0%*		*0%*	

[a] Sample size smaller than the original after dropping the upper 1% of households.

[5] Currency conversion as of 17/12/2020 taken from www.themoneyconverter.com ($1,000 Chilean pesos = US$1.41).

Figure 20. Disposable income distribution per capita (in Chilean pesos, data weighted, bottom 99% of the sample)

VII EPF Survey 2011/12	VIII EPF Survey 2016/17



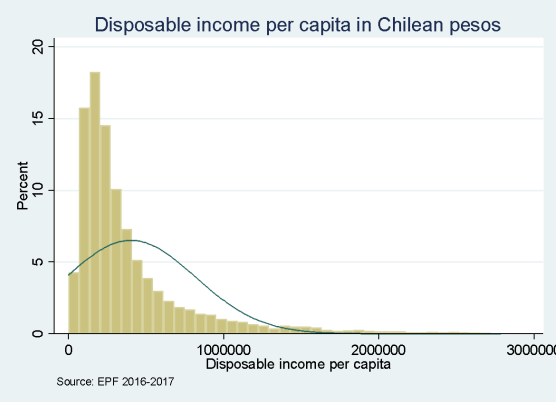


Table 27 shows the amount of total disposable income earned by the Chilean population according to income quintiles. On average, the total disposable income increased in all quintile groups between 2011/12 and 2016/17, with the highest mean percentage increase in the middle quintile category (53.6%). The Table also shows that the most affluent produced more than eight times the most deprived income in both surveys, which explains the skewed distribution of the variable.

Table 27. Income quintiles per capita (in Chilean pesos, data weighted, bottom 99% of the sample)

Income quintile	VII EPF 2011-2012		VIII EPF 2016-2017		% change	
	Mean ± SD	Median	Mean ± SD	Median	Mean	Median
1 (most deprived)	94,493 ± 54,824	78,987	137,891 ± 80,014	120,000	45.9	51.9
2	141,707 ± 79,884	120,667	215,464 ± 120,766	182,742	52.0	51.4
3	191,828 ± 105,928	162,672	294,724 ± 168,553	247,341	53.6	52.0
4	304,838 ± 189,420	252,536	436,548 ± 267,768	356,166	43.2	41.0
5 (most affluent)	824,282 ± 692,279	636,913	970,575 ± 567,827	840,294	17.7	31.9

5.4.3 Total household and per capita expenditure

The mean (SD) adjusted[6] total household expenditure was 861,060 (772,994) Chilean pesos in 2011/12 and 1,022,743 (796,874) pesos in 2016/17 (the difference

[6] Adjusted to 2017 CPI

corresponded to around US$200[7] as can be seen in Table 28). The median adjusted total household expenditure was lower in both samples with a positively skewed distribution.

Similar figures were seen for the adjusted total per capita expenditure: mean (SD) 313,175 (311,435) Chilean pesos in 2011/12, whilst it was also higher at 378,218 (315,909) pesos in 2016/17, around US$85 of difference. Figure 21 illustrates the distribution of this variable for both surveys.

Table 28. Total household and per capita expenditure (in Chilean pesos, data weighted, bottom 99% of the sample)

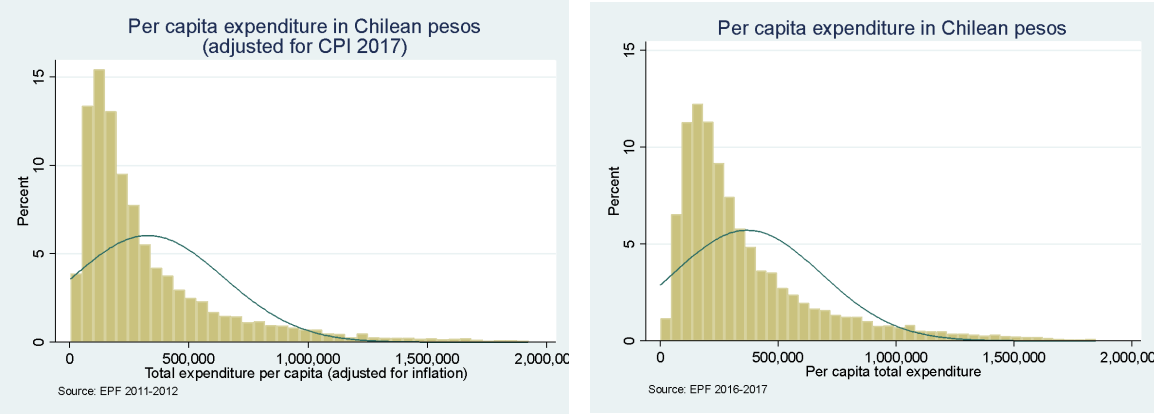
	VII EPF 2011/12[a] (n=10,427) [b]		**VIII EPF 2016/17** (n=14,856) [b]	
	Mean ± SD	**Median**	**Mean ± SD**	**Median**
Total household expenditure	861,060 ± 772,994	615,853	1,022,743 ± 796,874	793,770
Missing values	*0%*		*0%*	
Total per capita expenditure	313,175 ± 311,435	201,703	378,218 ± 315,909	267,854
Missing values	*0%*		*0%*	

[a] Data adjusted for CPI 2017

[b] Sample size smaller than the original after dropping the upper 1% of observations.

Figure 21. Total consumption expenditure per capita distribution (in Chilean pesos, data weighted, bottom 99% of the sample)

VII EPF Survey 2011/12	**VIII EPF Survey 2016/17**



[7] Currency conversion as of 17/12/2020 taken from www.themoneyconverter.com ($1,000 Chilean pesos = US$1.41).

The total consumption expenditure followed a similar distribution as the total disposable income described above. The upper 1% of the observations were dropped.

The following two tables (Table 29 and Table 30) compare the percentage of total disposable income per capita spent on goods and services (total consumption expenditure) in both surveys. In some quintile groups, the total expenditure was higher than the actual disposable income; however, this finding could have at least two possible explanations. Firstly, the poor tend to get more loans or pay by credit. This could show that they spent more as in the EPF surveys the total price of purchased items was recorded when the product was acquired as if it was paid in a cash transaction (INE, 2018). Alternatively, it could be that the information provided by households was not accurate. In large scale surveys, respondents may underestimate their earnings and overestimate their expenses (Moore et al., 2000).

Table 29. Proportion of income per capita spent on goods and services EPF 2011/12

Income quintile	**Total disposable income per capita**		**Total expenditure per capita**		**%**	
	Mean ± SD	**Median**	**Mean ± SD**	**Median**	**Mean**	**Median**
1 (most deprived)	94,521 ± 54,782	78,987	129,644 ± 110,223	101,132	137.1	128.0
2	141,559 ± 79,668	120,667	159,555 ± 136,182	122,737	112.7	101.7
3	191,802 ± 105,603	162,634	195,147 ± 149,379	154,079	101.7	94.7
4	300,905 ± 181,900	251,804	290,306 ± 229,121	224,646	96.5	89.2
5 (most affluent)	779,951 ± 640,847	621,496	564,310 ± 352,152	492,015	72.3	79.1

Table 30. Proportion of income per capita spent on goods and services EPF 2016/17

Income quintile	Total disposable income per capita		Total expenditure per capita		%	
	Mean ± SD	Median	Mean ± SD	Median	Mean	Median
1 (most deprived)	137,926 ± 80,085	120,000	217,930 ± 184,312	170,472	158.0	142.0
2	214,738 ± 120,241	182,430	255,445 ± 188,583	207,886	118.9	113.9
3	294,047 ± 167,653	247,341	314,310 ± 229,205	246,962	106.9	99.8
4	432,503 ± 261,266	355,421	413,844 ± 293,156	320,548	95.7	90.2
5 (most affluent)	936,254 ± 540,342	816,022	700,616 ± 382,187	629,560	74.8	77.1

5.4.4 Household and per capita beverage consumption expenditure

I included eight beverages in this part of the analysis: concentrates, isotonic beverages, energy beverages, flavoured water, mineral water, powdered juices, liquid juices and carbonated beverages.

9,268 households out of 10,426 (88.9%) reported spending money on at least one of these products in 2011/12, whilst this proportion was similar but slightly smaller in 2016/17 (87.6%). In general, the percentage of households buying each type of beverage remained similar after the policy implementation. In detail and from the highest percentage of households buying beverages to the lowest, carbonated beverages were the most popular product as three-quarters of households (76.0%) spent money on them in the VII EPF, whilst, this percentage went down in more than two percentage points in the VIII EPF (72.8%). Slightly less than half of the total households bought liquid juices making them the second product most bought in the two surveys with an almost unchanged figure (VII EPF: 46.9%; VIII EPF: 46.5%). Powdered juices were the third type most bought in the two surveys; however, fewer households reported having bought the product after implementing the policy (VII EPF: 35.0%; VIII EPF: 27.1%). Mineral water was one of the few types of beverage that showed an increase after the policy (VII EPF: 23.1%; VIII EPF: 32.1%), followed by flavoured water (VII EPF: 7.7%; VIII EPF: 10.8%), isotonic beverages (VII EPF: 3.2%; VIII EPF: 5.3%) and energy beverages (VII EPF: 3.1; VIII EPF: 5.1%). The least

popular type was concentrates with around 1% of households in the VII EPF (0.9%) reported having bought them and more than half of that (0.4%) in the VIII EPF.

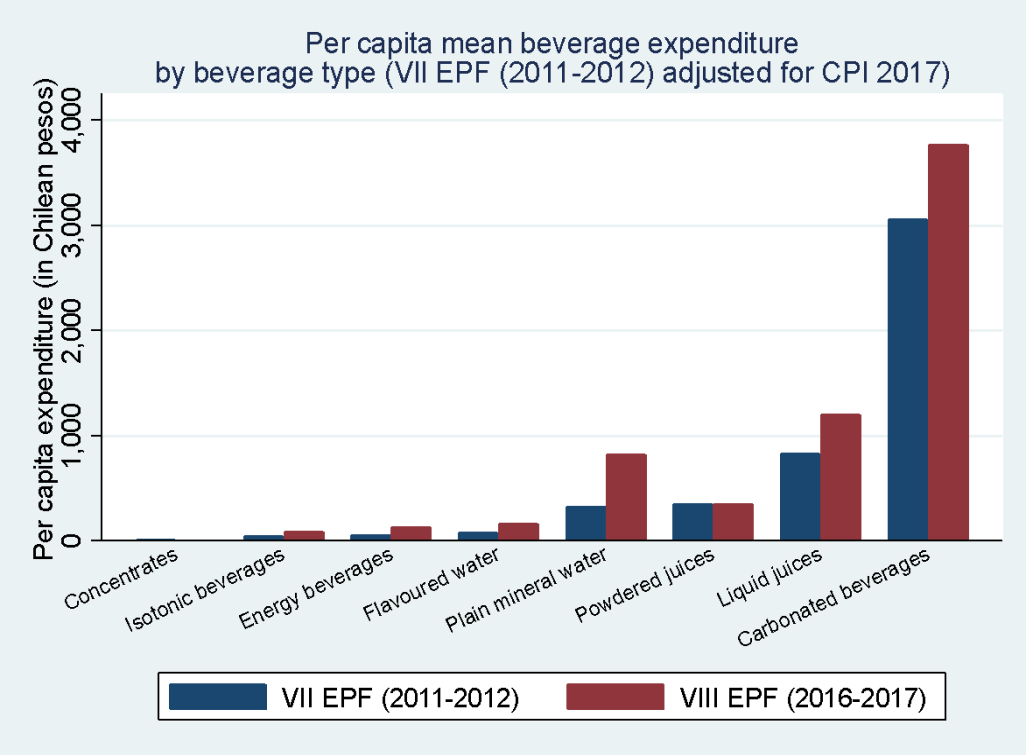
Overall, respondents reported that they spent a higher amount of money on carbonated beverages than any other non-alcoholic beverage (Table 31). In 2011/12 people recorded that they spent over 3,000 pesos a month on carbonated beverages on average, whilst in 2016/17 this amount was higher, around 700 pesos more (3,773 pesos) that corresponds to US$1. The second SSB type in which people spent a more considerable amount of money was liquid juices with a slight increase in expenditure after the policy, from just below 1,000 pesos a month in 2011/12 to $1,199 in 2016/17. Powdered juices and mineral water were the third and fourth products for which people spent more money in 2011/12 ($379 and $337 respectively). However, after the policy, powdered juice expenditure decreased, whilst mineral water expenditure had the most notable increase, doubling after the policy. The amount spent on the rest of the products all increased with the exemption of concentrates. However, the amount of money spent on these products was low.

Table 31. Mean and median beverage expenditure per capita by beverage type (in Chilean pesos, data weighted, EPF 2011/12 adjusted for CPI 2017)

Beverage type	**VII EPF 2011/12**		**VIII EPF 2016/17**	
	Mean ± SD	Median	Mean ± SD	Median
Mineral water	358 ± 1,208	0	827 ± 2,403	0
Carbonated beverage	3,286 ± 4,114	2,031	3,773 ± 4,852	2,275
Energy beverage	67 ± 565	0	136 ± 976	0
Isotonic beverage	53 ± 435	0	93 ± 577	0
Flavoured water	94 ± 528	0	173 ± 916	0
Liquid juice	894 ± 1,878	0	1,199 ± 2,392	0
Concentrate	20 ± 337	0	7 ± 159	0
Powdered juice	379 ± 848	0	358 ± 989	0

The following graph (Figure 22) provides a visual representation of Table 31 displayed above. It illustrates the mean expenditure per capita of each of the eight products in the two surveys.

Figure 22. Comparison of the mean beverage expenditure per capita by beverage type (in Chilean pesos; VII EPF 2011/12 adjusted for CPI 2017)



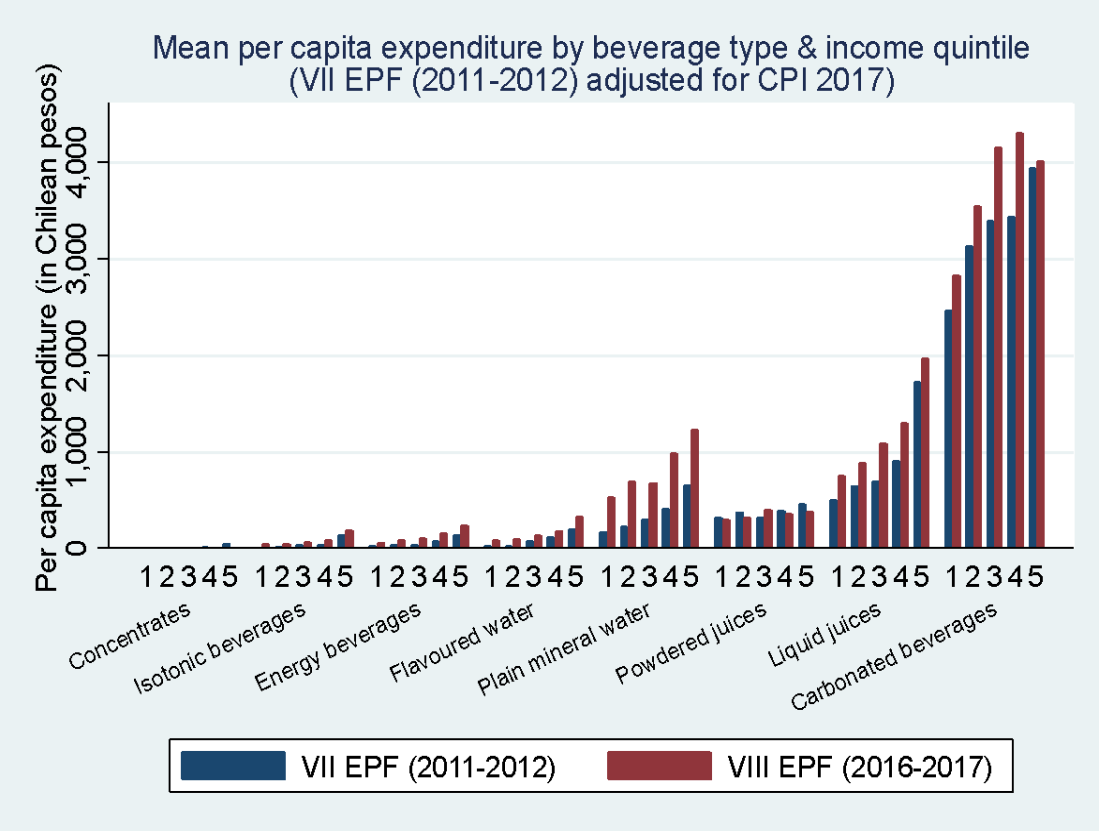
The amount of money spent on these products varied across income quintile groups. Table 32 shows the mean beverage consumption expenditure by income quintile and survey and provide data on the percentage change between the two waves.

Table 32. Per capita mean beverage expenditure (in Chilean pesos) by income quintile (EPF 2011/12, adjusted for CPI 2017) and survey wave

Income quintile	Survey	Mineral water	Carbonated beverage	Energy beverage	Isotonic beverage	Flavoured water	Liquid juice	Concentrate	Powdered juice
1 (most deprived)	VII EPF 2011/12	166	2,333	27	14	30	468	3	305
	VIII EPF 2016/17	535	2,836	68	56	96	757	13	304
	% change	222.3	21.5	151.8	300.0	220.0	61.7	333.3	-0.3
2	VII EPF 2011/12	219	2,939	44	20	27	607	11	354
	VIII EPF 2016/17	701	3,552	92	56	102	892	4	323
	% change	220.1	20.8	109.1	180.0	277.8	46.9	-63.6	-8.7
3	VII EPF 2011/12	285	3,162	42	38	74	649	6	304
	VIII EPF 2016/17	683	4,159	116	69	144	1,091	4	408
	% change	139.6	31.5	176.2	81.6	94.6	68.1	-33.3	34.2
4	VII EPF 2011/12	386	3,201	73	43	115	849	20	372
	VIII EPF 2016/17	995	4,313	166	97	188	1,304	8	366
	% change	157.7	34.7	127.4	125.6	63.5	53.6	-60.0	-1.6
5 (most affluent)	VII EPF 2011/12	618	3,670	130	133	194	1,615	53	431
	VIII EPF 2016/17	1,236	4,014	242	192	339	1,979	8	391
	% change	100.0	9.3	86.1	44.3	74.7	22.5	-84.9	-9.3

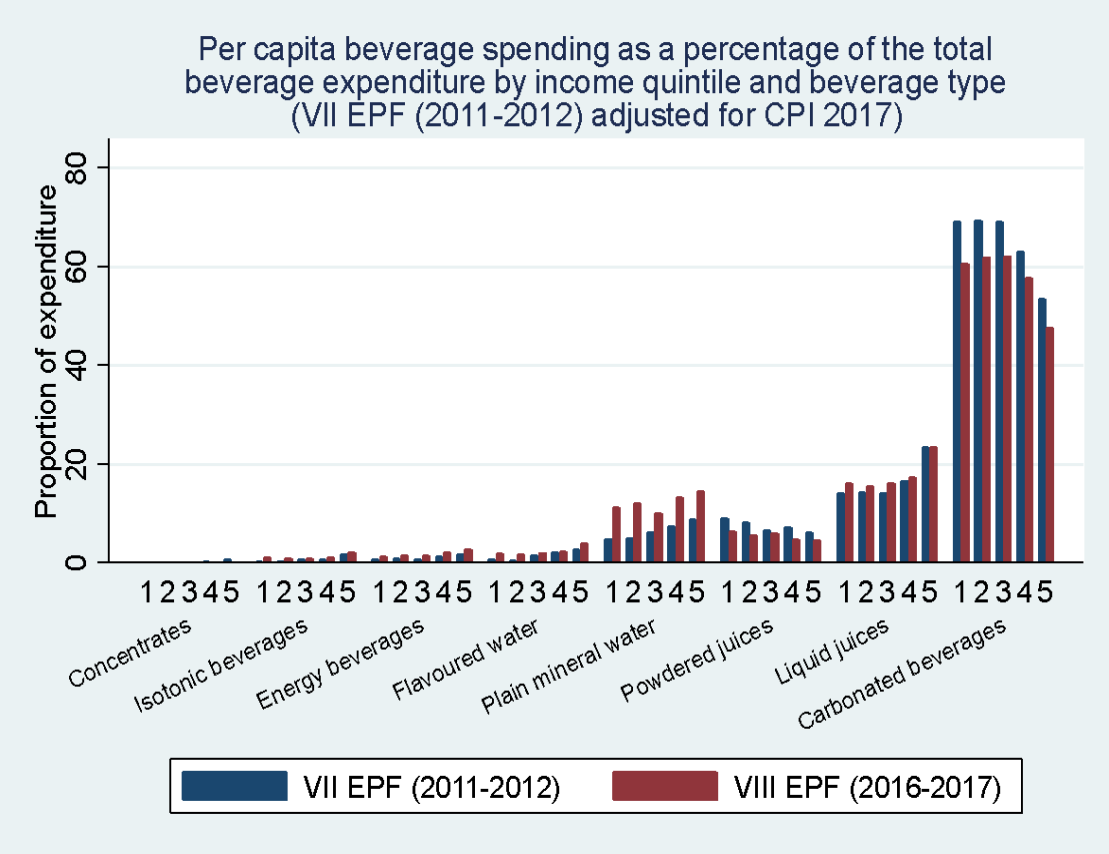
Figure 23 compares the mean beverage consumption expenditure per capita by income quintile. The graph shows the significant increase in plain mineral water expenditure across quintile groups compared to powdered juices which expenditure went down in all groups but the middle one (income quintile 3).

Figure 23. Comparison of the mean beverage expenditure per capita by type of beverage and income quintile between surveys (in Chilean pesos, data weighted, EPF 2011/12 adjusted for CPI 2017)



The following graph (Figure 24) shows the mean expenditure as a percentage of the total beverage expenditure by beverage type and income quintile. The graph shows that high income individuals spend less on carbonated beverages and powdered juices than the lower quintiles, but more on mineral water and less evidently on liquid juices. This might suggest a slight shift from carbonated beverages to mineral water in higher income individuals after the implementation of the Sugar Tax.

Figure 24. Comparison of beverage spending per capita as a percentage of the total beverage expenditure by beverage type and income quintile (VII EPF 2011/12 adjusted for CPI 2017)



In summary, the percentage of households that reported spending money on beverages, in general, was quite similar, with a slight decrease after the policy. For carbonated beverages, the most popular beverage type, while fewer households reported having bought them after the policy, a higher amount of money was spent on them. Almost the same proportion of households kept buying liquid juices; however, the expenditure per capita was also higher after the policy. In turn, mineral water consumption expenditure had an increase after the policy. A higher percentage of households reported having bought it after the policy, and the expenditure per capita more than doubled the expenditure before the policy.

5.4.5 SSB consumption volume

To estimate SSB consumption volume from SSB expenditure data, I considered three types of beverage from the group of beverages described above: carbonated beverages, liquid juices and flavoured waters; and I used the price per litre of SSB reported by Caro et al. (2018) in their study, as described in the methods section of this chapter (section 5.3.8.6).

The following tables (Table 33 and Table 34) show the mean and median volume of SSB (ml/day) consumed in both surveys by income quintile. Overall, and considering consumers and non-consumers, people increased their SSB consumption after implementation of the tax policy. In 2011/12 people consumed 175 ml/day on average, whereas in 2016/17 the average volume was higher (211 ml/day). Looking at consumption trends across income quintile groups, the volume of SSB consumption increased as people moved up the income ladder. On average, in 2011/12 those from the least affluent group consumed 125 ml/day of SSB, which corresponds roughly to half a glass of beverage, whilst the mean amount was slightly higher in 2016/17 (151 ml/day). In turn, the most affluent group consumed almost twice the amount of SSB of the most deprived (242 ml/day) in 2011/12, that is a glass portion of beverage a day, whilst this increased to 260 ml/day in 2016/17 which is closer to a regular sized can.

Table 33. Mean and median SSB consumption volume (ml/day) by income quintile and survey (includes non-consumers; data weighted, bottom 99% of the sample)[a]

Income quintile	VII EPF 2011/12		VIII EPF 2016/17	
	Mean ± SD	Median	Mean ± SD	Median
1 (most deprived)	125 ± 172	69	151 ± 210	82
2	158 ± 183	102	187 ± 221	121
3	171 ± 172	122	221 ± 226	166
4	184 ± 193	130	238 ± 232	182
5 (most affluent)	242 ± 238	195	260 ± 272	196
Total	175 ± 197	121	211 ± 236	145

[a] SSB price per litre taken from Caro et al. (2018) was adjusted for the foods and non-alcoholic beverages CPI for each survey (2012 and 2017) before estimating volume.

When non-consumers are excluded from the analysis, the mean and the median consumption levels go up across income groups, as shown in the table below (Table 34). However, the trend remains similar—the most affluent show higher consumption levels than the rest.

Table 34. Mean and median SSB consumption volume (ml/day) by income quintile and survey (excludes non-consumers, data weighted, bottom 99% of the sample)[a]

Income quintile	VII EPF 2011/12		VIII EPF 2016/17	
	Mean ± SD	Median	Mean ± SD	Median
1 (most deprived)	173 ± 181	125	221 ± 221	153
2	189 ± 185	134	229 ± 224	166
3	193 ± 170	147	252 ± 225	192
4	207 ± 193	156	271 ± 229	209
5 (most affluent)	269 ± 236	217	294 ± 271	224
Total	208 ± 198	153	255 ± 237	191

[a] The SSB price per litre taken from Caro et al. (2018) was adjusted for the foods and non-alcoholic beverages CPI for each survey (2012 and 2017) before estimating volume.

Figure 25 plots the information contained in the tables above. Graph A compares SSB volume by income quintiles, including non-consumers and Graph B, excluding those categorised as non-consumers. The graphs show that consumption increased with affluence in both surveys and increased in all deprivation groups between 2011/12 and 2016/17.

Figure 25. A-B Comparison of beverage consumption by income quintile (including and excluding non-consumers; data weighted, bottom 99% of the sample)

Figure 25.A

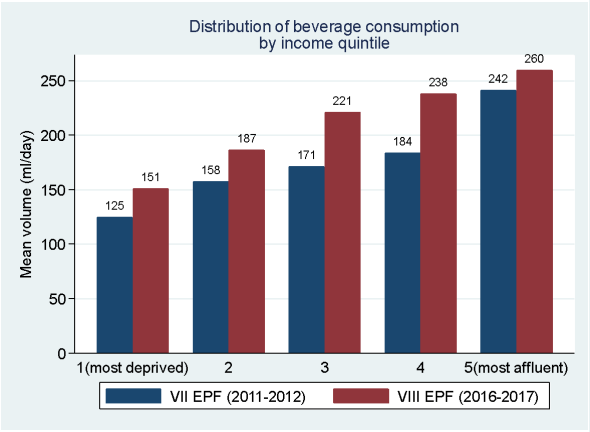
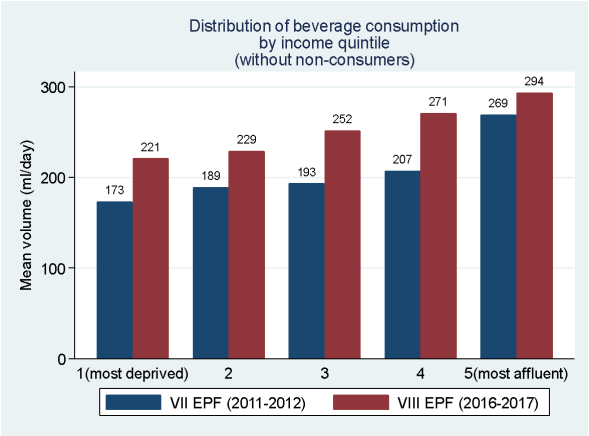


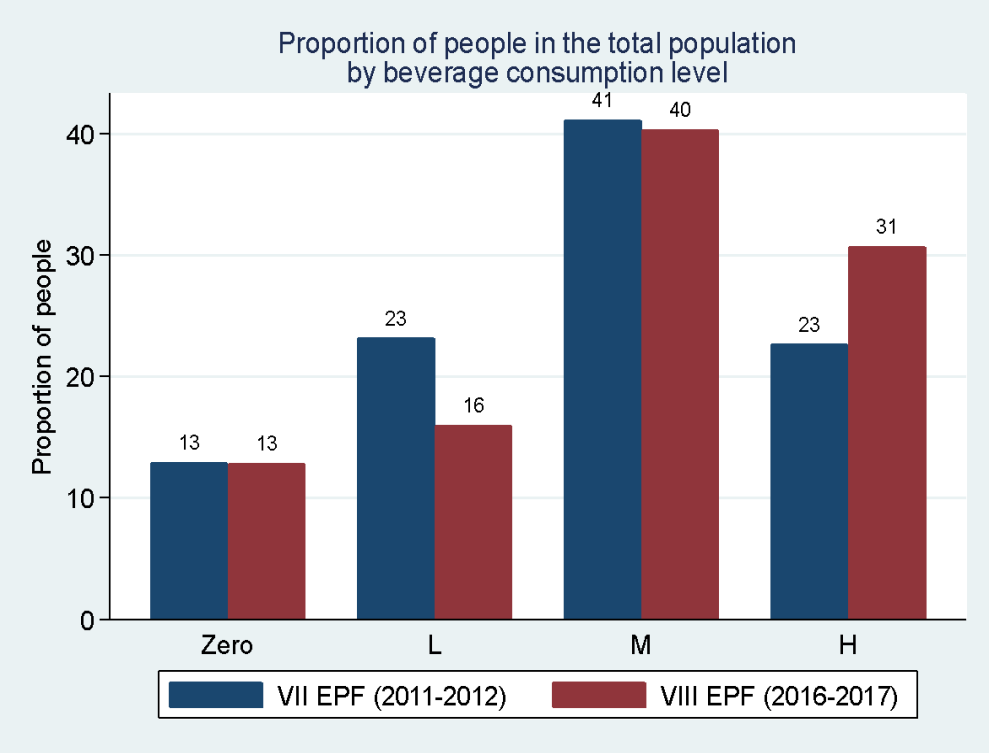
Figure 25.B



Using the findings of the systematic review, I categorised the daily consumption of SSB estimated in this study into zero (0 ml/day), low (0-71 ml/day), moderate (71-250 ml/day) and high (>250 ml/day). This classification was useful to further explore the changes in consumption levels after implementing the Sugar Tax policy.

As Figure 26 shows, only a tenth (13%) of the population did not consume SSB in 2011/12, and this percentage remained unchanged after the tax in 2012/17, with 87% spread across the low, medium and high categories. The percentage of people categorised as moderate-level consumers was almost the same in both survey waves (VII EPF: 41%; VIII EPF: 40%). In contrast, the percentage low-level consumers fell from 23% in 2011/12 to 16% in 2016/17, and the percentage of high-level consumers increased from 23% to 31%.

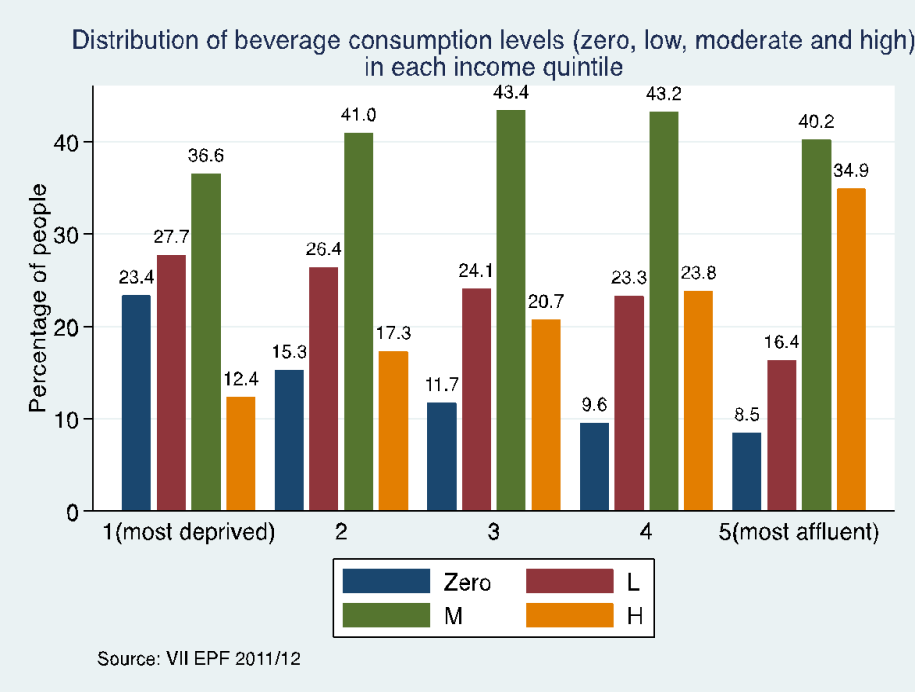
Figure 26. Comparison of the percentage of people in the total population by SSB consumption levels (data weighted, bottom 99% of the sample)



Baseline patterns of consumption varied with deprivation (Figure 27); there was a social gradient in high-level consumption (i.e. prevalence of high-level consumption increased with affluence) and a reverse social gradient in zero-level consumption (i.e. prevalence in zero-level consumption decreased with affluence). Against these different baselines, changes in patterns of consumption were broadly similar across income quintiles (Figure 27). For example, in 2011/12 most of the affluent group were moderate (40.2%) or high (34.9%) level consumers, and in 2016/17 there was a decrease in low level consumption (from 16.4% to 12.5%) and an increase in high level consumption (from 34.9% to 39.6%), suggestive of a general increase in consumption

across all levels. There were similar shifts in the other quintiles, although the magnitude of these shifts varied.

Figure 27. Distribution of the percentage of people by beverage consumption level and income quintile in the two surveys (data weighted, bottom 99% of the sample)



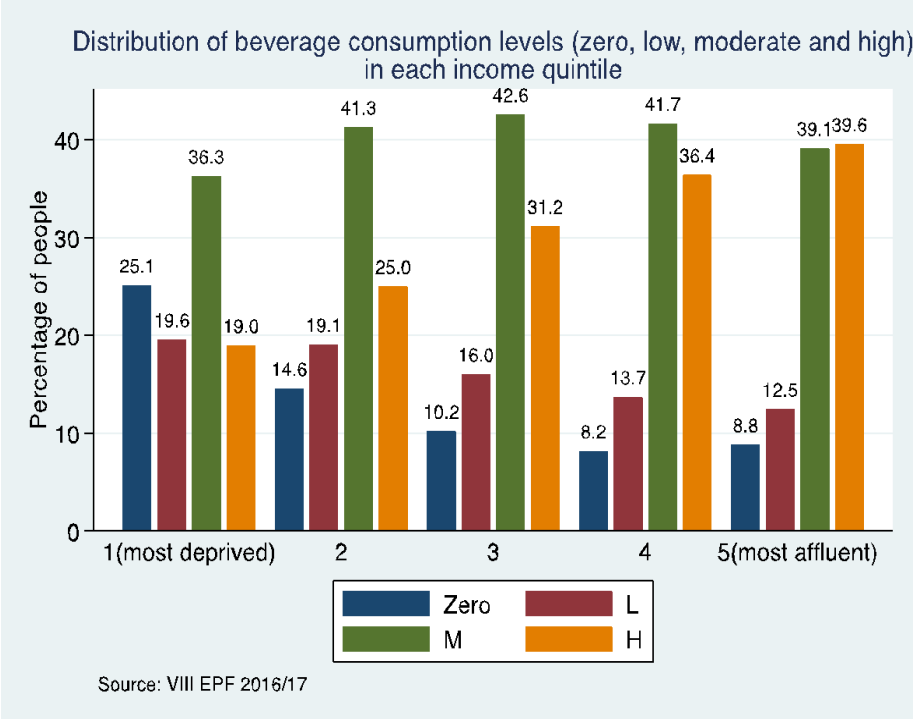
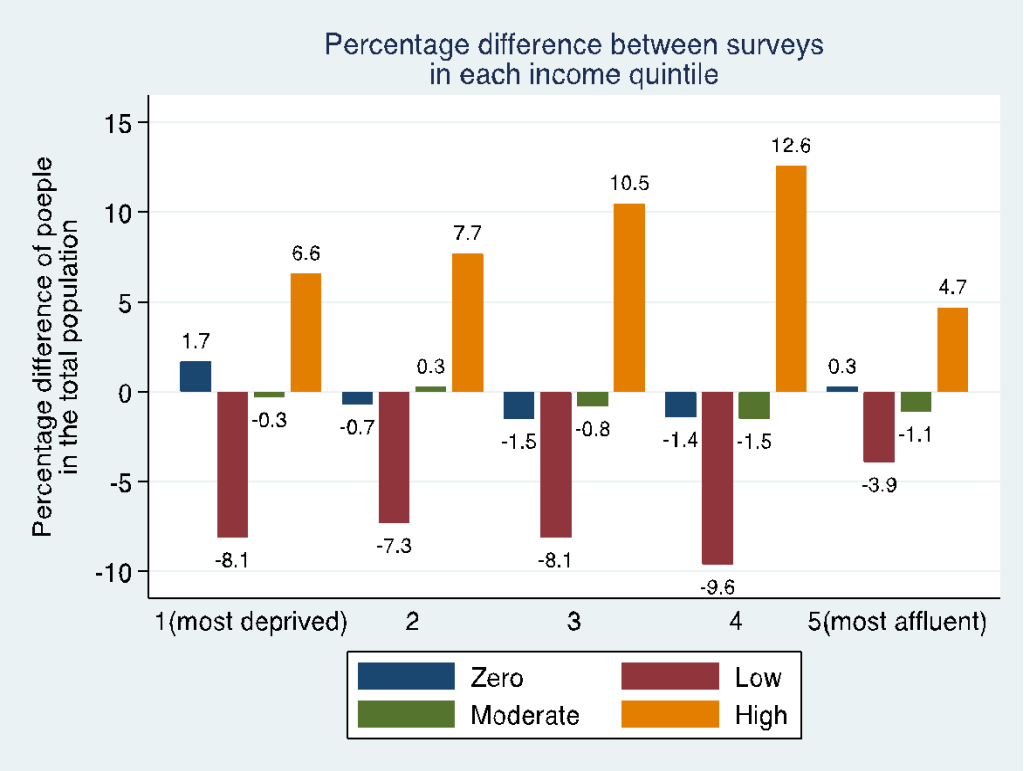


Figure 28 shows the change in prevalence of each SSB consumption level for each income quintile. Overall, in each income group, people moved from the lower levels to the higher levels, which suggests that the policy did not have the expected impact of

reducing SSB consumption. Instead, it seems that SSB consumption significantly increased after the implementation of the policy across all the income quintile groups, with large increases in the proportion categorised has high-level consumers and only a slight increase in the percentage of non-consumers among the poorest and the richest quintiles.

Figure 28. Difference in the percentage of people in the total population by beverage consumption levels in each income quintile between surveys (data weighted, bottom 99% of the sample)

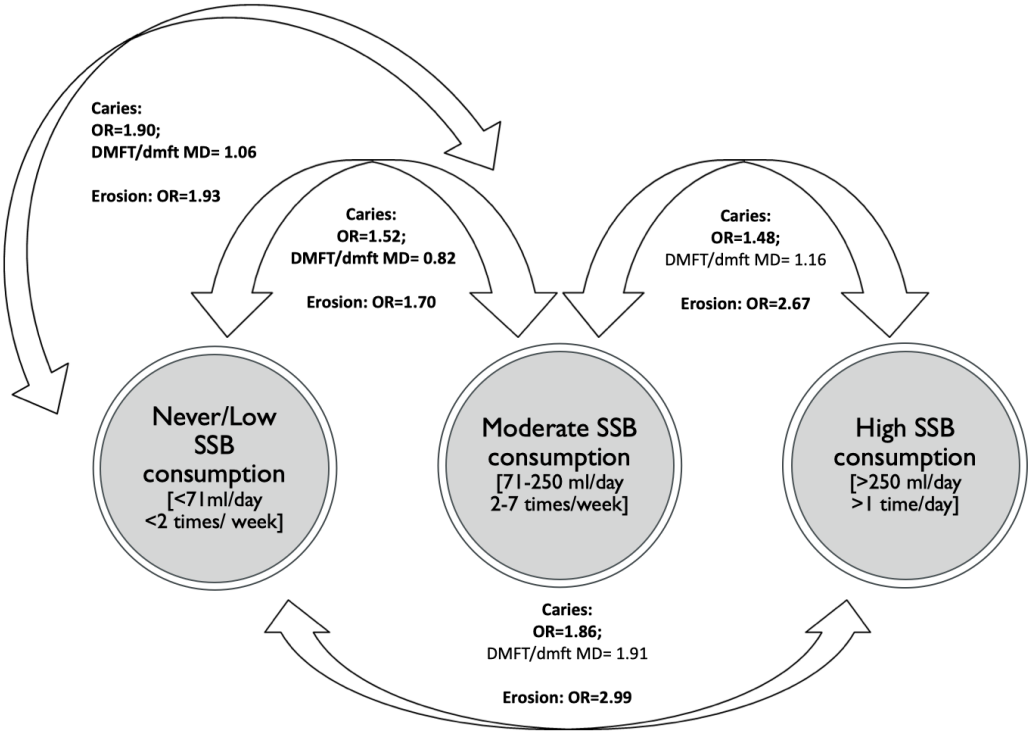


5.5 Projected effect of the Sugar Tax policy on oral health

Combining these data with the findings from the systematic review described in Chapter 4 and summarised in Figure 29 suggests that many low level and some moderate level consumers in 2011/12 moved into a higher category in 2016/17, potentially increasing their risk of having caries and erosion, depending on the time of exposure to the higher levels of consumption. In detail, those who moved from the low level to the moderate level of consumption likely increased their risk by 0.82 DMFT/dmft, with 1.52 more odds of having caries and 1.70 more odds of having erosion. Those who moved from the moderate level to the high level increased their risk by 1.16 DMFT/dmft, with 1.48 more odds of having caries and 2.67 more odds of having erosion (moderate to high level). However, this interpretation needs to be taken

with caution as the risk of having caries and erosion estimated from the review study considers people from different countries, with different levels and time frame of exposure. The review generally described people with long-term SSB consumption habits in the various consumption ranges, whereas this study described a relative short term change between the two surveys. Therefore, their risk of these oral health problems may not have increased by this much. Furthermore, these findings need to take into account that given the way SSB are classified in the EPF survey, it is not possible to distinguish between sugar and non-sugar SSB.

Figure 29. Risk of having caries and erosion by SSB consumption levels



SSB= sugar-sweetened beverages; ml= millilitres; OR= odds-ratio; MD= mean difference; DMFT/dmft: decayed, missed and filled teeth;

*Estimates in bold are statistically significant p<0.05

5.6 Chapter summary

In this chapter I presented the methodology and the findings of the quantitative study of this mixed methods thesis. I provided a description of changes in household and per capita consumption expenditures and SSB consumption levels following the implementation of the Chilean Sugar Tax policy in October 2014 and variation of these changes by socioeconomic status. I also presented the potential effect of the policy on oral health using the findings from the Systematic Review described in Chapter 4.

In summary, the analysis showed that, in general, people increased their SSB consumption after the policy's implementation from a mean volume of 175 ml/day to 211 ml/day. In terms of consumption trends across income quintile groups, consumption increased with affluence in both surveys and increased in all deprivation groups between 2011/12 and 2016/17. The findings also showed that high income individuals spend less on carbonated beverages and powdered juices as a proportion of the total beverage expenditure compared to the lower quintiles, but more on mineral water and less evidently on liquid juices. This might suggest a slight shift from carbonated beverages to mineral water in higher income individuals after the implementation of the Sugar Tax.

Using the consumption levels from the Systematic Review (Chapter 4, section 4.2.8.1), the analysis showed that baseline patterns of SSB consumption varied with deprivation; there was a social gradient in high-level consumption (i.e. prevalence of high-level consumption increased with affluence) and a reverse social gradient in zero-level consumption (i.e. prevalence of zero-level consumption decreased with affluence). Against these different baselines, changes in patterns of consumption were broadly similar across income quintiles in both surveys. Overall, there was a net movement in the population from all deprivation groups from the lower levels to the higher levels, suggesting that the policy did not have the expected impact of reducing SSB consumption. Instead, the findings showed that levels of SSB consumption increased after the implementation of the policy in the population across all the income quintile groups, with large increases in the proportion categorised has high-level consumers and only a slight increase in the percentage of non-consumers among the poorest and the richest quintiles.

The results also suggest that as many low level and some moderate level consumers in 2011/12 moved into a higher category in 2016/17, they likely increased their risk of having dental caries and erosion. Those who moved from the low level to the moderate level of consumption increased their risk by 0.82 DMFT/dmft, with 1.52 more odds of having caries and 1.70 more odds of having erosion. Those who moved from the moderate level to the high level increased their risk by 1.16 DMFT/dmft, with 1.48 more odds of having caries and 2.67 more odds of having erosion (moderate to high level). However, this assumption needs to be interpreted with caution as I explained in sections 5.3.8 and 5.5 in this chapter.

Chapter 6

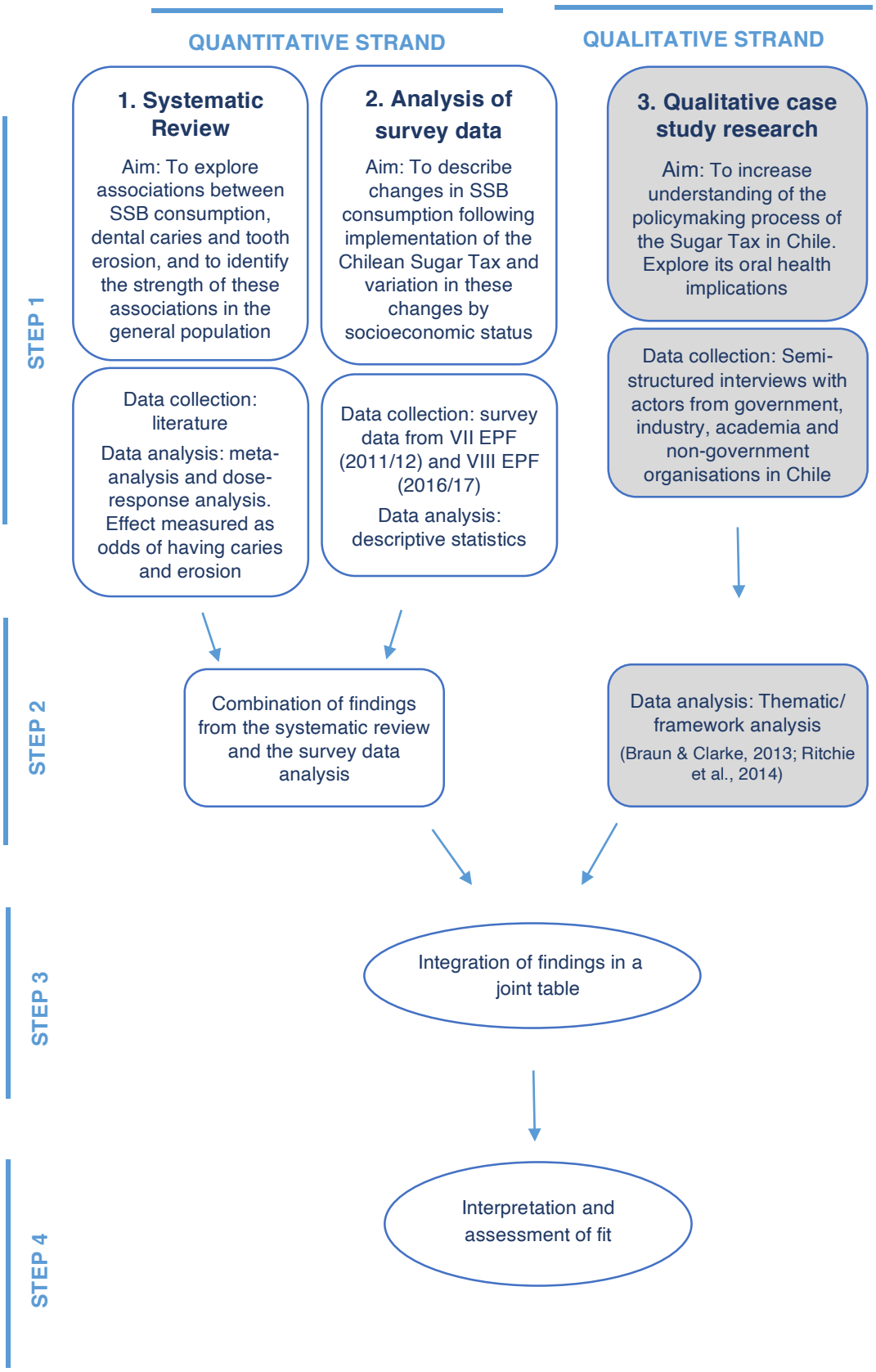
The Policymaking of Chile's Sugar Tax: a qualitative case study Methodology and Methods

---

In this chapter, I provide a detailed account of the methodology and methods of the qualitative strand of this mixed methods thesis (Figure 30). As I described in Chapter 3, I decided to include this qualitative case study to understand the policymaking process of the Sugar Tax in Chile, the context in which the policy was implemented, its implications for oral health and begin to understand the effects of the policy.

I followed the 'Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups' by Tong and colleagues (2007). I begin setting out the study aim and objectives. Then, I outline the methodology, including the rationale for the approaches and methods I used. I follow with a detailed explanation of the methods for the selection and recruitment of the sample and the approaches that informed the data analysis. Next, I discuss the credibility and trustworthiness of this research and I describe the techniques that I adopted to achieve this. I finish with a discussion around ethical considerations pertinent to this research. See Appendix 6 for the COREQ checklist.

Figure 30. Convergent mixed methods thesis diagram



6.1 Aim and objectives

This qualitative case study involving semi-structured interviews with policy actors aims to increase the understanding of the policymaking process of Chile's Sugar Tax policy and to explore the policy implications on oral health.

The study objectives are:

- To investigate how and why this policy got onto the political agenda and was formulated.
- To understand how this policy was implemented.
- To examine the role of the beverage industry in the policymaking process.
- To explore the policy implications for oral health.

6.2 Methodology

In this section I present the study methodology by describing the research paradigm and the research design of this study.

The research 'methodology' is an essential element in research as it sets out the conceptual and philosophical assumptions that underpin the use of methods in a research study. As Braun and Clarke (2013) point out, methodology "can be understood as the theory of how research needs to proceed, to produce valid knowledge about the psychological and social world" (p. 31). On the other hand, the research 'methods' refer to the actual techniques or procedures used for data collection and analysis in a research study that depends on the study aim (Kothari, 2004).

6.2.1 Research paradigm

It becomes crucial to describe the philosophical assumptions that I brought to this research as they underlined the decisions I took to plan, articulate and set up this study. These philosophical assumptions are often described as research paradigms, which are a "set of beliefs that guides action" (Guba, 1990, p.17).

Philosophical assumptions are beliefs about ontology, which is the nature of reality, and epistemology, which counts as knowledge and how they are justified (Creswell and Poth, 2018). As I described in the mixed methods methodology chapter (Chapter 3), this PhD thesis was underpinned by an all-encompassing worldview which is different than the traditional paradigms (positivism/postpositivism and constructivism/interpretivism): the pragmatism worldview. Although this study has its

own methodological procedures and could have been informed by other worldviews that usually go in line with qualitative methods, such as the interpretivist or constructivist worldviews (Creswell and Plano Clark, 2018), all the decisions I took to conduct this and the other studies were based on the research problem that this thesis sought to address and they were all informed by the pragmatism worldview. This worldview is concerned with 'what works' and solutions to research problems (Patton, 1990).

6.2.2 Research design

This study draws on qualitative case study methodology. Although Creswell and Poth (2018) identify case studies as one of the five approaches to undertake qualitative research together with narrative, phenomenology, grounded theory and ethnography, case studies can also include, and even be limited to, quantitative evidence (Yin, 2018). Methodologically, some authors argue that case study research is rather an approach to focus a research project on or the exploratory stage of another type of method failing to consider case study research as a formal method of research (Stake, 2005; Thomas, 2011). Others claim that case study is a formal strategy of inquiry (Merriam and Tisdell, 2015; Yin, 2009). I took the latter position by considering case study research as a research design.

Case study research is an appropriate methodology when the study tries to answer questions related to the 'how' and/or the 'why' of a phenomenon. This design is also useful when the intention is to analyse a contemporary event, over which the researcher has a direct observation, has the possibility to interview those involved and have little or no control over the event of interest. Yin (2009) defines case study research as:

> *"An empirical method that investigates contemporary phenomenon (the 'case') in depth and within its real-world context, especially when the boundaries between the phenomenon and context may not be clearly evident. A case study […] relies on multiple sources of evidence, with data needing to converge in a triangulation fashion" (*p. 15).

In other words, this method is useful when the researcher wants to understand a real-world case assuming that such an understanding is likely to involve relevant contextual surroundings.

It is essential to define what 'case' is and the 'case' in this particular case study. When I write about a 'case', I refer to a spatially and temporally delimited phenomenon

that I intend to understand (Gerring, 2017). In this study, the ‘case’ is the Chilean Sugar Tax policy. The spatial boundary is the Chilean territory, and the temporal boundary is when the policy was formulated, put onto the government's agenda and implemented. As Yin (2018) points out, “bounding the case will help to determine the scope of your data collection and, in particular, how you will distinguish data about the subject of your case study (the “phenomenon”) from data external to the case (the “context”)” (p. 31).

Three types of case study are described in the literature: instrumental, collective and intrinsic (Creswell and Poth, 2018; Stake, 1995). In the instrumental case study, the researcher focusses on a problem and chooses one case to illustrate the issue. Similarly, the collective or multiple case study focuses on an issue, but the researcher selects multiple cases to depict the issue. The third type and the one that best fits with this study's purpose is the intrinsic case study that focuses on one case: a person, a programme, or a policy. Therefore, this study is an intrinsic qualitative case study.

The rationale for using a qualitative case study design is fourfold. First, the flexibility of the case study methodology enabled me to fully understand and contextualise the complex phenomenon of the Sugar Tax policymaking process through face-to-face semi-structured interviews which were impossible to obtain from official documents. Second, this approach allowed me to triangulate and explore the ‘how’ and ‘why’ of the process through the perspectives of different policy actors, which permitted me to gain a more comprehensive picture of the process. Third, the case study approach allowed me to explore the implications of oral health problems, particularly during the policymaking process of this policy, and generally, at the public policy level from the participants’ point views. Finally, by using the case study research design, I was able to explore policy-relevant questions that are useful to policymakers contemplating the introduction of SSB tax policies (Pal, 2005).

In conclusion, the qualitative case study's nature seemed the most appropriate design that fitted best with the aim and objectives.

6.3 Methods

I undertook semi-structured face-to-face interviews with stakeholders to develop an in-depth understanding of the Sugar Tax policymaking process and explore its implications on oral health. Case study methodology involves drawing on multiple evidence sources to build up an understanding of the case, therefore I decided that the

sample had to include stakeholders from varied sectors, such as academia, government, beverage industry, and non-governmental organisations. Whilst participants from the government would provide an inside and more detailed account of the policy process, those from the academia, non-government organisations and the industry would complement the picture from a more peripheral perspective (Wright et al., 2017). To allow for triangulation of different evidence sources, I analysed thematically the collected data, using the process of thematic analysis developed by Braun and Clarke (2006) and techniques from Framework analysis to assist with the development of themes (Ritchie and Spencer, 1994).

6.3.1 Sampling strategy

Participants were eligible for this study if they had influenced directly or indirectly the Chilean Sugar Tax policymaking process. In line with the case study methodology, my decision of collecting data from stakeholders from varied sectors was based on the purpose of this study to characterise multiple interpretations of how the policy was formulated and implemented, and how the policymaking process evolved. The selection of the different sectors was informed by policy analysis literature that supports the idea that a diverse set of actors can become involved in the making of public policies (Araral et al., 2015; Howlett and Ramesh, 2003). Policy actors refer not only to individuals but also to groups and institutions (Howlett and Ramesh, 2003). They can be placed in two broad categories: government and non-government actors. The first group considers those who are involved more directly in the formulation of public policies and in the implementation process, such as elected politicians and appointees who serve in advisory roles inside government (also referred to as the 'bureaucracy'), whereas the second, is a more diverse group and includes interest groups, lobbyist groups, non-government organisations and representatives from civil society organisations.

Within the 'government' group, I did not select participants based on reputation or job position. It was according to involvement in the policymaking process. In many cases, not only high-profile public figures participate in the policymaking process, but also actors with a lower profile or position within the policy-making hierarchy may have contributed (Stephens, 2007). Therefore, the policy's lawmakers and appointed officials were considered in the sample. The latter usually have the function of assisting politicians in their tasks' performance; however, their role goes beyond this. As Howlett

and Ramesh (2003) point out, “bureaucrats are very often the keystone in the policy process” (p.67).

In the ‘non-government group’, I considered the beverage industry, academia and non-government organisations as valuable sources of data, thus I included them in the sample. Among these, the beverage industry, as other private businesses, are described in the literature to be powerful and significant actors - outside government - to affect SSB taxes, as policies often have a direct effect on the financials of businesses (Wright et al., 2017). I included participants from the beverage industry to incorporate and contrast the other sector’s views, as they may have acted as opponents to the policy.

I also recruited scholars and researchers working at universities or research institutes. With interests in government or public problems, I considered this group of actors for inclusion as they usually contribute as opinion-makers through public policy debates, academic presentations, and scientific publications and often impact the shape of policies (Eykelenboom et al., 2019).

The final group I included were non-governmental organisations or interest groups. One of the most important resources of this group is knowledge, especially information that may be less available to others. The members of specialised groups often know most of the area of concern and usually are invited to participate in the development and implementation of policies (Baumgartner and Leech, 1998). I considered participants from this group if they had acted as public health advocates to support the Sugar Tax during the policymaking process. I identified them from online news websites from the time of the policy process.

My choice of the sampling strategy approach was guided by the study's aim and the methodology that underpinned this research. I used stratified purposive and snowballing sampling strategies to identify participants. As Bryman (2008) points out, “purposive sampling is a non-probability form of sampling. The goal of purposive sampling is to sample cases/participants in a strategic way, so that those sampled are relevant to the research questions” (p. 415). Stratified purposive sampling refers to a hybrid approach in which subgroups are selected that “display variation on a particular phenomena but each of which is fairly homogeneous” (Ritchie et al., 2014, p. 114) so that the views from different policy actors within each group can be compared. In turn, snowballing sampling was part of the purposive sampling which, as Braun and Clarke (2013) describe it, “involve the sample being built up thorough the networks of the

researcher and other participants" (p. 57). I used the snowballing strategy to find further participants that were difficult to identify from public sources (described in the following section) or were hard to reach given their job positions especially from government and the beverage industry. Some of these actors are considered elites, which are commonly challenging to identify and are sometimes inaccessible (Odendahl and Shaw, 2001).

I chose participants with the 'purpose' of representing all sectors described above, but also, as Table 35 shows, I identified different policy actors to achieve enough in-depth data to compare and contrast experiences and perspectives from different roles within each sector (Creswell and Poth, 2018). These sampling strategies allowed me to recruit participants from varied backgrounds within the four sectors with different involvement levels in the policy process. Within the government sector, I not only recruited those in high government positions but also assessors or other civil servants hoping that they would have more flexibility to discuss the policy.

These strategies also guided the size of the sample. As this was exploratory research, and given the level of in-depth focus required to meet the study aim and objectives, I considered a sample size of twenty stakeholders across the four sectors sufficient although this number was considered provisional and it was planned to be guided by the level of data saturation (Glacer and Strauss, 1967; Mason, 2010). Also described as information redundancy, data saturation refers to the point in which the researcher stops the data collection when sufficient or adequate depth of understanding of the phenomenon under study is reached (Dey, 1999). However, Braun and Clarke (2019) argue that "there is far more at play and at stake in considering saturation…" (p.6). The authors claim that the sample size decision should be made in-situ and should be shaped by the adequacy (richness) of the data and constrained by the time and resources available for the researcher in a pragmatic way. Therefore, I made the final sample size decision within the process of data collection and while reviewing the data quality during the process.

Table 35. Sample groups

Stakeholder sectors	Policy actors
Government	Elected officials
	Appointed officials
Academia	Public universities
	Private universities
Non-governmental organisations	N.G.O.
	Independent societies
Beverage industry	

The inclusion of individuals involved in the policy process enabled me to access information unreachable from the literature as the sample included the policy actors involved in the policy process.

Unfortunately for this study, published documents with detailed information about the Sugar Tax policy were non-existent or inaccessible due to privacy reasons. However, case study research needs to corroborate the evidence found through interviews with evidence from other sources. I triangulated this study's findings with the limited information available in the literature about the policy process in the discussion chapter (Chapter 8) (Yin, 2018). In any case, I believe that exploring the accounts of the individuals involved in the actual policymaking process offered a more nuanced perspective than examining documents (Gubrium and Holstein, 2001).

6.3.2 Recruitment

In an initial stage, I searched seven online sources to identify potential participants. These included institutional websites in which specific information of the Sugar Tax and its policymaking process was available, including www.hacienda.cl (Ministry of Finance), www.minsal.cl (Ministry of Health), www.senado.cl (Senate), www.bcn.cl (Congress), and www.sii.cl (Tax Administration Entity). Then, to identify further participants, especially from the sectors outside government, I consulted the online websites of the two most salient national newspapers, which had varied news materials about the public debates generated in the time of the policy. These were www.emol.com (El Mercurio) and www.latercera.com (La Tercera). In a later stage and following the snowballing approach, I asked participants agreeing to be interviewed to provide names and contact details of other participants that may have been involved in

the policy process. I invited them to participate if they met the eligibility criteria to ensure no potential bias in the selection process.

I used the sampling strategy to guide the recruitment process and to ensure the sample was obtained reliably and robustly. After purposively identifying an adequate number of policy actors across the four different sectors, I contacted them via email with an invitation to take part in the study. The email included a brief explanation of the nature of the research. It contained an information sheet (Appendix 7) and a consent form (Appendix 8) to allow participants to read a more detailed description of the study characteristics and make a fully informed and voluntary decision to participate in this research. If no reply was received, after two weeks, a follow-up email was sent. Understanding that those invited were likely to be busy, the reminder email was not intended to push them to participate, but to make sure they received the invitation.

I made a particular effort to ensure that the participants understood the purpose of the interview as well as the aim of the study. In some cases, despite having received the information sheet, and having agreed to participate, some participants did not understand why I was approaching them as they did not have a dental background. After having this issue during the first couple of interviews, I revised the invitation letter and changed the wording highlighting the policymaking process scope of the study rather than the implications for oral health (see Appendix 9 and 10 for the original and the revised invitation letter). After doing this, I realised that participants were more prone to participate and then were more relaxed to discuss oral health implications even though some of them had no experience in dental public health. This was an important feature, mainly when I interviewed lawmakers and participants from the beverage industry who considered the policy solely a tax collection tool.

When participants replied to the invitation email interested in participating in the study, I offered them the opportunity to ask further queries about the study's aim and the interview. After solving these, a convenient date, time and place was arranged for the face-to-face interview.

The recruitment of policy actors from the government group took several scheduling requests, and in many cases, I had to approach them through third persons, i.e. personal assistants. Powerful people are often difficult to access as they try to protect themselves from outsiders, and it is likely that researchers need to get past gatekeepers such as personal assistants first to reach them (Odendahl and Shaw, 2011). Participants from academia were reasonably easy to recruit. Compared to

stakeholders from the other three sectors, academics were more inclined to agree to participate in the first invitation email. In contrast, participants from non-government organisations and the beverage industry were challenging to recruit. The former, because not many civil organisations advocating for public policies existed in Chile, leaving a small pool of potential participants to access. The latter group because their representatives were extremely reluctant to participate, and many refused to take part making their access particularly challenging. No responses to invitations from the industry sector's stakeholders were received when the email was sent directly to them. However, some agreed to participate when a common contact existed between the researcher and the stakeholder, e.g. family member or friend. It may be possible that these stakeholders were afraid of disclosing delicate information. Those who agreed to participate requested a set of questions before the meeting to evaluate the scope of the researcher's enquiry and make an ultimate decision.

I invited thirty-nine potential participants to take part in the study. Twenty-three agreed and were interviewed, five declined explaining that they would not add valuable information, did not have time or were not allowed to disclose information about the policy given their current work positions, and 11 did not respond. The participating rate, therefore, corresponded to around 60%.

6.3.3 Data collection

I collected the data through in-depth semi-structured face-to-face interviews, which I recorded using a digital audio recorder. This process took place in Santiago, Chile and was undertaken in two stages. First, to pilot the topic guide I conducted four interviews, one from each of the stakeholder groups in December 2017. Then, the main data collection took place in April and May 2018. Data collected in both stages were included in the final analysis.

Yin (2018) states that one of the most critical data sources of case study evidence is the interview. Interviews are a useful way to answer questions such as 'how' and 'why' of an event, as well as the perspectives of those involved in the event. I chose the semi-structured approach for the interviewing as I wanted to guide the inquiry line during the interviews while simultaneously allowing the participants to describe their own accounts of what happened. I considered interviewing policy actors from different sectors the best and most appropriate way to obtain in-depth information about the policy process. The value of the one-to-one interaction that individual interviews provide lays on the level of in-depth investigation of each participant's

individual perspective within the context of his personal history or experience where the phenomenon developed (Ritchie et al., 2014).

At the start of each interview, I discussed the aim and details of the study with the participant, so he/she would make an informed decision to participate in the interview. This was highly important in some interviews, as some participants were not prepared for the questions. In these cases, I made an effort to explain the study and rephrase some of the questions to immerse them slowly in the topic to reach the desired information.

Then, I continued with a short personal introduction to demonstrate my experience and sound knowledge in the topic, expecting to gain respect and achieve a more balanced symmetry in the interview relationship with the participant (Dexter, 2012). I also underlined some interview practicalities at this point about, for example, the time length of the meeting, and also to answer any query about the interview process. As participants may have felt uneasy about being recorded due to the study's political sensitivity, I also reassured confidentiality and anonymity concerns. I then asked the participant to sign the consent form, and the interview commenced guided by the topic guide. Although audio recordings are an efficient method to capture the interviewee’s responses (Gubrium and Holstein, 2001), I also took notes during and after the interview to note the participant's special remarks that may not be captured in the audio recording.

6.3.3.1 Developing and piloting the topic guide

I developed the topic guide (see Appendices 11 and 12 for the initial and the final topic guides) from policy analysis literature, the research aim and objectives, and discussions with my academic supervisors. The interviews were semi-structured around the questions included in the topic guide, which guided the topics in the discussion to make sure that the interviews were consistent across the sample, but also enabled participants to take the lead at times to provide their own accounts of the process.

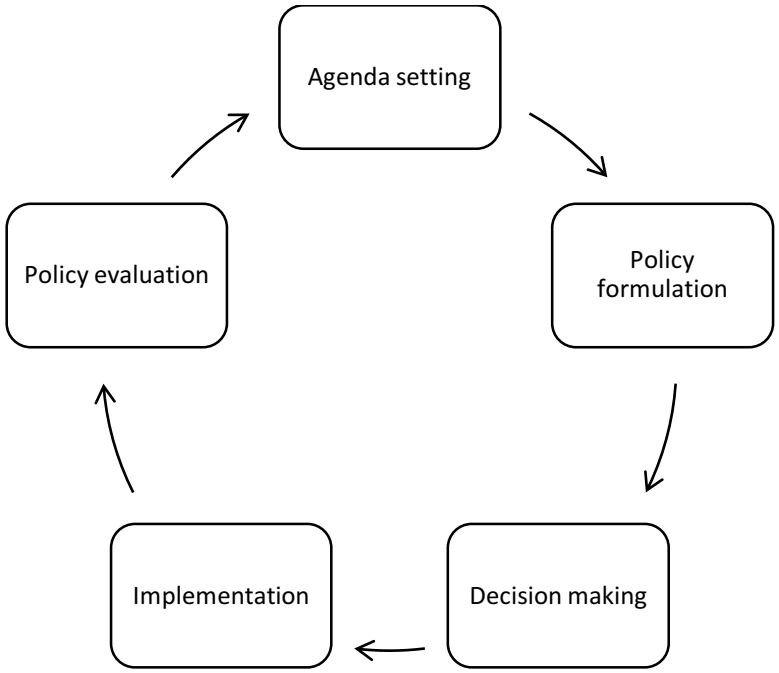
The piloting process of the topic guide was undertaken to test procedures before starting with the main data collection. This enabled me to improve my interviewing skills, familiarise with the interview process and the topic guide and anticipate practical issues that may have affected the subsequent interviews' quality (Arthur et al., 2014). This stage also tested the suitability of the topic guide's pre-set questions and helped identify topic areas not taken into account (Schmeer, 1999).

Piloting the topic guide was very useful as these initial interviews revealed limited awareness and understanding of the policy among some participants.

Topic guides are a valuable tool in qualitative interviews to ensure consistency while still allowing for flexibility when obtaining the data from participants (Arthur et al., 2014). Well-designed topic guides are essential for these two purposes and require planning and careful reflection about the nature of the data needed (Bryman, 2008).

For this study, I started outlining the main topics that needed to be included based on the study's aim and objectives. Then, I consulted the relevant literature, which allowed me to start forming the structure and to find a way to order these critical topics in the guide. Varied policymaking process models were reviewed. I considered the cycle model proposed by Howlett and Giest (2013) to be the most appropriate to use as it includes the different stages of a policy process efficiently and comprehensively (see Figure 31). The initially defined questions in the topic guide tried to cover the five stages of the policymaking cycle, including agenda setting, policy formulation, decision-making, policy implementation, and policy evaluation (Howlett and Giest, 2013). Although the questions in the topic guide covered the whole cycle, I emphasised the first three stages of the process due to this study's purpose.

Figure 31. Policymaking cycle (own construction from Howlett and Giest, 2013)



I reviewed the topic guide several times. At an early stage, I discussed the questions with my supervision and the thesis advisory panel team members who helped me

refine, refocus, and reduce the number of some questions. Then, during the pilot stage, I also reviewed the topic guide as this stage served me to test the questions' appropriateness. During the first few interviews, I tested whether the topic guide allowed participants to give a coherent and complete account of the policymaking process and at the same time incorporate further issues that they identified important to discuss (Arthur et al., 2014).

6.3.4 Data analysis

Although Yin (2018) has made an effort to provide guidance to conduct case studies, the analytical stage remains vague. Yin (2018) points out, “the analysis of case study evidence is one of the least developed aspects of doing case studies” (p.165). He also highlights that this stage depends on the researcher’s own capabilities and preferences. He recommends starting the analytical process by playing with the data to identify patterns, insights and topics that may appear promising. And then continue with four analytical techniques: pattern matching; explanation building; time-series analysis; logic models; and cross-case synthesis. According to the author, these techniques are not easy to use and can be used in combination or alone. Yet, as he suggests that the analytical approach's selection should depend on the researcher's preferences and skills, I found myself in need of a more detailed and structured direction to conduct the analysis of the data.

Consequently, I used the thematic analysis approach described by Braun and Clarke (2006) to analyse the data reflectively and flexibly. This approach was first proposed in 2006, and since then, it has been increasingly used and refined. Thematic analysis is a data analysis method that involves a systematic search for themes by reading and reading again the collected data, to identify and report patterns whilst going through six stages. These stages are familiarisation with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes and producing the report (Braun and Clarke, 2006). The authors claim that rather than rigid and structured, this approach encourages researchers to conduct a rigorous and systematic coding and theme development in a fluid and flexible way, acknowledging the researcher's subjectivity to the interpretations. This method has many strengths, including its flexibility and easy steps to follow (especially useful for researchers with little experience in qualitative research). Braun and Clarke (2019b) highlight that the findings after the analytical process are the “product of deep and prolonged data immersion, thoughtfulness and reflection” (p.7). I found this approach relatively

straightforward to follow and allowed me to have continuous thinking, reflecting and evolving attitude towards the data. Yet, after the coding, and finding and refining the themes, I felt that I needed further direction to develop a more abstract representation and interpretation of the data. I borrowed some guidance from the framework analysis approach proposed by Ritchie et al. (2014) to give a more interpretative account of the findings. This approach is described in detail in section 6.3.4 further below in this chapter.

I transcribed verbatim all audio recordings in the same Spanish language as the interviews. I used the computer software package QSR International NVivo version 12 Pro to manage, shape and code the data. Computer-assisted qualitative data analysis software packages have been increasingly accessible and comprehensive in their functionality (Ritchie et al., 2018). Yin (2018) recommends using such packages in case study research. They are useful tools that assist researchers in the analytical process, particularly for data management, interpretation of findings and project management. However, some authors claim that using computer software packages in qualitative research may lead researchers to take 'short-cuts' instead of analysing the data in the interview context (Weitzman, 2000). But it is essential to understand that computer packages are just a tool that assists you, which will never do the final analysis own their own (Yin, 2018). The NVivo software package was particularly useful in supporting the analysis and interpretation process by aiding me with storing and coding the data and illustrating some of the preliminary codes graphically.

It is essential to highlight that the analytical process began during the data collection through the process of familiarisation and reflection. This combination of processes – data collection and analysis – was essential as when I asked questions, I generated preliminary themes and codes that served me to reflect on the topic guide and adapt further the questions to capture the in-depth level of data that I wanted.

I took an inductive, reflective and flexible approach to analyse the data and capture its essential meaning (Patton, 1990). I undertook the analysis inductively as I did not intend to fit the data into a pre-existing theoretical framework. However, it is important to note that the analysis may have been unconsciously influenced by my background and training in dental health, the oral health implications that I was hoping to find, and the policymaking cycle described in section 6.3.3.1 that guided the articulation of the topic guide. Despite acknowledging this potential bias, I made my best to represent the participant's voice and not my preconceptions on the topic. More

about how I ensured my own views did not shape the analysis is presented in section 6.4.1.

I analysed the data across participant groups, but I also looked at differences between groups to capture the whole picture and reach a greater understanding of the Sugar Tax policymaking process. I explored different perspectives and deviant accounts of similar content to provide alternative explanations of the data. Corbin and Strauss (2008) highlight that this approach improves the 'richness' of the findings and allows for a greater exploration of the study concepts.

Although the analytical stage in this chapter is described as an isolated procedure, the actual analysis started alongside the first interview, during which I started familiarising with the data. As Spencer et al. (2014) point out, the "analysis does not begin when the researcher has finished collecting their data, but is an ongoing and inherent part of the whole process of qualitative research" (p.275). This is one of the flexibility and pragmatic benefits of qualitative research.

6.3.4.1 Familiarisation

Data familiarisation started from the transcription of the first interview. As Braun and Clarke (2013) point out, this process was not about "simply absorbing the surface meaning of the words (or images), as you typically absorb a crime novel … but reading the words actively, analytically and critically, starting to think about what the data mean" (p. 205). The process of data transcription enabled me to immerse in the dataset's content and begin noticing things potentially relevant for the analysis (Spencer et al., 2014). I read and re-read the interview transcripts to gain a greater understanding of the nature and diversity of the data. During this stage, I took handwritten notes about emerging items of potential interest alongside the transcripts. These notes were useful to reflect on the data and served to inform the coding process in the subsequent stage.

6.3.4.2 Generating initial codes

The coding process consisted of generating initial codes based on aspects of the data relevant to the study aim and objectives. It started with the first data transcript and then continued systematically to ensure continuity throughout all participants' data. As this process began, I used the software NVivo to create a coding framework. Appendix 14 contains screenshots of the coding process from mind-maps to the coding framework

showing a large number of codes generated during this stage and the volume of quotations included in each code.

Rather than undertaking a selective coding, I used a complete approach in this process. This means that instead of capturing particular items, I identified ‘anything and everything’ of interest within the entire dataset, and only in a later stage, the process became more selective (Braun and Clarke, 2013). The codes were words or short phrases that labelled features of the data potentially relevant to the study aim. Some captured the explicit content, whereas others the implicit meanings of the data. Their combination helped me develop an interpretative analysis to go beyond what was evident in the data set (Braun and Clarke, 2013). After finishing all transcripts, I went through the codes and for those too similar or overlapping, I combined and renamed them to organise the dataset better and start capturing the actual meanings.

I conducted this process in July 2018 and then reviewed it in February 2019. A second researcher (M.C.S.) checked the generated codes afterwards. This served to check whether the coding framework had consistently captured different and varied concepts, issues, and meanings across the data set. It is important to note, that this strategy did not intend to give an inter-rater agreement estimate, but to assess the trustworthiness of the coding process (Braun and Clarke, 2013).

6.3.4.3 Searching for themes

Once the data had been coded and the coding framework reviewed, I started “playing with data” (Yin, 2018) and searching for patterns, and recurrent themes that Braun and Clarke (2006) describe as labels that capture “something important about the data in relation to the research question, and represents some level of patterned response or meaning within the dataset” (p. 82). I identified several candidate themes and sub-themes by sorting and organising the codes using tables and mind-maps (see Appendices 13 and 15). These visual techniques helped me to analyse potential relationships and different levels between the candidate themes (Braun and Clarke, 2006). Codes that seemed to not fit within the identified themes I coded as 'miscellaneous', but I included them in a later stage.

It is important to acknowledge that the ‘themes’ that I developed from the collected data were based on shared meaning patterns rather than a summary of data domains organised around a shared topic or focus area (Clarke and Braun, 2018). The themes generated in this study did not passively emerge from the data. They instead resulted from a creative and interpretative exercise that I did during the data analysis

based on my previous knowledge in the field, analytical resources and skills, and philosophical assumptions. This way, the analytical process did not aim just to provide a description; it went further into a more interpretative account of the data.

6.3.4.4 Reviewing, defining and naming themes

I reviewed, reorganised, merged and renamed the constructed themes several times to obtain a coherent and meaningful representation of the data (see Appendices 15 and 16). At this point, candidate themes made sense together; however, although the previous exercise led to the construction of themes informed by Braun and Clarke's Thematic Analysis approach, I found this tool insufficient. I needed further guidance to reach a more interpretative account of the data. For this reason, I consulted and decided to borrow some aspects of framework analysis, a form of thematic analysis, which gave me more direction to go beyond of just a description of the data and allowed me to provide more transparency to this process (Ritchie et al., 2014).

Ritchie and Spencer first proposed the framework approach to analysing qualitative data in 1994. It has evolved over the years to a particular method of analysis suited for policy research (Ritchie and Spencer, 1994). This method of qualitative data analysis includes two main parts – data management and abstraction and interpretation. The data management involves five stages: familiarisation; constructing an initial thematic framework; indexing and sorting; reviewing data extracts; and data summary and display (Ritchie et al., 2014). The second part involves the construction of categories; identification of linkages; and accounting for patterns. Both the thematic and framework approaches, share similar analytical paths of data management that begin with familiarisation and then follow with the labelling and sorting of the data. However, framework analysis suggests the additional stage of abstraction and interpretation, which as Ritchie and Spencer (1994) point out, “the serious and systematic process of detection begins” (p. 186).

6.3.4.5 Abstraction and interpretation

Drawing on the abstraction and interpretation stage of framework analysis (Ritchie and Spencer, 1994; Ritchie et al. 2014), I charted the data from each code according to candidate themes and sub-themes and I explored their corresponding quotes in detail. This detailed exploration consisted of summarising each quote's main idea within each code and selecting the most relevant quotes for the report. This served me to build up a greater understanding of each code, develop a clearer insight of linkages between them, and assess the data's coherence within each theme and sub-theme. Although

described as distinctive stages, the first part of the analytical process involved data management, and the second part of interpretation was somewhat iterative. The data management involved some interpretation, and the interpretation involved some data management. The interpretative account of the data was integral throughout the analytical process. It started at the beginning, with the familiarisation stage and ended up with the findings' writing. Chapter 7 represent the result of this process. An important point that needs to be acknowledged at this point is that although the analytical process was made inductively, it was still influenced by the study's aim and objectives and the thesis as a whole.

6.3.4.6 Cross-language analysis

Interpreting and understanding the meanings of data and how these meanings are transferred to the reader is a fundamental component of qualitative research (Van Nes et al., 2010). In some cases, the data is reported in a different language than the original data, for which it requires a translation process. The communication of data collected in a language different from the reporting one may be highly challenging, as the intended meaning of a participant’s voice sometimes cannot be accurately expressed in another language (Esposito, 2001).

Varied techniques have been suggested in the literature to avoid translation-related problems and ensure the trustworthiness of cross-language qualitative research (Birbili, 2000). I adopted some of these in this study. First, to minimise the risk of losing contextual information or meanings, and avoid misinterpretations, I undertook the analysis in Spanish, the original language of the interviews and my first language (Van Nes et al., 2010). Then, I translated the quotes used to evidence the analysis into English with the support of a second researcher to enhance the quality of the translation and prevent losing the intended meanings and the quotes' context (Lincoln et al., 2016). As I was familiar with the study's local context, language, and scope, I first translated the quotes from Spanish to English. Then, the second researcher checked whether the quotes were grammatically correct and syntactically accurate. Some authors suggest that the best practice is to back-translate the data to ensure agreement of a correct version of the text. However, others argue that there is no single correct translation, but a representation of the participants’ voice and the meaning of the phenomena; therefore, the translated quotes also reflect my own understanding and interpretation of the data (Al-Amer et al., 2014; Temple and Young,

2004). Appendix 17 provides an example of quotes in both languages used in the study findings (Chapter 7).

6.4 Trustworthiness and credibility of the research

Following what Yin (2018) remarks in his latest book “no matter what specific analytic strategy or techniques have been chosen, you must do everything to make sure that your analysis is of the highest quality” (p. 199), I put my best effort to ensure the highest rigour and credibility of this study.

How to ensure quality in qualitative research has been subject to much debate and an increasing number of criteria to assess it. While some authors agree that all research should be considered subjective and therefore judged by the common conventional criteria of validity, generalisability, and reliability, others argue that qualitative research represents a distinctive paradigm that cannot be compared to quantitative research and therefore needs to be assessed with different quality criteria (Mays and Pope, 2006). Lincoln and Guba (1985) suggest that the quality of qualitative research should be rather understood as the trustworthiness of the research. Varied techniques have been suggested in the literature to enhance the validity, credibility and rigour in qualitative research. For example, Patton (1999) proposes that the credibility issue in qualitative inquiry depends on the rigorous techniques and methods used for gathering and analysing the data; the credibility of the researcher; and the philosophical beliefs that informed the methods and analysis. A combination of techniques informed this study to enhance the trustworthiness and credibility of this study. With a rigorous and transparent approach, I provide in this section a reflexive account of my position as a researcher and I present how I used the technique of triangulation from different data sources to corroborate the evidence and find potential disconfirming evidence. I also provided evidence of my rigorous work by presenting a ‘rich’ description of the methods and findings (Cresswell and Poth, 2018; Mays and Pope, 2006; Patton, 1999; Yin, 2018).

6.4.1 Reflexivity

Because the researcher is the main instrument in qualitative inquiry, this chapter needs to include a reflexive consideration of my background and position as a researcher (Patton, 1999). Being reflexive, researchers disclose their understanding of biases, values and experiences that they may have brought to the study, so the reader can understand the researcher's position when judging the research. There are two types,

functional and personal reflexivity (Braun and Clarke, 2013). The functional reflexivity is provided throughout this chapter where I reflect on the methods and approaches that I chose to use and why; yet, at this point, it becomes necessary to layout a more personal reflective account of my position as a researcher, as my experience, beliefs and background may have unconsciously shaped the methodological procedures and interpretations of the study.

This research was carried out by me (M.J.V.), the author of this PhD thesis. I am a young dentist and a future scholar. Before embarking on my PhD, I obtained a dental surgery degree from the University of Andes in Chile, and a masters' degree in public health from the University of York in the United Kingdom. I worked in a dental practice for two years in different clinical settings in Santiago, where I attended patients from varied socioeconomic backgrounds. During this time, I witnessed the poor oral health of children and adults across social strata. I also have previous experience in conducting research. My first research experience was during my undergraduate studies, for which I conducted an observational study to gain my dental degree. My research experience evolved during my master's studies, for which I undertook a scoping review. During my PhD studies, I have had the opportunity to refine my research skills while planning and conducting my doctoral project, and teaching masters-level students and collaborating with other researchers from the Department of Health Sciences at the University of York.

Within the current study context, some preconceptions on the topic due to my academic background and experience in the field may have influenced three main aspects of this research. First, the conception and planning of this study. My knowledge of oral health and the assumption of the limited use of public policies to reduce the burden of oral diseases may have influenced the early stages of this research. For example, my dental background made me initially more inclined to analyse only the oral health implications of the Sugar Tax policy rather than the complete policymaking process. However, my view broadened after discussing with my supervisors and thesis advisory panel members about the study's practicalities, generalizability, and how it would fit within the thesis project.

Second, the data collection. I may have influenced the dynamics of the interviews and the responses of participants given my dental background. For instance, I perceived that the vast majority of participants showed little knowledge of and engagement with the implications of public policies on oral health compared with other

diseases, e.g. obesity and diabetes, during the interviews. This is important to consider, as participants' attitudes and answers could have been different with a researcher from a different background. Nevertheless, I made an effort to avoid putting too much emphasis on the importance of oral health. To ensure that my dental background did not influence the participants' answers, I introduced myself as a research student from the University of York rather than as a dentist. I only went further to disclose my professional background if participants asked, and mostly this happened after the interview. However, given the aim of the study and the questions asked during the interviews, it may have been possible that some participants assumed my background. Another aspect that may have influenced the interviews' dynamics was my expertise or power gap between me as a young female student and participants occupying senior positions, i.e. those working in the government. This hierarchical difference may have shaped our relationship and openness at the time of the interview. Attempting to balance the potential situation of having the participant dominate the interview given his/her power status, I tried to stand as a knowledgeable researcher rather than an inexperienced student. There were a few cases where I felt the interviewee tried to direct too much the conversation. Although I allowed this when the information provided was of interest, I always tried to restore my control over the questions.

Third, the interpretation of findings. I was aware of the potential impact of previous knowledge on oral health and policy analysis on the analytical stage. Although it was not possible to remove all my personal interpretations and assumptions, I tried to remain as neutral as possible during this process. I used varied strategies to avoid subjectivity and ensure an accurate representation of findings, including the involvement of my supervisors and thesis advisory panel in the research process, the use of field notes recorded during the interviews and the analytical process, the rigorous approach to analysis involving an iterative process of checking and rechecking codes, themes and sub-themes, and the assessment of the coding framework with a second researcher.

6.4.2 Triangulation

Triangulation is a strategy that aims to enhance the process of empirical research by using multiple approaches. According to Denzin (1978), there are five forms of triangulation. 'Methodological triangulation' enables researchers to use one or more data collection methods within one or between two or more methodological

approaches. 'Investigator triangulation' in which two or more researchers are involved in the process. 'Data triangulation' in which the researcher uses more than one data source. 'Theory triangulation' that uses two or more theoretical approaches. The last one is the 'multiple triangulation', which combines more than one type described above.

In this study, I used methodological, investigator, and data triangulation. In order to ensure comprehensiveness in the study findings and enhance their accuracy, the analytical process was informed by two thematic analysis approaches (thematic analysis and framework analysis), two researchers coded the interview data, and policy actors from varied sectors were included as participants representing different sources of data, all of which described in detail in section 6.3, where the methods of this study were described. By interviewing policy actors from different sectors, the credibility of the findings was enriched as the diverse points of view of the policymaking process served to corroborate the evidence, but also show some rival explanations which I describe in the findings chapter (Chapter 7).

The data triangulation, however, urges further reflection. I considered data from official documents relevant to complement the stakeholder's accounts of the policymaking process, as these may have been biased by their political views and levels of involvement in the process. However, as I explained in section 6.3.1, rather than undertaking a document analysis, which was very difficult to do given the non-existence or inaccessibility of official documents due to privacy reasons and because it was beyond the scope of this study, I used data from reports publicly available online, and documents shared by the interviewees, as background information for the study, and also in the discussion chapter of this thesis (Chapter 8).

6.4.3 A detailed description of the methods

Providing a clear account of the methods employed, the data collection and data analysis processes is an integral feature of trustworthy and credible research (Gerring, 2017). As Mays and Pope (2006) point out, transparency in qualitative research allows the reader to “judge the evidence upon which conclusions are drawn, taking account of the way that the evidence was gathered and analysed” (p. 88). For this purpose, I described the processes I undertook in detail throughout this chapter providing evidence of the research quality and credibility. These included using a stratified purposive sample, using data saturation to determine the sample size, and the level of abstraction and interpretation achieved in the analytical process. I also included interview quotations in the findings (Chapter 7) to provide sufficient information for the

reader to judge whether the procedures I used were adequate and the interpretations were accurate and supported by the data collected. See Appendices 13-16 as evidence for the analytical process and the development of themes and sub-themes.

6.5 Ethical considerations

Given this study's political sensitivity, due to the type of participants involved and the topic explored, I carefully undertook this study considering ethics standards. Ethics were an integral component throughout the study and were particularly relevant in five areas described below.

6.5.1 Informed consent

Before asking the participants to sign the informed consent form (Appendix 8), I explained again the purpose of the study and although it was sent in advance via email, I handed out a printed copy of the information sheet to ensure that they fully understood the data collection process and the use of the data to make an informed choice. Although it was explicitly written in the form, I still explained to participants that they were free to stop the interview and withdraw from the study at any time during the interview, and until four weeks after the interview. I also reassured the data confidentiality and anonymity at this point, and I allowed participants to ask further questions about their involvement in the study. I asked participants to sign two copies of the consent form; one for me and one for them, for both to keep a record of voluntary agreement of participation.

6.5.2 Confidentiality and anonymity

At the beginning of each interview, I reassured participants that the data provided would be held in confidence and that their identity would be kept anonymised in any report or published material.

Due to this study's nature, I was cautious about maintaining the confidentiality of participants' data and keeping their anonymity at all times. This is particularly important in studies where a limited group of people are able to provide the necessary information given their key roles or level of involvement in the policy process (Lancaster, 2017). However, maintaining participants' confidentiality and anonymity was challenging for some participants during the data collection due to close relationships between them. Many knew each other, and some were highly interested in knowing about others' participation in the study. In order to protect their identity, I

often gave ambiguous answers to questions or assumptions about others. Also, as I used a snowballing sampling approach, it is essential to note that at some point, some would be able to recognise particular 'voices' by others in the field. As Vainio (2013) suggests, all identifying information that was not relevant to the study aim was excluded when describing the sample to prevent participants' potential identification. I removed data related to their age, gender, name, role, and work affiliation from the outputs of this study to protect participants' anonymity. I assigned an I.D. code to each participant to classify them by stakeholder sector: government, academia, beverage industry, and non-government organisation. I also carefully selected the quotations presented in the study findings (Chapter 7) to ensure participants were not identifiable from their narrative about the policy process.

6.5.3 Data protection and record-keeping

Every stage of this study complied with the requirements of the Data Protection Act 2018 (Great Britain, 2018) and the Department of Health Sciences' data management policies for data confidentiality. I destroyed the audio recordings after transcribing them. Transcripts had no identifiable information apart from the I.D. code. I kept a document linking the I.D. code with the participant's name in a separate and secured location at the university together with their signed consent forms. All electronic data were secured in password-protected computers. I stored all paper-based and backup data copies created to prevent any potential loss of information in locked cabinets at the University of York. Only me and the supervision team had access to the data.

I will store all data for three years post-PhD thesis submission in a password secured network as stated in the consent form. This will allow me to access the original data if the thesis requires corrections after submitting and if further analysis is necessary for scientific publications. After this period, I will destroy the stored data.

6.5.4 Anticipated risks for participants

Although I tried as much as possible to prevent potential adverse consequences to participants, these need some reflection. Potential harms may happen if the participants' identity is not appropriately secured or if other stakeholders in the field identify the participants 'voice' in the report. These harms may include possible repercussions in their job due to criticisms towards their organisation or other policymakers with public recognition or revealing sensitive information concerning their organisation (Gubrium and Holstein, 2001). For these reasons, I carefully followed the

principles of anonymity, confidentiality, and data protection to avoid non-desirable repercussions.

6.5.5 Researcher safety

Since I began the planning of my fieldwork, I discussed the potential risks that I could encounter by doing the data collection on my own with my supervision team. In order to safeguard my own safety, I followed a set of recommendations that they gave me and also that I found in the literature to avoid potential risks (Williamson and Burns, 2014). First, I scheduled the interviews as early in the mornings as possible and always within office hours and in daylight. Second, I checked out the location of the meeting in advance to familiarise myself with the surroundings. Third, I ensured my personal mobile phone was in good working conditions and fully charged in case I needed to make an emergency call. Fourth, I carried the minimum equipment necessary for the interview. Fifth, I made sure my family had the full details of the location and time of each meeting. Sixth, when I had meetings in risky locations, I asked someone to come with me. Seventh, I called a family member when the meetings had started and finished. Lastly, I made an effort to organise the meetings in public places whenever possible. Fortunately, I did not encounter any threats to my safety during the fieldwork.

6.5.6 Ethical approval

The study was approved on 6th October 2017 by the Research Governance Committee (HSRGC) of the Department of Health Sciences at the University of York without amendments (see Appendix 18 for the approval letter). One recommendation was provided, however, concerning the need for seeking an in-country ethics committee approval. To ensure that I did not need further ethics approval, I got a letter from the Latin American School of Social Sciences (FLACSO-Chile[8]) confirming that the project met the local ethics governance requirements and that the research did not need to pass through another ethics committee (see Appendix 19).

[8] FLACSO-Chile is an inter-governmental organisation for Latin America and the Caribbean dedicated to research and teaching social sciences. It has offices in most countries in the Americas.

6.6 Chapter summary

In this chapter, I described the methodological approach and methods I used in this study to understand the complex and multifactorial phenomenon of the Sugar Tax policymaking process and its implications on oral health. I justified why I considered the qualitative case study method as the most appropriate approach for this study's purpose. I used semi-structured interviewing to collect data and reach a sufficient depth and contextual understating of the policy process. I included four groups of policy actors to gain a complete account of the phenomena. I followed a thematic analysis approach and also borrowed the last stage of the framework approach for the analytical process. I provided details of the strategies I used to enhance this study's trustworthiness and credibility, such as reflexivity and triangulation. And I set out the study ethical considerations.

In the following chapter I describe the findings of this study. I provide a written representation of the data analysis, which is evidenced with quotations from the interviews. I present the findings by the main themes and sub-themes, and I explore the relationships between sub-themes.

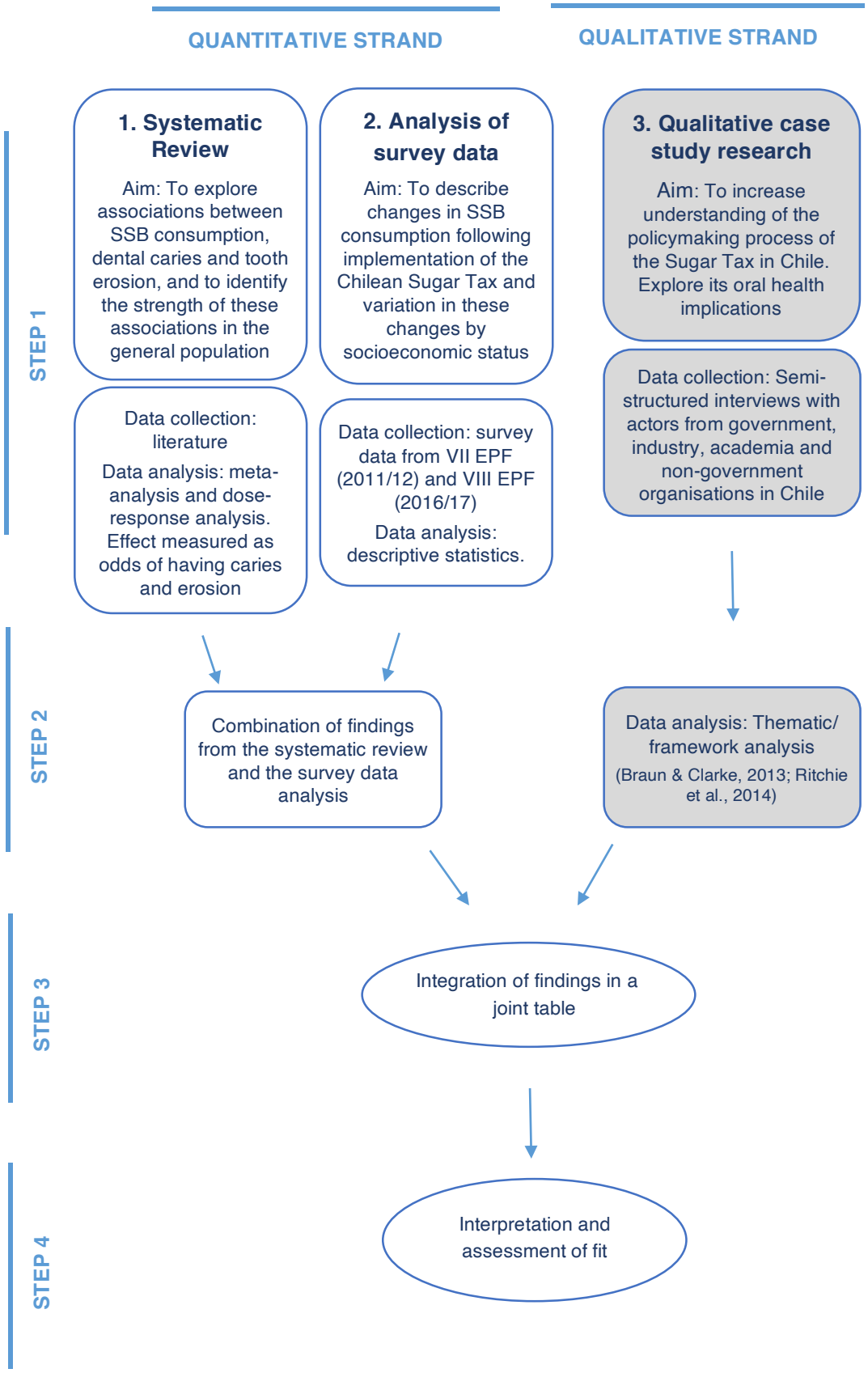
Chapter 7

The Policymaking of Chile's Sugar Tax: a qualitative study

The Findings

After describing the study methods and methodology, I present in this chapter the findings of the qualitative case study (Figure 32). I begin with a brief description of how the construction of the final themes and sub-themes evolved and I follow with the findings providing quotes to evidence the origin of the data interpretations.

Figure 32. Convergent mixed methods thesis diagram



7.1 Characteristics of the included participants

I recruited twenty-three policy actors to the study (Table 36). Eleven were from the government sector, of whom four were elected officials or worked in another senior-level position in the senate or a ministry; and seven were appointed officials, such as analysts. The inclusion of assessors proved fruitful. They were more open during the interviews, had more time to meet, and were more prone to share other potential participants' contact than other policy actors in higher government positions.

I recruited six participants from the academic sector. The majority worked full-time in different university' research centres in public health, medicine and economics. All of them contributed to the policymaking process by supporting government officials with health-related evidence to approve Congress's policy, writing reports for the Ministry of Finance or disseminating the policy within the academic world.

I also recruited three stakeholders from non-governmental organisations and three from the beverage industry.

Table 36. Sample overview

Stakeholder sectors	**Total**	**Policy actors**	**Number of participants**
Government	11	Elected officials	8
		Appointed officials	3
Academia	6	Public universities	3
		Private universities	3
Non-governmental organisations	3	N.G.O.	2
		Independent societies	1
Beverage industry	3		3
		Total participants	**23**

While I undertook most interviews at the participant’s workplace or cafés, one interview took place at the participant’s house. Interviews lasted on average around 40 minutes, in which the shortest was 18 minutes and the longest 68 minutes.

7.2 Final edits to the constructed themes

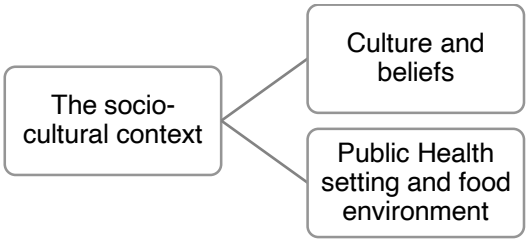
Following the analytical stages described in the previous chapter, I identified four themes and sixteen sub-themes from the data (Table 37). It is important to highlight that although I took an inductive approach for the construction of themes and sub-themes, they were influenced by the policymaking cycle that informed part of the topic guide (Howlett and Giest, 2013), my experience and knowledge of the field and the objectives of the study, which included the implications of oral health.

Before deciding on the final set of themes and sub-themes, each theme had a specific sub-theme for the data related to oral health. However, after discussing it with my supervision team, I decided to merge the oral health data with all themes and sub-themes. The rationale for this was that I would provide a more comprehensive account of oral health implications within each theme.

Table 37. Overview of themes and sub-themes

Themes	Sub-themes
1. The socio-cultural context	Culture and beliefs
	Public Health setting and food environment
2. The policymaking of the Sugar Tax	Defining the agenda
	Policy formulation
	Policy negotiations
	Implementation and evaluation
3. The power of industry	The power of lobbies
	Positive response
	Perverse and powerful strategies
4. Good policy, not enough	Public Health potential
	Policy re-design
	Political will
	Other strategies

7.3 Theme 1: The Socio-Cultural Context



Participants identified the socio-cultural context as an important determinant for sugar-sweetened beverages (SSB) consumption and the Sugar Tax's effectiveness in Chile. This theme explores participants' perceptions on how cultural practices, myths and beliefs, and the public health setting and food and drink environment may be shaping people's behaviours.

7.3.1 Culture and beliefs

The majority of participants expressed concerns about the close relationship between SSB consumption and Chile's socio and cultural practices. They said that SSB were entrenched in the culture to the point that it was impossible to talk about one without considering the other. Many factors were identified to exemplify this relationship. First, participants described SSB as an essential part of people's lives as a way of celebration and self-reward. They believed that it had become the norm to have SSB as the principal non-alcoholic beverage in social events, either big parties or small gatherings.

> *"In cultures like ours, where the consumption of sugary drinks is so deeply rooted as a cultural practice, not only to quench thirst but also as a cultural practice of coexistence, for parties, for a family reunion, for indulgence. […] because it's the Chilean culture, you're invited to a house in a vulnerable situation, and it is a regular Coke, or regular Fanta, or regular Sprite. It's part of the culture, the Chilean indulgence. I mean if I want to make a good impression and receive you properly [...]." (ORG_003)*

Participants believed that the happiness and satisfaction feelings after drinking SSB was another factor influencing people's consumption. The preference for a moment of indulgence was seen to be more important than any potential health consequence, as

an academia participant described it, “obesity is going to end in diabetes, but people, in general, don’t live thinking about the future, people live thinking about the moment” (ACA_001).

There was a common concern with young children’s increased SSB consumption, which was believed to be part of the Chilean culture.

> *“Before, everyone drank tap water, I mean… when I was a girl, lunchtime was with tap water, and you drank a glass of sugary drink only in the weekend. Nowadays, you can’t find a house in Chile where you open the refrigerator and there isn’t a bottle of sugary drink. Children, despite everything we’ve worked for with recommendations of zero sugar consumption before the first 1000 days of life, you can see them on the street with their bottles filled with Coca-Cola.” (GOV_001)*

There was a common understanding across all sectors that SSB consumption was associated with gender-related values. Participants reported that adult males, mostly construction workers – who were commonly identified as the working-class population - primarily consumed high-sugar beverages. According to several participants, the wider society believes that low-sugar beverages are only for women to keep their figure. One participant explained that men usually make fun of their peers when they are seen drinking low-sugar beverages:

> *“There are groups, for example, adult men over 18 years-old, who don't change because there are myths and tales… many say that low-sugary drinks are associated with women who are on a diet, so when they see a male friend drinking a low-sugar beverage, they bully them. […] If you see, for example, in construction sites, if you go to a supermarket at lunchtime, the construction workers are buying a roast chicken with French fries and a high-sugar beverage, the classic two litres bottle with sugar.” (ACA_001)*

All participants believed that socioeconomic status (SES) was another factor associated with SSB consumption. People from disadvantaged backgrounds were described as being extremely loyal to high-sugar beverages, compared to high SES groups, as one industry participant pointed out:

> *“In the most affluent parts of Santiago, […] people drink Light, Coca-Cola Light. [...] If you go to the outskirt areas […], that guy consumes a lot of sugar, [...] they like Coca-Cola with sugar and that's the only beverage they buy.” (BEV_003)*

At the same time, some participants described that the ability to access and consume SSB, in general, had become linked to a higher social status, partly due to the industry's marketing strategies. As an academic participant explained "the industry's marketing has made this product very aspirational especially for people from low socioeconomic status groups wanting to arise by buying sugary drinks, as a sign of status." (ACA_003). In the past, only high SES groups could afford SSB, as they used to be highly expensive. This generated a desire in people from lower SES groups to access them. Nowadays, being able to purchase and consume SSB instead of water represents having more capital and occupying a higher position on the social ladder:

> *"And also, because the fact of drinking sugary drinks instead of water it's culturally associated with improving your socioeconomic status. These beverages somehow matched people, it's like I went up, I have more money, I can drink sugary drinks." (ACA_001)*

Although participants associated water consumption with lower social status, they also valued water as the best SSB substitute. Many highlighted Chile's unique condition as one of the few Latin American countries where the vast majority of the population had access to drinking water.

> *"It is a privilege to have very high water sanitation coverage and drinking water for the entire population in Chile. […] so that it couldn't be better as a substitute." (ACA_004)*

Likewise, they commented that most areas in the country have fluoridated water, which increases the value of this substitute and also as a dental public health strategy:

> *"we have a wonderful substitute, almost free, which is water. In Chile we have 100% coverage of drinking water and it is fluoridated in the majority of the territory. It protects your teeth." (ORG_003)*

However, the majority of participants believed there were public misconceptions about its quality and taste, as a government participant described it, "there are many myths, that the water in Santiago is bad that has bad taste, about the water plant, about the water pipes, etc." that have driven people to prefer bottled beverages to tap water. However, they also believed that this was most apparent among people with high cultural capital and income, as one participant described it:

"[…] it's something for people with an advanced cultural capital, [...] I teach in a university, where most of the students are women from high social status, who walk around with a little water bottle. I feel that they know that water is healthier. […] I'm not sure if the same thing would happen in a technical class at another university. So, I insist that this is a cultural issue." (ORG_001)

Juices and nectars were also identified as potential substitutes for SSB. However, there was a general wariness of whether these were healthy options or not as some juices and nectars were reported to contain added sugar.

There was a common feeling amongst academia, non-government, and government participants that substituting SSB with water at the individual and population level was going to be a great challenge, as one participant described it, "water consumption is a cultural thing because you can get used to anything but water" (GOV_002), but most participants said that this substitution was necessary. The role of culture was perceived as such an important factor in shaping SSB consumption that participants felt that cultural change was the only way to increase water consumption effectively. Several strategies were suggested, which are analysed in Theme 4.

7.3.2 Public Health setting and food environment

The obesity epidemic, current SSB consumption trends, industry-led marketing and the government agenda were highlighted as important features shaping the local environment and the cultural SSB consumption in Chile.

Participants reported a significant shift in the public health environment over the past twenty years. As many participants described, in the past Chile had an undernutrition problem, for which the government put together a series of programmes to increase people's weight and overall health. However, participants explained that these efforts had been ineffective and nowadays, a large proportion of the population is obese or overweight:

"Chile comes from years of malnutrition [...], and today the problem is obesity. […] This is typical in societies where people increase their income. They have a higher level of well-being and zero culture." (ACA_002)

There was a common belief that obesity was the most urgent public health problem in Chile rather than any other SSB related health condition such as oral health. As one

participant pointed out, “It's mainly sugar, and because of sugar, there is obesity, and diabetes and insulin shock.” (GOV_008).

According to participants, because of the obesity epidemic, policymakers had redirected their efforts and resources into three major public health regulations: Sugar Tax, Labelling Policy, and Marketing Regulation Law. However, although these policies and other programmes had been implemented in Chile, participants believed that SSB consumption was persistently and disproportionally high. They believed that SSB was one of the primary sources of sugar in the Chilean diet, and one of the highest in the Latin American region. Participants from industry seemed to agree with this observation; however, they perceived the high consumption levels as a positive feature of Chile’s market:

> *“In Chile, the sugary drinks industry is super matured. Per capita consumption is the best in the world. In Chile, we consume more carbonated beverages than any other country. On average, so that you can have an idea, […] we consume 400cc of Coca-Cola drinks a day.” (BEV_001)*

All other participants (those from government, academia and non-government organisations) blamed the food and drink industry for the obesity epidemiological situation in Chile. They said that the industry had manipulated the food environment in terms of access, advertising and availability to the extent that it encourages people to consume more and more SSB:

> *“[...] This is basic economics: price, marketing and physical availability. The price is low, the marketing is extraordinary, and the physical availability is impressive.” (ACA_003)*

Further views about the industry strategies to promote their products are presented in Theme 3 (section 7.5.3).

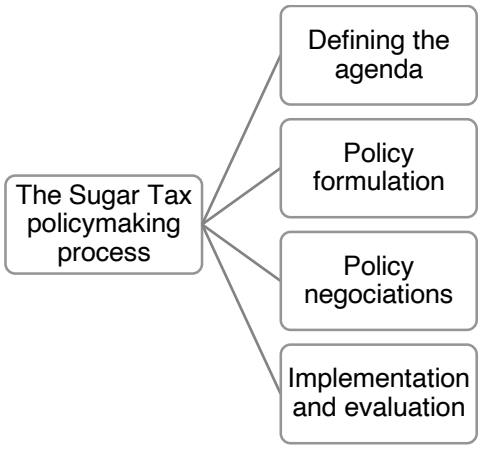
7.3.3 Theme summary

This theme describes participants’ perceptions about cultural factors influencing whether the Sugar Tax reduces SSB consumption. It also explores how SSB consumption was believed to be central to cultural practices in Chile. SSB consumption was perceived to be essential for indulgence, happiness and linked to identity and status within society, regardless of its potential health effects. Perhaps the most salient representation mentioned in the interviews was the association between higher SES

and the ability to afford SSB. Tap water was identified as a valuable substitute; however, there was a common understanding that public misconceptions about its taste and quality might be undermining its consumption.

The environment was another perceived factor that may shape SSB consumption. From malnutrition problems to the beverage industry’s interests driving the population against the health authorities' efforts to reduce SSB consumption. It is important to note that as participants talked about public health priorities and SSB consumption, oral health was not proactively discussed. Despite the study's scope to explore oral health implications, obesity was raised as the primary disease linked to SSB consumption.

7.4 Theme 2: The Sugar Tax Policymaking Process



This theme covers the circumstances and events that led to the Sugar Tax policy design in Chile. It presents the stages of the policymaking process and some features of its implementation. It reveals how participants believed the policy had little priority in the broader design and formulation of the Tax Reform (TR – explained in detail in Chapter 2, section 2.6.2). It unveils limited awareness about the Sugar Tax existence among different actors and the general public. It describes how two contradictory aims were used in its design and how oral health was unlikely to have been considered in its conception. It starts with the agenda-setting, follows with the policy formulation and political negotiations in Congress, and concludes with the policy implementation and impact evaluation. The construction of this theme was informed by the policy cycle theory described in Chapter 6, sections 6.3.3 - 6.3.4.

7.4.1 Defining the agenda

Participants identified a series of circumstances that shaped the agenda for implementing the Sugar Tax: a new administration was taking office, students were demanding free education, and a new obesity epidemic was rapidly becoming a public health crisis. Participants commented that President Michelle Bachelet (2014-2018) promised several new regulations to gain public support and win the elections during her presidential campaign. Bachelet's government proposed reforming the educational system to provide free education to students, who were demonstrating in the country. She also suggested reforming the tax system by introducing new taxes to increase the total GDP by 3% to collect the necessary funds to fulfil her promises.

There were contradictory views of the appropriateness of this reform among participants. While some thought that the introduction of the Tax Reform was a good idea to raise treasury funds, others were sceptical. The following quote captures the messiness, iterative and negotiated process that led to the final policy:

> *"The Tax Reform was a scary thing, but in its form, [...] in the way it was designed. Because it changed so many times that it ended up being an invention [...] it ended up as a bizarre thing." (GOV_002)*

Many participants explained that the Sugar Tax was one of the many taxes proposed in the Tax Reform. They identified many factors that they believed might have influenced the decision to consider taxing SSB. First, government participants explained that the Sugar Tax idea appeared after reading alcohol tax documents, which they wanted to increase. Without knowing, they discovered that non-alcoholic beverages were already taxed under the same Law:

> *"[…] To my surprise, when I looked at the [alcohol] Law [...] in letter A, the non-alcoholic drinks were taxed, natural or artificial, energising, hypertonic, syrups in general. So, I insist, I don't know if it was to get the equation straight, or we said, wouldn't it be a good idea to add it, raise taxes on Coca-Cola? I'm talking about that level of conversation. Hey, I didn't think about it. So the first idea was thrown […] and probably we discussed it for a bit, and we said, hey it would be a good sign to create a tax on drinks with high sugar content." (GOV_009)*

Second, government and academia participants commented that the Sugar Tax was considered for inclusion in the Tax Reform as they believed that those who drafted this reform were afraid of the lobby against the alcohol tax. According to them, they thought that it was going to be so intense that by introducing a Sugar Tax increase, they would balance the numbers if the alcohol tax was rejected or kept low:

> *"What happened was that there was a powerful lobby from the alcohol industry […] and because those resources were not available and we needed them for the reform, we introduced the tobacco tax and I wouldn't be surprised if we also added the sugary drinks." (ACA_006)*

Third, many participants believed that policymakers thought it was more politically acceptable for the TR's approval to introduce several small taxes instead of just a few and big taxes. The Sugar Tax, therefore, was just another item "in the equation […] to

balance the [RT] budget" (GOV_009), as one participant described it. They also felt that it was easier to modify an existing tax, rather than introduce new ones.

Lastly, the vast majority of participants commented that those who drafted the policy might have thought that introducing corrective taxes would have helped the TR get better political acceptability. As one government participant described it "it's true, that these taxes help raise revenue. […] also that they were corrective taxes, but on the other, they were framed within a much larger reform." (GOV_008). Government and academia participants explained that five correctives taxes were included in the reform: alcohol tax, tobacco tax, green taxes, which include taxes on stationary sources emitting certain pollutants and vehicles performance concerning pollutants, and the SSB tax, also known as the 'Sugar Tax'. All these were perceived by the academia and non-government participants as effective to correct negative externalities; however, within the TR context, the ultimate aim was to collect revenue. This 'aim paradox' is described further below in this theme. According to some participants, lawmakers were looking for support from a specific group of parliamentarians who were known for being particularly interested in supporting health policies, as one government participant commented "Specifically for the sugar tax… I think it was evaluated as it would bring in influential votes. […] so it was a way to have support." (GOV_004).

7.4.2 Policy formulation

Participants who were involved in the early stages of the policy formulation, explained that the Sugar Tax was designed and drafted during Michelle Bachelet's presidential campaign, and that this process was done behind closed doors without intervention from experts. They said that given the aim of the TR to collect revenue rather than to reduce SSB consumption, and the context of a wider reform in which the policy was formulated, there was no time nor the resources to consult the evidence:

> *"I think that when we presented the project because this was handled under seven keys[9], […] we started working almost without permission from the future minister with the internal tax team because we wouldn't have got it on time. […] Nobody got involved when we prepared the bill draft. In this nobody. I mean, there were no experts there. So, everything was kind of intuitive, without much evidence. This idea comes out, an original idea in the right line, that could generate support from the health world [...] there was*

[9] An analagous expression in English would be 'kept under lock and key'.

some validation from a foreign experience like Mexico, and probably had something to do with increasing the revenue a little or not to increase the tax too much on alcohol, that is the summary." (GOV_009)

Participants who were not directly involved felt similarly. They believed, based on its characteristics, that the policy's original design was the result of internal negotiations rather than informed by evidence:

"It was all arbitrarily [...] It doesn't have any evidence, to have it increased to 18, why not to 30? That was absolutely subjective [...] The [Sugar] tax is a show, we have to do it properly. This policy is based on nothing." (GOV_007)

Some academia, government and non-government participants with a public health background felt that beyond the political context in which the Sugar Tax was being formulated, the lack of consulting the evidence was due to the scarce international data available to support the design of this policy. Participants highlighted the experience of Mexico with their SSB tax. However, as one participant said, "now there may be more evidence, but at that time, there were no studies. Mexico had just implemented its tax" (GOV_008). They also discussed the recommendations published by the World Health Organisation supporting the use of fiscal policies in the battle against obesity but commented that the document lacked robust evidence about elasticity, effectiveness to reduce SSB consumption and implementation. Thus, there was a general feeling that policymakers were just looking for political and industry acceptance rather than a significant impact on health.

The vast majority of participants emphasised the importance of considering the evidence in the formulation of effective policies. One appointed official was particularly concerned with the lack of it. He pointed out:

"Just in these cases that policies are rather innovative, sufficient evidence is needed to support them. […] having political support, progress can be made, but progress can also be made when there is scientific support. [...] We need a mechanism so that this really comes together and that academic activity really contributes to the development of states and countries." (GOV_005)

Some participants compared the Sugar Tax formulation process with the Labelling Policy. They explained that unlike the Sugar Tax, the Labelling Policy was conceived from a public health perspective. A thorough analysis of the relevant evidence and a

stage of citizen consultation were included. There was a general agreement among participants that including the opinion of the general public is a good practice in the formulation of policies, which they perceived essential to have a more significant impact, increase adherence and change behaviours:

> *"Public policy is successful when it has incorporated citizen participation as a central actor. [...] because it generates a culture change. [...] Why was the sign of the labelling policy so effective? Because it was a citizen's decision." (GOV_010)*

Many participants, particularly from academia, government and non-government organisations, believed that the Ministry of Health (MoH) was absent during the Sugar Tax formulation process. Some participants believed that this was because the MoH and public health officials were preoccupied with the Labelling Policy and the Marketing Regulation Law, which were both under Congress debate during the design of the TR:

> *"I believe that it [the Sugar Tax] was diluted in the reform, which was complex and it was also diluted in the discussion of the labelling policy, the marketing regulation and school sales restriction. In other words, there were bigger policies that people were worried about." (GOV_003)*

However, some government participants believed that the MoH and the oral health department were absent because they did not have the chance to participate in this process as they were not approached nor consulted to contribute:

> *"I have the feeling that the Ministry of Health did not impose this. Going back to the labelling policy that the Ministry of Health proposed. They worked since the beginning […] even consulting citizens throughout the country to design the label. […] So, I don't really know how this occurred, which was the process to include it [the Sugar Tax]." (GOV_001)*

Controversial features were identified during the interviews regarding the Sugar Tax design. First, some participants believed that the Sugar Tax was designed to be applied to the industry rather than consumers. While some, especially those interested in the policy's potential health effects, commented that this was a mistake and that the tax should have been applied directly onto consumers, others thought that this was the best way to apply taxes:

"To the producer. It is the most efficient way to do it. Usually, these taxes are applied to the producer […]. What the tax authority wants is to collect as much as possible, at the lowest cost. So, it's much easier to charge it to the producers that are just a few, rather than to consumers at sales points who are thousands." (ACA_006)

Second, the inability to earmark the policy's revenue. Some explained that, by Constitutional Law, all tax revenues go into a joint coffin. Some academia and non-government participants believed this was a considerable weakness of the Chilean system stressing that the revenue generated by these type of policies should be used to cover the cost that, in this case, SSB consumption impose to the society. As one participant pointed out: "[…] So, nothing makes sure that in the end, these funds will benefit the health of those affected for the damage caused. So, the negative externalities generated by this product are not directly compensated." (ACA_003)

7.4.3 Policy negotiation

The vast majority of participants believed that the actual negotiation to approve the Sugar Tax began after the TR bill was presented to Congress. They commented that this action was rushed through to prevent further rejections as one participant described it, "The TR entered straightaway to Congress, so they didn't even have time to see the proposal." (GOV_008)

Participants identified many actors who participated in the negotiation process of the Sugar Tax. Governmental actors included policymakers from the Ministries of Finance (MoF), Economy (MoE) and Health (MoH), senators and deputies from Congress. Participants also commented that non-governmental actors were represented mainly by the industry and to a lesser extent by the academia, civil society, and NGO's. Participants reported that all these actors had diverse positions towards the Sugar Tax. Participants described as primary opponents the industry, represented by AB Chile - a gremial entity - some parliamentarians who were against the TR given their party's position, and according to a few, the MoE, as it was ensuring the welfare of big corporations in the country.

Participants described that whilst the main argument that supporters put forward was that the policy would help to reduce SSB consumption, and thus the prevalence of many NCD, many arguments were used against the taxes of the TR by the opposition. The Sugar Tax was claimed to be a nanny state policy, which would interfere with

personal choices. Participants from academia commented that the industry representatives argued that this policy was “not effective and that it was regressive as they said that this would affect most likely those with low socioeconomic status.” (ACA_005). However, participants from government and non-government organisations explained that the Sugar Tax, in particular, cannot be considered regressive, as one participant described it, “From an economic point of view, this tax could be regressive, right? […] but the truth is that we have a wonderful alternative substitute that is almost free, which is water.” (ORG_003)

On the other hand, all participants commented that the main supporters during the Sugar Tax negotiations were Congress representatives led by Senator Guido Girardi, a politician and advocate of health bills. He was highlighted in almost all the interviews:

> *“The figure of this guy was so powerful, I’m referring to Guido Girardi, that there was no other figure. If you ask me, for example, I have no idea who the Minister of Health was at that time.” (BEV_001)*

There was a common belief that academics and civil groups did not participate in the negotiation process, as one participant described it:

> *“I don't remember having heard of any organisation that wanted to speak out to say, look we represent who knows who and we are very worried that Congress hasn’t approved the tax increase and that it should also be higher.” (GOV_006)*

The MoH was another missing actor identified. The majority of participants believed that health officials were called to participate mainly to give arguments favouring the policy to gain more supporters. However, some participants, mainly from academia, thought that despite this little contribution, the MoH somehow missed the opportunity to significantly influence the debate:

> *“Later, the Ministry of Health appears linking itself to the debate. […] But when the discussion regarding how much was going to increase, or if it was going to increase or not, the decision was already taken by other stronger powers within the executive.” (ACA_005)*

On the other hand, one participant from government argued that the MoH tried to be more involved in the formulation and negotiation stages but they only managed to influence the non-alcoholic beverage definition in the legal document of the policy:

"So, we didn't have many options. It's like the Ministry of Finance it has said hey, why the Ministry of Health is fighting when they should be grateful that we put a tax on sugary drinks. That was my feeling, my perception, nobody told me that phrase of course, but it was my perception, it was like I was knocking on the door and nobody was answering on the other side."
(GOV_003)

The vast majority of participants believed that during Congress debate, some parliamentarians claimed that the proposed tax "at 5% was not enough" (GOV_005). However, as some government participants commented, a higher tax was politically impossible. After long debate, participants explained that some parliamentarians presented two conditions to support the Sugar Tax: to create a gap between high and low-sugar beverages and to assemble a commission of experts to analyse different tax alternatives.

As participants commented, the first condition considered creating a differential tax between high-sugar and low-sugar beverages to encourage people to shift their preferences to healthier options and reduce the level of sugar consumption. In consequence, parliamentarians and the executive agreed to keep the proposed 18% tax only on beverages high in sugar content and reduce it to 10% otherwise, hoping for an 8% tax gap which was somehow "closer to the maximum expected that it was around 20%." (GOV_005)

However, several participants, mostly from academia and non-government organisations, expressed disagreement with this two-tiered design. They felt that by lowering the tax of low-sugar beverages, consumers would shift consumption from high- to low-sugar beverages arguing that "the opportunity to create a clear incentive towards water consumption as a substitute rather than low-sugar beverages was lost." (ACA_005)

There was a common lack of awareness of how the policy's threshold was decided. At the same time there was consensus in the belief that it was done arbitrarily and there was no robust evidence on the best threshold to categorise the sugar content in products. However, few participants from the government sector explained that this threshold was based on another policy because, as one pointed out, "[...] you can't establish random parameters in a regulation, you have to establish them from the law" (GOV_009). They commented that while the negotiations to divide the Sugar Tax into two taxes was in progress, the Labelling Policy Bill was closed to be approved by

Congress and its initial design included this threshold to categorise products with the "HIGH IN" label or not.

The second condition to approve the Sugar Tax that participants reported was creating a commission of experts to study the evidence about the effectiveness of the Sugar Tax to reduce SSB consumption. Participants continued describing that a second commission was assembled with academics, which after a year concluded that taxing sugars present in foods was a feasible strategy. Yet, more research was needed to identify the best rate and application mode.

Many factors were believed to have influenced the debate in Congress during the Sugar Tax negotiations. First, the political context concerning the MoH's focus on the Labelling Policy and the Marketing Regulation Law instead of the Sugar Tax, as their debate "was very complex, and it occurred at the same time of the Tax Reform debate, so everyone in the business sector was moody." (GOV_008) Second, many participants mentioned the industry Lobby, which is explored further in Theme 3. Third, government participants, commented that partisan politics also influenced the negotiation process. Some said that whether to support the Sugar Tax or not was not defined by the policy value, but rather the party's position on the issue and whether supporting this reform would reflect well with their constituency. Participants from and outside government explained that the TR debate was negotiated behind closed doors in what it was called "The Kitchen, that is when issues that can't be solved with a public discussion, the heads of each party meet in the kitchen, where they put together the 'cake' ingredients. Because as there was no agreement of what ingredients they needed, then three or four people got together and agreed on them." (GOV_002) Fourth, all participants, regardless of sector, believed that the Sugar Tax debate was also shaped by the little priority given compared to other taxes within the TR. Three reasons were described in the interviews for this: because the policy's tax increase was perceived to be too small compared to other taxes; because it was perceived as ineffective to generate revenue unlike other taxes; and because other regulations were considered more effective to tackle the obesity problem:

> *"This was a major reform. This [the Sugar Tax] was like the tail's hair within the process for the government. I mean, the tax on sugary drinks was nothing; it was not even one of the most important ones in terms of revenue collection." (ACA_005)*

Fifth, the absence of the civil society in the debate was another factor identified by participants. They believed this may have been due to the low priority given to the Sugar Tax in the TR, as one participant described it, “At least as an informed citizen, although its importance, it was not a matter of national debate.” (ORG_003). Some participants commented that if more debate had occurred in civil society, the policy would be higher. One government participant believed that “Having mixed it [the Sugar Tax] with everything; I think it was something complex. [...] for sugary drinks, as it is a public health policy, where what you want is to change behaviour […] If you ask me now, this corrective tax with a health point of view would have been better to have done it separately.” (GOV_008).

Lastly, the rationale for introducing the policy. Participants believed that the Sugar Tax was presented as one of the many items of the TR, which aim was to collect revenue. However, as the MoH began to argue about the value of this policy to reduce SSB consumption, the ‘aim paradox’ became the centre of the debate. All participants agreed that, unfortunately, although the Sugar Tax potential as a public health strategy, this policy was designed to generate revenue. Government participants, in particular, believed that these two aims were clashing and should not be used simultaneously considered in the design of Sugar Tax policies:

> *“The reform also had this dual issue, on the one hand, to raise revenue and on the other hand to attack certain goods such as this [sugary drinks] [...]. So it's complicated when you argue when you have two objectives that seem to be contradictory.” (GOV_004)*

There was a general impression that oral health did not weigh in the formulation nor the Sugar Tax negotiations. One government participant explained that, generally, oral health is not a solid argument to push policies forward in politics, unlike obesity:

> *“[...] they don’t raise political votes. But they create a niche pressure. Probably, for a few parliamentarians, this made much sense, but the political pressure is completely proportional to your ability to mobilise voters. […] Cavities are not going to do the political trick, despite their social value, and high costs…” (GOV_004)*

7.4.4 Implementation and evaluation

As all participants reported, the Sugar Tax was approved in 2014 and implemented in October of the same year. The Sugar Tax's final design comprised an 18% tax on SSB

with more than 6.25 gr/100 ml and 10% tax on SSB with less than that amount of sugar.

The majority of participants commented about the absence of a communicational campaign alongside implementing the Sugar Tax, which was believed to be due to its fiscal objective. As one participant pointed out:

> *"How is the State going to make a campaign when what it really wants is to generate more money? They want people to consume more sugary drinks to generate more resources." (GOV_010)*

Another participant from the government sector explained that the resources were scarce and the tax increase was insignificant to relocate resources from government to such media deployment as "they are super expensive, and funds and resources are not available for this type of topics." (GOV_005) Consequently, participants commented that only those involved in the policymaking process were aware of the Sugar Tax's existence. Even among the study participants there was mixed awareness about the policy as one of them commented with a surprise "Wait, is this something that's already done? I didn't know […] I had no idea that it had become effective for sugary drinks." (ORG_001)

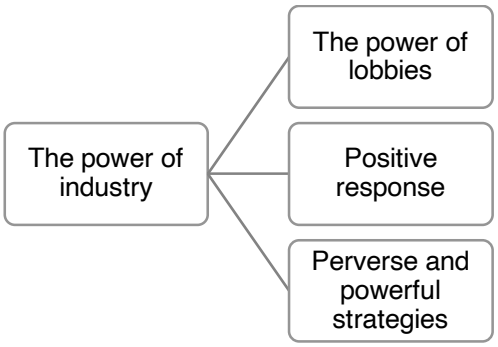
Most participants believed there was a lack of evaluation and expressed concerns about this as one participant explained "I insist, we didn't have baseline data, we put all our efforts into creating baseline data for the other taxes that were larger […] But, the sugary drinks tax was more like a pilot." (GOV_008). However, another government participant believed there was indeed one ongoing study.

7.4.5 Theme summary

This theme presented the participants' views about the Sugar Tax policymaking process. A series of circumstances were believed to have shaped the process, including the change of government and the introduction of the Tax Reform and other health policies. Participants described how they believed the Sugar Tax was put onto the government agenda and explained different aspects about the formulation, negotiation and implementation stages. The fact that the Sugar Tax was part of a wider Tax Reform, which had the aim of collecting revenue, was believed to have impacted the policy's public health potential. There was a common understanding about the incompatibility between the fiscal aim of the Tax Reform and the health aim of the Sugar Tax to reduce SSB consumption effectively. The non-use of evidence in the

design of the policy, the closed doors negotiations, the low participation of the Ministry of Health in the design and Congress debate, and the absence of citizen consultation and communicational campaign were outlined as key factors that made the Sugar Tax have a low priority within the Tax Reform and the final two-tiered design. The policy formulation process lacked any serious consideration of health and most importantly of oral health, and while health officials were more involved in a later stage during the negotiation process, there was limited scope for change.

7.5 Theme 3: The Power of Industry



This theme explores the SSB industry's influential role as perceived by participants during Chile's Sugar Tax policymaking process. Participants described varied strategies that the industry employed during and after the policy's implementation, lobbying tactics and leading negotiations in Congress, manipulating the drinks market and environment, and influencing people's purchasing behaviours.

7.5.1 The power of lobbies

All participants identified the industry as a significant player during the Sugar Tax policymaking process and described various strategies they believed industry actors employed. The most commonly identified tactic that the industry used to influence the Sugar Tax was lobbying. All participants but those from the industry sector believed that the tax's two-tiered characteristic was in part a consequence of "declared lobbies and undeclared lobbies. […] and direct or indirect pressures that they exerted on parliamentarians." (GOV_006)

Industry participants were quite reluctant to talk about their company's lobby tactics, as one participant described it, "we're cautious about what we say and what we do." (BEV_001). They believed that the industry was more interested in influencing the 6.25gr/100ml threshold of the policy, rather than the tax increase percentage. According to them, the industry was against a low threshold, which would have affected their products significantly, as one participant explained: "The main consumption driver is not wellness, it's taste" (BEV_002). Another industry participant illustrated the importance of taste in their sales with a particular beverage type:

"Due to flavour… with Stevia. Well, it was terrible. We sold it for a while. […] We don't sell it anymore. [...] it wasn't well-received by the consumers." (BEV_001)

The most commonly identified arguments that the industry used to lobby against the Sugar Tax were ineffectiveness in preventing obesity and the lack of supporting evidence, the regressive and nanny-state aspects of the policy, the negative impact on small businesses, which would result in job losses and economic harm:

"They had an important point: the amount of sugar in a litre of sugary drink can be lesser than in a caramel. So at the end of the day, what happens with any corporation, this is not about good or bad, is just about defending their companies." (GOV_004)

There were some contradictory opinions about the strength of the industry lobby. Some participants from academia, government and non-government organisations commented about the powerful aspect of the industry lobby, as one participant described it: "The intensity of the pressure didn't change because the regulation was small." (GOV_006). However, others from the same sectors said that the lobby was weaker compared to the other taxes in the TR, as the Sugar Tax "was part of a much larger Tax Reform. Number two, because sugary drinks were already taxed. Number three, because the same sugary drinks producers also produce low-sugar beverages, and therefore it's true that some of their products were going to increase, and for others it was going to decrease." (GOV_003) An industry participant believed that the industry was more concerned with lobbying the Labelling policy than the Sugar Tax, as "what did the industry fear? *They're going to screw us up later*, which makes a lot of sense. The label was going to be a way to put a tax to discourage this public health problem. [...] And what may happen, they're already analysing it, *you know sir, you have labels, and the label is bad, lots of externalities for the healthcare system, a lot of externalities for the workforce, so we have to put a specific tax per gram of sugar.*" (BEV_002)

7.5.2 Positive response

Most participants believed that the Sugar Tax had positively nudged the industry to reformulate products. However, some participants had mixed feelings about this, raising concerns with the use of artificial sweeteners and future regulations on their use as then the industry will not have any more substitutes.

Many reasons were highlighted during the interviews explaining why the industry product reformulated. Whilst some participants said that it was easier to reformulate rather than pay more taxes, others claimed that this was an industry strategy to prevent having 'HIGH IN' labels on their products. This is important because it suggests that it will not be possible to tease apart the effects of the Sugar Tax and the Labelling Policy.

Industry participants disclosed that the industry "always thought that this [the Sugar Tax] was a real opportunity" (BEV_001) to increase corporate profits. They explained that the policy's two-tiered tax resulted in great benefits to their companies, identifying two reasons. First, because by shifting the consumer's demand towards low-sugar beverages, companies would pay less tax. Second, because artificial sweeteners used in low-sugar beverages are significantly cheaper than sugar, which reduces the cost of these beverages. An industry participant explained this:

> *"There are two things: when you move to the low-sugar world, you have the benefit that you pay eight points less tax, which is huge in terms of money. If you move to the low-sugar world, your profits are higher, and it allows you to invest that in marketing and push the category you want to promote. Besides, the cost structure is cheaper; you have efficiency in using artificial-sweeteners versus sugar. Therefore, you also earn money from there." (BEV_002)*

Another reason reported by industry participants for why their products were reformulated was the improvement of their corporate image and social responsibility engagement within the context of an ongoing obesity epidemic:

> *"For us to cooperate and also go with the trend, which is sugar-free, eat healthily [...] The incentive is to improve health and also to earn more money, it can't be better." (BEV_001)*

At the same time, participants from academia, government and non-government organisations identified this as one of the many perverse strategies used by the industry to counter the threat of obesity to sales and profits. This social responsibility marketing, they believed, just favours corporate image, accumulates moral credit, creates the illusion that their products are healthier and promotes sales. This is further explored in the next sub-theme (section 7.5.3).

7.5.3 Perverse and powerful strategies

The majority of participants explained that the Sugar Tax was beneficial to the SSB industry as long as customers preferred low-sugar beverages. For this, the industry deployed, as an academic described it, an “extremely powerful marketing campaign” (ACA_001) to promote low-sugar beverages consumption and prevent sales loss after the implementation of the Sugar Tax. Industry participants also noted this:

> *“The suppliers did solid strategic work, increasing communication, promotion, and making more exhibitions of the products […] and the client automatically started to hook up with these things without wanting to; without knowing, he started to acquire a little more of these products without labels.” (BEV_003)*

Participants from academia, government and non-government organisations believed that SSB companies wanted consumers to consider them part of the solution to obesity rather than the cause by “telling the community that they are now much healthier.” (ACA_004) Academics also explained that the industry engaged with health professionals to build alliances and prevent campaigns against their products. One participant recalled this:

> *“One very funny anecdote was when they [SSB companies] scored a goal to the Chilean Pediatric Society. They financed seminars and distributed agendas to medic doctors. We realised that Coca-Cola financed it. So this motivated a complaint from the society and academics against the Pediatric Society, and the society had to cancel what they had done with them.” (ACA_003)*

Industry participants explained that besides the marketing to boost low-sugar beverages consumption, companies also expanded their product portfolio. They reported that apart from reformulating most of their products to put them below the policy's 6.25gr/100ml of sugar threshold, they reduced serving sizes and introduced new low-sugar products into the market. As one participant described it, “The company aims for the year 2020, to have 50% of its products with zero sugar.” (BEV_001). Participants from the other three sectors also perceived this by commenting about the increasing variety of low-sugar beverages in the market:

"about five years ago, you could only find one or two Light or Zero beverages, whereas today there isn't a single beverage brand without its Light counterpart." (GOV_003)

At the same time, they expressed concern about the industry tactic of reducing the amount of sugar just below the threshold instead of removing sugars from their products, as one academia participant explained:

"When you put a threshold, everyone sticks to the ceiling of the lower interval, so if now it is 15 grams of sugar per 240 ml, then what I'd do would be to produce with 14.9 by 240 ml, and I'm going to pay 10% instead of 18%." (ACA_006)

Apart from shifting consumption from high- into low-sugar beverages, industry participants reported that they were also interested in maintaining consumers' loyalty to SSB rather than water as SSB were more profitable than water. However, they stressed that they still wanted to maintain the loyalty of consumers who prefer water. One industry participant described how they were controlling the market:

"[...] we care that people don't move to waters. I mean, have water as an alternative, but keep sugary drinks as the main refreshment. [...] the logistic and operational cost of water is much higher, we have twice as much profit selling [SSB brand] than water. [...] we have to manage and redirect consumption, maintaining a decent share in waters. Because we know that, the world is moving to waters. We are going to try to delay it as much as possible with other healthy products." (BEV_001)

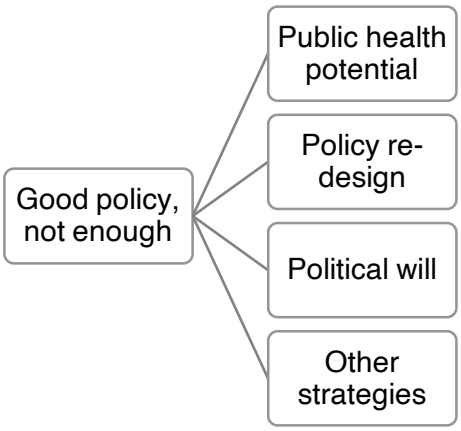
There was a general feeling amongst participants from academia and non-government organisations that the industry was "manipulating the price" (ACA_002) of low- and high-sugar beverages in the market and now both beverage types have the same price. Industry participants explained that they were absorbing the cost of the tax, therefore, consumers did not feel the price difference. One participant said, (29) "the distribution of the cost is different. [...] the consumer sees the same sale price, but the supplier in his structure is where gets benefited, there's no direct [tax gap] transfer, at all." (BEV_003)

7.5.4 Theme summary

This theme described the powerful role the industry may have played during the Sugar Tax policymaking process. However, limited examples of this were provided by

participants, as industry participants were not happy to discuss this and it was suggested by one participant that these activities sometimes happen behind closed doors. Participants believed the industry was more focused on fighting the Labelling Policy as it would significantly impact their products. Different strategies and strong lobby were identified. It was believed that the Sugar Tax had nudged the industry to reformulate their products, which was perceived as a positive effect by all participants including from industry. Industry participants also believed that by product reformulating the industry benefited financially and publicly as they felt their corporate image improved. Industry participants also explained how and why they promote SSB consumption over water as it is more cost-effective to produce SSB compared to bottled water. Despite the common understating of the policy as a positive strategy for product reformulation, oral health implications were not discussed.

7.6 Theme 4: Good Policy, Not Enough



Most participants believed that the Sugar Tax had the potential to reduce SSB consumption; however, they felt that this was not the intention of the policy and because of the way it was designed and implemented, the policy did not reach this objective. This theme explores different perceptions about what was missing in the policymaking process, unintended consequences of the policy, the need and political will for policy change, and other strategies that may complement the Sugar Tax.

7.6.1 Public Health Potential

Academia and non-government organisation participants believed that the Sugar Tax, despite having a minor impact on prices, had been an effective fiscal policy. As one participant described it: “the aim was to collect more revenue, and it's what has certainly happened” (ACA_006). Others highlighted its value as a public health strategy nudging the industry to reformulate their products and changing consumer behaviours, as one participant pointed out, “this type of public policy protects populations that are more vulnerable to the obesity epidemic.” (ACA_004)

Most participants believed the policy was a valuable tool to reduce the burden of oral health diseases. Most academics, were hopeful about the potential of this policy in this arena. However, not many details were offered:

> *“I think so, yes. What we know is that sugary drinks are the second source of free sugars in Chile’s diet. The first is from table sugar, and the second is sugar-sweetened beverages, and between those two, they represent 50% of the free sugar consumption. […] I understand that within the pathogenesis of caries, the most important factor is consuming free sugars, then we find an*

obvious rationale for this. If the effectiveness of the tax reduces the consumption of sugars, then it should affect the incidence and prevalence of dental diseases." (ACA_005)

Another policy value highlighted by participants was that the Sugar Tax had imposed a new trend in Chile demonstrating "a clear sign that the food market could be intervened." (GOV_010). Also, that it was a useful tool for increasing awareness of the health effects of sugars nationally and internationally.

There was a common view that the Sugar Tax was a good precedent for future health policies, and participants, mainly from academia and non-government organisations, believed that the tax was going to increase in the next few years:

"Maybe the evidence will say that there has been a smaller impact than expected, but it's ok, let's work on the next step to have a greater impact." (ACA_004)

On the other hand, some participants resisted the idea of the Sugar Tax's success. They believed that SSB consumption had not changed after this policy due to the lack of price difference between high- and low-sugar beverages:

"So, one observes that there were positive effects, because it induced manufacturers to modify the sugar content, but not in such a significant way to have different prices." (GOV_006)

There were common concerns about the Sugar Tax effect. First, some believed that the policy had nudged low-sugar beverage consumption instead of water, as one participant pointed out:

"I think people didn't replace them with water, but with drinks with less sugar. From a nutritional point of view, this isn't bad, but from a public health point of view, one would have wanted to have the replacement for water." (GOV_003)

Second, the increasing use of artificial sweeteners, especially in children's beverages, as it was commented, (8,9) "kids still have the same need for sweet flavours in their mouth. They are not used to natural non-sweet foods. […] if I manage to get children used to a lower sweetness in food, in the future, I'm betting on a healthier and more balanced diet." (GOV_010) And because as their effect on health is still unknown it could be a potential risk factor for many diseases and it will be extremely difficult to regulate them:

"The strong fight will come. Because basically many of these companies, what they are doing for a long time is to move from sugars to artificial sweeteners. It will be very difficult, if not impossible, to eliminate artificial sweeteners." (ACA_006)

When I asked about the potential effect of SSB consumption on oral health, most participants, including those from the beverage sector, were aware that regardless of the sugar context, SSB were still detrimental for teeth:

"Teeth obviously suffer from sugar, so it's clear, the less sugar you get, the better. But I don't know if it's the main harmful factor for teeth. What about the other ingredients? Are they also bad for teeth? I don't know that, but I guess it's not just the sugar that is detrimental, but other factors and ingredients may be worse." (BEV_003)

7.6.2 Policy re-design

All participants valued the concept of taxing SSB to reduce consumption; however, there was a common belief that the policy had to be re-designed within a public health rather than a fiscal framework. As one participant pointed out, the Sugar Tax design and implementation was "some kind of amphibian, with no communicational campaign, with no citizen debate, with no debate of civil society […]. Because for this to be effective, it has to be understood as a public health problem, not as a fiscal problem." (ORG_003).

Also, academia participants felt that to effectively nudge the population to reduce SSB consumption and increase the preference for water, the tax had to be significantly higher as "if it's a small tax that anyone can pay, the truth is that the impact is going to be mediocre." (ACA_004)

Another modification to the policy suggested by some participants excluding those from the industry sector, was that the tax rather than add-valorem, had to be applied per gram of sugar because "otherwise, you have created an incentive to change from one drink to the other" (ACA_005), and it had to be expanded to solid sugars that are "important sources of calories and sugars for children." (GOV_003)

Some participants also suggested that the policy had to consider the public's opinion in the design because the evidence shows that "the effect of a tax is much greater if there is a linked informational campaign. If you tell people that this product is

more expensive because it has taxes, compared to not telling it, the resulting effect is different." (ACA_005)

7.6.3 Political will

Although most participants insisted that the Sugar Tax needed to undergo a re-design, there was a common view that there was need for robust evidence and advocacy groups to change the policy, but also political will, which was perceived to be low. Some said that the government had other priorities and that politicians usually avoid these policies given the high opposition level. However, others were more positive and believed that there was always room for change in politics.

The majority believed that re-designing the Sugar Tax was not part of the government's agenda, at least at the time of the interviews. Participants reported that Sebastián Piñera, the president taking office after Michelle Bachelet and from the opposition party, announced that he would reduce taxes at the beginning of his administration. One government participant reported an anecdote to support this point of view:

> *"That report [the second Sugar Tax commission's report] was available on the Ministry of Finance and Health's websites, for about a month, and there was a change of government and the new government put it down. It's not available now. They were public, but the fact of removing it from the website speaks of the intention of not going ahead with it." (GOV_003)*

However, a few participants from academia were more optimistic. They believed that the president's agenda could result in a "political window […] to increase other taxes." They also believed that a Sugar Tax re-design was forthcoming given the national and international public health panoramas due to sugar consumption:

> *"I think it's inevitable. I don't know if it's immediate, but it's inevitable. […] everything is going in that direction. […] the increase in obesity is notorious. The increase in diabetes is super-obvious. Also, the caries issue." (ACA_006)*

They also explained that taxes normally begin low to be increased over time, although particular circumstances could accelerate the process as it happened in 2010 after the earthquake in which the alcohol and tobacco taxes were increased to generate more revenue and reconstruct the country:

"I would put it [the Sugar Tax] as the first candidate so that if the country needs fast cash… that kind of thing could accelerate the process." (ACA_004)

7.6.4 Other strategies

There was a common belief that the Sugar Tax needed to be complemented with other strategies to address cultural barriers and effectively reduce SSB consumption and tackle "common factors that can be effective for many chronic diseases without needing to be disease-specific." (ACA_004). Overall, participant's suggestions covered broadly three main dimensions: access, availability and marketing. All participants highlighted the importance to promote water consumption as SSB substitute as Chile has extensive coverage of drinking water unlike most of the Latin American countries:

"We must increase the availability of water, especially in schools, in public places. We must have drinking fountains, of good infrastructure quality, to allow people to have access anywhere. We must have water as a widely available substitute." (ACA_005)

The majority of participants also identified the need for a massive communication campaign to increase and maintain the debate about the Sugar Tax in civil society, increase awareness about potential health risks of SSB consumption, and promote water consumption by making it more desirable than SSB.

Participants, in general, highlighted the importance of education. Participants from academia and non-government organisations believed that drinking behaviours are somewhat changing because of better healthy lifestyles. However, they explained that Chile's cultural practices and the industry nudging strategies to increase SSB consumption, plus lack of appropriate educational support and incentives, behaviour change was challenging. As one participant pointed out:

"Everyone knows that eating an excess of salt or sugar is bad, but nobody knew how many spoons of sugar you were consuming in a sugary drink." (ORG_002)

Participants perceived this lack of informed knowledge as the cause of many misconceptions about the healthiness of low or no sugar-sweetened beverages among the general public:

"I insist that this perception that, because it has no sugar but Stevia or Sucralose, is healthy, I feel it's false." (ORG_001)

Likewise, there was a common understanding with regards to poor oral health education in the population and the need to improve it:

"people consume too many sugary drinks without considering the potential impact as they don't have dental health education. Young children are taught that they have to brush their teeth, but the mother is not educated, so her child ends up drinking sugary drinks all the time or sweet juices." (ACA_001)

"And if we say, drink water, but why? What are the benefits? The population needs reinforcement, which seems super important to me. What we talked about at the beginning, the importance of knowing that carbonated drinks have an acidic pH that affects the teeth and that water is the natural replacement that has a neutral pH; this is something that most people don't know." (ACA_004)

Participants, in general suggested that by improving the education and knowledge about the risks associated with SSB consumption it would nudge a cultural change. Children were perceived as the main target as one participant pointed out:

"We have learned a lot by working in vulnerable communities that the family's change agent is the child. So we have to wait for the child to come to his house and say 'mom no more sugary drinks. Please don't buy more; I don't want to drink them anymore, I prefer water'." (ORG_003)

Lastly, a government participant believed that the best way to change unhealthy behaviours was embracing the population's right to healthy eating as a "constitutional standard, not only to eat but to eat healthily. [This way] the individual is respected; each one decides what to eat or not; there is absolute respect for that. But there's a greater good as a society, protected by the constitution." (GOV_010)

7.6.5 Theme summary

This theme described how participants trusted in the Sugar Tax value to reduce SSB consumption but acknowledged that the policy needs to undergo a re-design process. The political will was identified as an important factor for policy change. Many ideas and strategies were suggested by participants to improve the policy's design and impact on both general and oral health, including the promotion of water consumption,

the use of communicational and educational campaigns, a tax increase, and targeting children to change detrimental cultural practices, among others.

7.7 Chapter summary

As the quotes presented in this chapter illustrate, participants had diverse views of the Sugar Tax policymaking process. Additionally, the background and the level of involvement in the process seemed to have influenced participants' perceptions. This upholds the decision to include actors from different sectors, as it allowed for data triangulation.

The four themes covered aspects of the Chilean culture in SSB consumption, the Sugar Tax policymaking process, the beverage industry role, and the need for policy change. Overall, participants believed that the Sugar Tax was a valuable policy to reduce SSB consumption; however, some factors were perceived to have a strong influence in its effectiveness. Firstly, the policy's fiscal nature was perceived incompatible with a public health objective, as the former intends to increase revenue from SSB purchases and the latter aims the opposite. Secondly, it was believed that the policy missed the opportunity to effectively affect consumption by not incorporating evidence base in its design, citizen consultation stage, and communicational campaigns during its implementation. Thirdly, the low priority given within the wider Tax Reform and the absence of debate in the civil society, which resulted in low awareness of its existence.

Although participants had a perception that obesity was a more urgent matter than oral health when the health implications of the Sugar Tax where discussed, they believed that the Sugar Tax was generally an effective tool for reducing the risk of oral diseases. However, the policy needs to undergo a re-design process within a public health framework and be complemented with a comprehensive package of strategies to increase its potential effectiveness. Suggestions to improve the current Sugar Tax included a tax increase, change in mode of application based on evidence, introduction of water consumption incentives, improvement of awareness of the oral health risks associated with SSB consumption through education and communicational campaigns, and policies regulating access, availability and marketing of SSB.

Chapter 8
Integration of findings and discussion

In this final chapter, I discuss and integrate the findings from the three studies presented in chapters 4 to 7. I begin by summarising the main findings of each study. Next, based on the convergent mixed methods design and taking a pragmatic approach I describe the integrated findings through narrative and joint display techniques by thesis overall aim and objectives with reference to the wider literature (Fetters et al., 2013; Creswell and Plano Clark, 2018; Johnson et al., 2019). I follow with a summary of findings, the thesis' contributions, I compare the integrated findings in the context of the current literature and I discuss the strengths and limitations of the studies. Finally, I bring the research to a close by considering the implications of my research for policy and research.

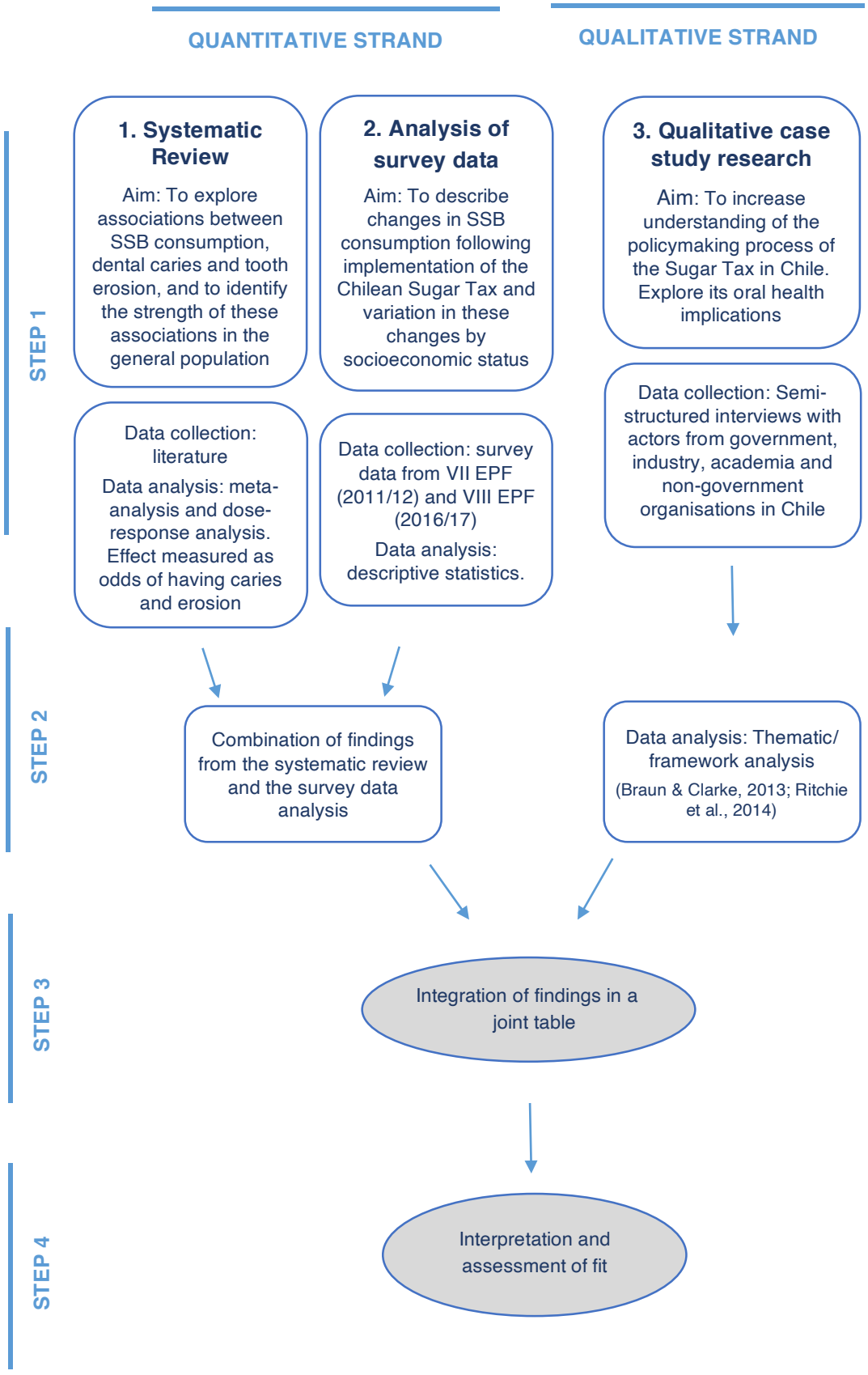
The overall aim of this mixed methods convergent PhD thesis was to improve understanding of the potential effect of the Sugar Tax on oral health. For this, I conducted three studies: a systematic review, a quantitative study and a qualitative case study, which addressed the following objectives:

- Objective 1: To explore if the consumption of higher levels of sugar-sweetened beverages compared with lower levels of consumption is associated with dental caries and/or tooth erosion, and the strength of the association in the general population.
- Objective 2: To describe changes in SSB consumption levels following implementation of the Chilean SSB Tax policy in 2014 and variation in these changes by socio-economic status (SES).
- Objective 3: To increase understanding of Chile's Sugar Tax policymaking process and explore the implications on oral health policy and outcomes.

As I described in Chapter 2, section 2.6.2, the Chilean National Congress passed the Sugar Tax policy in the context of an extensive reform to the taxation system, called Reforma Tributaria (RT, in Spanish). All-naturally or artificially sweetened non-alcoholic beverages, energy or hypertonic drinks, syrups and mineral or thermal waters with added colouring, flavouring or sweeteners were already taxed at 13%. With the

implementation of the Sugar Tax in 2014, the previous tax rate was modified with a tax rate increase from 13% to 18% for beverages with a sugar content greater than 6.25 grams per 100 millilitres and a reduction from 13% to 10% for beverages below this threshold. These changes created an 8% tax difference between both beverage groups (BCN, 2015).

Figure 33. Convergent mixed methods thesis diagram



8.1 Summary of main findings

8.1.1 Systematic review

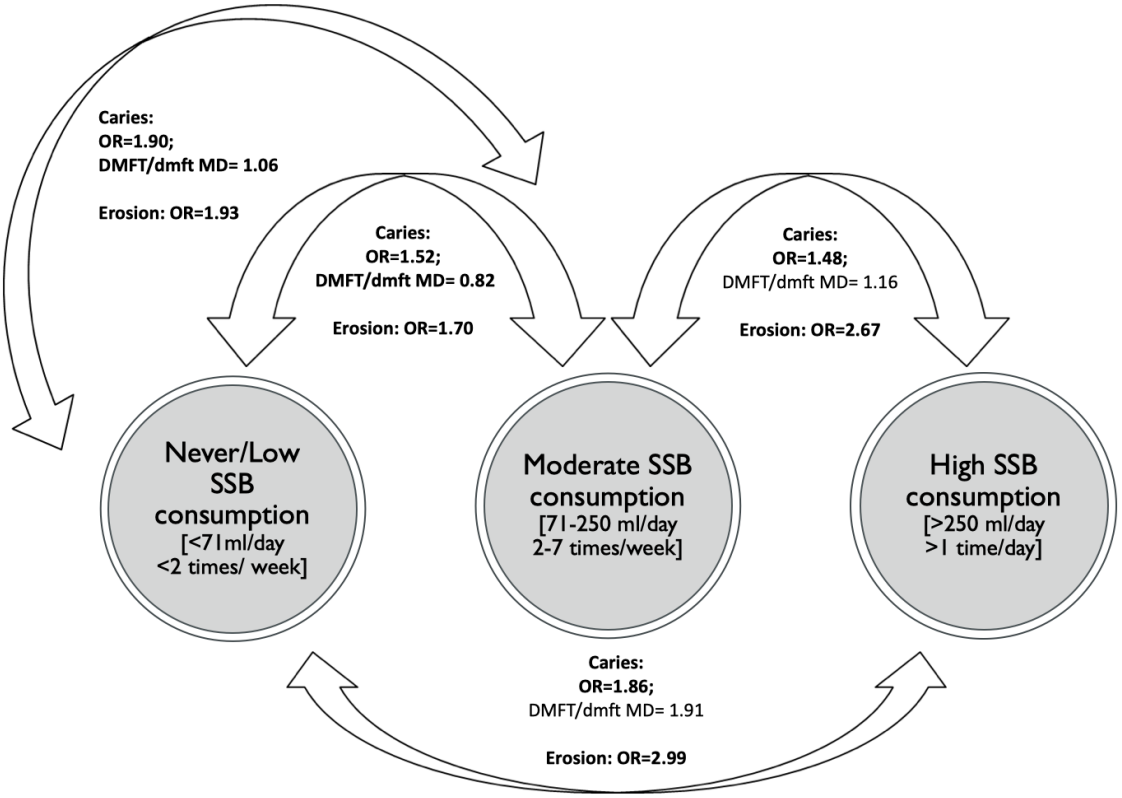
I conducted the systematic review to explore (1) whether the consumption of higher levels of sugar-sweetened beverages (SSB) compared with lower levels is associated with dental caries and/or tooth erosion, (2) the strength of the association in the general population, and (3) whether this association followed a dose-response relationship. Forty-four studies met the inclusion criteria, which I pooled using meta-analysis and dose-response analysis methods.

I found not only a positive association but also a dose-response gradient between SSB consumption and caries. I included twenty-three studies in the meta-analyses that estimated the OR of having caries and thirteen studies that estimated the difference in mean DMFT/dmft. Most OR and WMD random-effects meta-analyses revealed a statistically significant association between SSB consumption and caries (see Figure 34). I included ten studies in the dose-response analysis, which revealed that the risk of caries follows a dose-response relationship with the amount of SSB consumed daily. I also found a clear effect difference between types of dentition. Overall, the OR in the primary dentition is higher than the permanent dentition, and in contrast, the WMD is more severe during adulthood compared to the early years.

For tooth erosion, I included eighteen studies in the meta-analyses that estimated the OR effect of SSB consumption. Overall, the OR random-effects meta-analyses revealed statistically significant effects of SSB consumption on tooth erosion (see Figure 34). The OR of having erosion between the different levels of SSB consumption is larger than caries. Similar to dental caries, there is a clear effect difference across types of dentition; however, for erosion the OR is lower in the primary compared to permanent dentition.

Although the studies included in this systematic review were cross-sectional and cannot inform temporal relationships as longitudinal studies would (Bowling, 2009), the established biological plausibility of the relationship between sugar consumption and caries (Moynihan and Kelly, 2014), along with the strength of association and dose-response relationship observed in the review, suggest that the relationship between SSB consumption and dental carries is likely to be causal.

Figure 34. Systematic review summary of findings



8.1.2 Quantitative study

I conducted the quantitative study to describe changes in SSB consumption levels following the implementation of the Chilean SSB Tax policy and variation in these changes by SES. For this, I analysed two waves of the anonymous national representative and cross-sectional Chilean Household Budget Survey (Encuesta de Presupuestos Familiares - EPF), one before (November 2011 - October 2012) and one after (July 2016 – June 2017) the implementation of the Sugar Tax in 2014. I estimated SSB consumption volume from SSB expenditure data using the price per litre of SSB reported by Caro et al. (2018) in their study. I also combined the results with findings from the systematic review presented in Chapter 4 to provide a more comprehensive account of SSB consumption and likely oral health risk changes resulting from the policy.

The first part of the data analysis revealed little change in household composition between the surveys, which enabled me to draw reliable comparisons between the datasets. Overall, the percentage of households that reported spending money on any beverage was similar, slightly decreasing after the policy. There was, however, a marked increase in mean per capita expenditure of carbonated beverages

and an even larger increase in mineral water after the policy implementation across income quintile groups.

Considering SSB only (carbonated beverages, liquid juices and flavoured waters), and consumers and non-consumers, people increased their consumption after the Sugar Tax's implementation from a mean volume of 175 ml/day to 211 ml/day. Looking at trends across income quintile groups, consumption increased with affluence in both surveys and increased in all deprivation groups between 2011/12 and 2016/17. On average, in 2011/12 those from the least affluent group consumed 125 ml/day of SSB, which corresponds roughly to half a glass of beverage, whilst the mean amount was slightly higher in 2016/17 (151 ml/day). In turn, the most affluent group consumed almost twice the amount of SSB of the most deprived (242 ml/day) in 2011/12, that is a glass portion of beverage a day, whilst this increased to 260 ml/day in 2016/17 which is closer to a regular sized can.

Using the classification levels of consumption from the systematic review (Chapter 4, section 4.2.8.1), the analysis showed that baseline patterns of consumption varied with deprivation; there was a social gradient in high-level consumption (i.e. prevalence of high-level consumption increased with affluence) and a reverse social gradient in zero-level consumption (i.e. prevalence of zero-level consumption decreased with affluence). Against these different baselines, changes in patterns of consumption were broadly similar across income quintiles. For example, in 2011/12 most of the affluent group were moderate (40.2%) or high (34.9%) level consumers, and in 2016/17 there was a decrease in low-level consumption (from 16.4% to 12.5%) and an increase in high-level consumption (to 39.6%), suggestive of a general increase in consumption across all levels. There were similar shifts in the other quintiles, although the magnitude of these shifts varied.

Overall, in each income group, there was a net movement in the population from the lower levels to the higher levels, suggesting that the policy did not have the expected impact reducing SSB consumption. Instead, the findings suggest that the population SSB consumption significantly increased after the implementation of the policy in all deprivation groups, with large increases in the proportion categorised as high-level consumers and only a slight increase in the percentage of non-consumers among the poorest and the richest quintiles.

Although this analysis did not follow individuals over time, the evidence from these two cross-sectional samples, and the combination of these data with the

systematic review findings suggest that, depending on the time of exposure to the higher levels of consumption, the average level of risk of population caries and erosion is likely to have increased between 2011/12 and 2016/17. In detail, those who moved from the low level to the moderate level of consumption were likely to have increased their risk by 0.82 DMFT/dmft, with 52% more odds of having caries and 70% more odds of having erosion. Those who moved from the moderate level to the high level were likely to have increased their risk by 1.16 DMFT/dmft, with 48% more odds of having caries and 167% more odds of having erosion (moderate to high level).

However, it is important to note that although the analysis was conducted rigorously, the findings need to be interpreted with caution, as they did not consider a comparison group or counterfactual, and were based on two cross-sectional surveys and oral health data that assumed long-term consumption habits from general populations, not from Chile. Causality cannot be established due to the study design.

8.1.3 Qualitative study

I conducted the qualitative study described in Chapter 7 to increase understanding of the Sugar Tax's policymaking process and explore the policy implications on oral health. I conducted in-depth semi-structured interviews to 23 policy actors from government and non-government organisations, academia and beverage industry in 2017/18. I identified four themes and thirteen sub-themes from the thematic analysis (Table 38), which broadly covered aspects of the influence of cultural practices on SSB consumption, the stages of the policymaking process, the role of the beverage industry on the formulation process and the need for re-designing the policy.

Table 38. Themes and sub-themes identified in the qualitative case study

Themes	Sub-themes
1. The socio-cultural context	1.1 Culture and beliefs 1.2 Public Health setting and food environment
2. The policymaking of the Sugar Tax	2.1 Defining the agenda 2.2 Policy formulation 2.3 Policy negotiations 2.4 Implementation and evaluation
3. The power of industry	3.1 The power of lobbies 3.2 Positive response 3.3 Perverse and powerful strategies
4. Good policy, not enough	4.1 Public Health potential 4.2 Policy re-design 4.3 Political will 4.4 Other strategies

Overall, the Sugar Tax was believed to be a valuable strategy to push the industry to reformulate their products and reduce SSB consumption. However, factors such as the policy design, the magnitude of the tax, the pass through rates, the context in which it was implemented, the role of industry and citizens, and the use of communicational campaigns were perceived to be key drivers of impact. SSB consumption was believed to be in part determined by its association with indulgence and happiness, and it was linked to identity and status within society, regardless of its potential health effects. Perhaps the most salient representation mentioned in the interviews was the association between higher SES and the ability to afford SSB. In contrast, tap water was identified as a valuable substitute; however, misconceptions about taste and quality might be undermining its consumption.

Participants believed that the new government coming into power in 2014 and the introduction of the Tax Reform and other health policies set the grounds to put the Sugar Tax onto the government agenda. They described different aspects of the formulation, negotiations and implementation stages. Despite having positive views about the policy's potential to reduce consumption, the fact that it was part of a wider Tax Reform that primarily aimed to generate more revenue instead of reducing SSB consumption was believed to have negatively impacted the policy's public health potential. According to participants, the formulation process lacked any serious consideration of health, and while health officials were more involved in the negotiation process, there was limited scope for change at later stages. Further criticisms identified were that the policy was handled behind closed doors, lacked a stage of citizen consultation, and was implemented without a communicational campaign, which prompted a lack of debate within the general public, which caused the policy to have a low priority in Congress.

Most non-industry participants described the SSB industry as a powerful actor during the Sugar Tax's policymaking process. The strategies mentioned included lobbying, manipulating the drinks market and environment, and influencing people's purchasing behaviours. Despite acting as opponents to regulatory policies, for business reasons, participants from the SSB industry explained that they were concerned about health and wanted to be viewed as part of the solution to obesity rather than the cause. However, they intended to continue manufacturing less healthful beverages as they were focused on maximising profit and put their health promoting efforts into expanding their portfolio of low and no-calorie beverage options, introducing smaller sizes to the market and educating the public about key concepts such as

energy balance, hydration and physical activity. Non-industry participants perceived these to be perverse marketing activities to deflect attention from the contribution of SSB to obesity and poor health and shift responsibility for poor choices and inactivity to consumers.

Participants described that whilst the main argument that supporters put forward was that the policy would help to reduce SSB consumption, and thus the prevalence of many NCD, many arguments were used against the taxes by the opposition. Among these, the Sugar Tax was claimed to be a nanny state policy interfering with personal choices, a non-effective policy, highly regressive and that it would result in job losses. Other arguments against the policy included that sugar was not the only unhealthy nutrient that needed to be taxed, it was unfair for consumers, it was unconstitutional, and it would affect disproportionately those from lower SES groups (BCN, 2014).

Many ideas and strategies were suggested by participants to improve the policy's design and impact on both general and oral health, including the promotion of water consumption, the use of communicational and educational campaigns, a tax increase, and the use of children as the target population, among others.

Overall, there was low awareness of the implications of the Sugar Tax on oral health. As participants talked about public health priorities and SSB consumption, oral health was not proactively discussed. Instead, participants were more inclined to associate the policy with obesity and other general health problems than oral health. Most acknowledged the importance of considering dental caries; however, obesity was raised as the primary disease linked to SSB consumption and was thought to be a more pressing public health problem.

8.2 Integration of findings

In mixed methods studies, the integration stage brings quantitative and qualitative data together to address common research questions and hypotheses (Guetterman et al., 2015). Integration can be achieved at different stages, broadly through study design, methods, and interpretation and reporting. Based on the convergent mixed methods design and the pragmatic approach that underpinned this thesis, I collected the quantitative and the qualitative data concurrently and then I analysed them separately (see Chapters 4, 5 and 6 for the methods I used in each study). Next, borrowing from the first two stages of the 'Pillar Integration Process' (PIP) developed by Johnson and colleagues (2019) and following recommendations and techniques proposed by Fetters

et al. (2013) and Creswell and Plano Clark (2018), I integrated the findings from the three studies as I described in Chapter 3, section 3.1.3, at the interpretation and reporting stage.

In this section I present the integrated findings organised by the overall aim and objectives of the thesis, first narratively and then in joint display tables (Fetters et al., 2013; Creswell and Plano Clark, 2018). As described by Fetters and colleagues (2013), a joint display is an approach to illustrate the integration data analysis in a table or figure. This approach enabled me to draw patterns across the data by presenting both the qualitative and quantitative data simultaneously. Additionally, the joint table allowed me to assess whether the findings from the different studies fit together (Creswell and Plano Clark, 2018). The coherence or fit of both types of data could include discordance, expansion or confirmation between results. Although the integration is presented by thesis overall aim and objectives, all findings build together to address a common purpose that is to increase the understanding of the potential effect of the Sugar Tax on oral health.

8.2.1 Objective 1: To explore the effect of sugar-sweetened beverages on dental caries and tooth erosion.

By integrating the systematic review (Chapter 4, section 4.3.5) with the qualitative interview findings (Chapter 7, sections 7.3-7.6), I not only quantified the strength of association between consumption of different levels of SSB and dental caries and erosion in the general population by using meta-analyses and dose-response analyses, I also explored this effect from the perspective of policy actors that were involved in the policymaking process of the Sugar Tax in Chile.

As I described in Chapter 3, section 3.1.2.2, this first objective was primarily included in this thesis due to the limited availability of oral health data sources in Chile to assess the effect of the Sugar Tax on oral health. Findings from the systematic review demonstrated a positive association and a dose-response gradient between SSB consumption and caries. The meta-analyses showed that people who consume larger quantities of SSB (daily or several times a week) have greater odds of having dental caries and erosion and higher caries rates than people who consume smaller amounts (less than twice a week). The evidence was robust in establishing these relationships given the lack of publication bias, quality of studies, the strength of the effect and the dose-response relationship found between SSB and caries and erosion. These findings are consistent with other studies (Bleich and Vercammen, 2018; Du,

2014; Vartanian et al., 2007; Li et al., 2012; Salas et al., 2015); however, previous reviews have not quantified the strength of the association between different levels of SSB consumption and caries and erosion. Instead, studies that report the effect of SSB on either caries or erosion compare the effect of any amount versus no consumption of SSB.

Interestingly, participants from the qualitative study did not perceive the oral health risk associated with SSB consumption and the potential consequences on people's well-being as important as other general health problems. Overall, participants were aware of the adverse effects of SSB consumption on oral health; however, this relationship was not raised as much as obesity during the interviews despite that the study objectives included the exploration of the implications of the policy and SSB consumption on oral health. Similar perceptions have been found in other studies investigating policymakers' views of SSB tax policies, where participants regarded obesity as the most important public health problem, which prevention should be a priority for governments over other health problems (Tamir et al., 2018).

Whilst the majority of participants believed that artificially-sweetened beverages were a healthier alternative to sugar-sweetened beverages as they identified the presence of sugars as the main factor detrimental to oral health, only two participants raised concerns about the acidic pH and erosive potential of SSB on teeth. This low awareness of the acidic effect of SSB on teeth was also evident in the systematic review. From the included studies, only a third measured tooth erosion as the primary oral health outcome associated with SSB consumption compared to caries, suggesting that tooth erosion may not be considered as important as dental caries when the effect of SSB is examined. Alternatively, this might reflect the lack of a standardised tool for data collection (Lopez-Frias et al., 2012). This is important to note, as although my systematic review included some studies that pooled the effect of sugar and no-sugar beverages in their results, there is robust evidence supporting that artificially-sweetened beverages are also harmful to teeth as they are still acidic (Tahmassebi and BaniHani, 2020). Levels of acid in the oral cavity at which enamel demineralisation occurs (below pH 5.5) result in the loss of the tooth surface if left unchecked (Stephan and Miller, 1943). The harmful effect of SSB acidity on oral health is therefore important to consider when designing and implementing public health promotion strategies, for example by promoting plain water as a healthier alternative.

Most participants believed that lack of appropriate oral health education was the cause of low awareness of the adverse effects of SSB consumption on oral health and misconceptions about the healthiness of artificially-sweetened beverages. However, although understanding the need to reduce SSB consumption is an important step in behaviour change, knowledge alone is often not sufficient to change dietary behaviour (Worsley, 2002). Aiming at behaviour change only through health education is a downstream approach often only effective in the short term and might even increase socioeconomic inequalities in oral health. Hence a range of policies and strategies targeting upstream, midstream, and downstream policies are required to reduce the prevalence of oral diseases and tackle the underlying social and commercial causes of oral diseases (Watt et al., 2019).

Table 39. Integration of main findings – Objective 1: to explore the effect of sugar-sweetened beverages on dental caries and/or tooth erosion

Study findings			Mixed-methods fit of integration
Systematic review (Chapter 4)	**Survey analysis (Chapter 5)**	**Qualitative case study (Chapters 6 & 7)**	
- Moderate and high-level consumers have almost twice the odds of caries and erosion of low-level consumers, and have an average of 1.06 more DMFT/dmft. Across types of dentition, the OR is lower in the primary dentition. - Moderate level consumers have one third more odds of having caries of low-level consumers and 0.82 more DMFT/dmft, whereas high levels consumers around half the odds of moderate-level consumers with a mean of 1.16 more DMFT/dmft. - The odds of having caries and the WMD among high-level consumers is twice the odds of caries and they have almost two DMFT/dmft than low-level consumers. Overall, WMD is more severe during adulthood. - The OR of having erosion between the different levels of SSB consumption is larger than caries. SSB consumers have almost three times the odds of both moderate and low-level consumers, whereas between low and moderate-level consumers this estimate is lower, but still significant. - The risk of caries follows a dose-response relationship with the amount of SSB consumed daily.	(No relevant findings)	- Participants had some knowledge of the adverse effects of sugar and SSB consumption on oral health [Theme 4]: "I understand that within the pathogenesis of caries, the most important factor is consuming free sugars, then we find an obvious rationale for this." (ACA_005) "Teeth obviously suffer from sugar, so it's clear, the less sugar you get, the better. […] what about the other ingredients? Are they also bad for teeth? I don't know that, but I guess it's not just the sugar that is detrimental." (BEV_003) - There was a common perception that the general public had misconceptions about the healthiness of low or no sugar beverages [Theme 4]: "I insist that this perception that, because it has no sugar but Stevia or Sucralose, is healthy, I feel it's false." (ORG_001) - Participants also raised concerns with the poor oral health education in the population and the need to improve it [Theme 4]: "If we say, drink water, but why? What are the benefits? The population needs reinforcement, which seems super important to me. […] the importance of knowing that carbonated drinks have an acidic pH that affects teeth and that water is the natural replacement that has a neutral pH; this is something that most people don't know." (ACA_004)	- Qualitative case study findings on low awareness of potential effect of SSB consumption on oral health **expands** the systematic review findings. - Also, the low number of articles measuring the association between erosion and SSB consumption – compared to caries - identified in the systematic review **confirms** the perception of policy actors that sugar and caries are more relevant than erosion and acidic ph.

8.2.2 Objective 2: To describe changes in SSB consumption levels after the Chilean SSB Tax policy implementation.

To address the second objective of this thesis, I analysed two waves of the nationally representative Chilean Household Budget Survey (Encuesta de Presupuestos Familiares - EPF), one before and one after the Sugar Tax implementation (Chapter 5). The qualitative study adds to the quantitative findings with policy actors' accounts about the impact of the Sugar Tax on SSB consumption (Chapter 6-7).

Non-industry participants from the qualitative case study had a common view that SSB taxation was an appropriate intervention to reduce SSB consumption in the population; however, whilst a few believed that the policy had effectively reduced consumption in Chile, the majority thought the opposite. Indeed, findings from the survey analysis confirms the latter perception. The analysis showed that overall, and considering non-consumers, SSB volume consumption increased from 175 ml/day in 2011/12 to 211 ml/day after the policy.

Participants described a series of factors related to the policy formulation and design that may have influenced the policy's outcome. They believed the tax was too low, which they thought did not resulted in price changes and that having designed it within a fiscal framework was incompatible with a public health objective, as one intends to increase revenue from SSB purchases and the other aims the opposite. Furthermore, participants considered that the policy missed the opportunity to further impact consumption by not incorporating an evidence base design, a citizen consultation stage, and a communicational campaign. Similar criticisms were documented in a systematic review of SSB taxation that concluded that the tax increase had to be at least 20% and it needed to be framed as a health tax since the beginning to have a significant health impact (Wright et al., 2017). In contrast, lower and incremental taxes are more likely to provide a stable revenue source, but they are less likely to achieve behaviour changes (Chouinard et al., 2007).

The survey analysis also showed that SSB consumption levels in Chile were high in 2011/12 with around 70% of Chileans categorised either moderate or high-level consumers (see Chapter 4, section 4.2.8.1 for a description of these categories). After the policy implementation, this proportion increased further as the percentage of low-level consumers fell from 23% to 16%, whereas moderate-level consumers remained fairly similar (around 40%) and high-level consumers increased from 23% to 31%. The majority of participants raised concerns about the high levels of SSB consumption in

Chile and their status as the preferred non-alcoholic beverage in most Chilean households. This was confirmed in the survey analysis, which showed that the most popular product for households overall was carbonated beverages. To put this into context, the amount spent on carbonated beverages was seven times the amount spent on mineral water in both surveys.

Interview participants recognised the socio-cultural context as an important determinant for the high level and increased consumption of SSB in Chile. Many factors were outlined, including local cultural practices, SES, gender, age, public health scenario, and food environment shaped by the industry. For example, young adults from low-SES groups were identified as loyal high-sugar beverage consumers, unlike women from high-SES groups whose loyalty was believed to lie with low sugar versions. Another example that participants believed illustrates the influence of the culture on SSB consumption patterns relates to SSB access and good hospitality. Most participants said that being able to purchase SSB instead of water represented more outstanding capital and a higher social status, which might explain in part the high level and the increasing SSB consumption. Other studies have found similar variations in SSB consumption by gender and sociodemographic characteristics (Han and Powell, 2013). For most people, food habits are cultural rather than nutritional. As Freimer et al. (1983) described, culture involves a set of values, attitudes, habits and customs that play an important role as a determinant of food and beverage habits. Because food habits are deeply entrenched in many cultures, they are difficult to change. This is important to consider as the evidence shows that consumption patterns develop in childhood and persist over time (Birch et al., 2007); for example, children are much more likely to consume SSB regularly if their parents do (Grimm et al., 2004). Habit formation and persistence therefore needs to be taken into account when implementing SSB taxes.

Although interview participants thought that people from lower SES groups consumed more SSB than high SES groups, the findings from the survey analysis contradicted this view, showing that prevalence of high-level consumption increased and prevalence of zero-level consumption decreased with affluence. After policy implementation, there was a net movement of people in every income group from lower to the higher levels of consumption, with the greatest increase in the number of high-level consumers. There was only a slight increase in non-consumers among the poorest and the richest quintiles. This could be explained by the social status desirability among low SES groups that participants described in the interviews.

According to other countries' experiences, people from lower SES groups are more sensitive to price changes than other groups and are more likely to change behaviours due to a tax increase (Backholer et al, 2016; Powell et al., 2013). This may imply that SSB taxes play a role in reducing health inequalities, as people from poorer backgrounds may reduce their SSB consumption by shifting to healthier options (Wright et al., 2017). The absence of SSB consumption decline in the most deprived income quintiles in the survey analysis could be explained, in part, to the ultimate aim of the policy to increase revenue rather than reduce consumption and to the industry tactics to prevent the loss of customers. Another explanation could be that people changed their consumption preferences from high-sugar to low-sugar beverages, which unfortunately, was not separated in the beverage categories in the EPF surveys therefore could not be explored.

The food environment shaped by the industry marketing was another important determinant identified in the interviews for the high level and increased consumption of SSB in Chile. Industry participants explained that their marketing strategies were meant to compensate for the effect of the policy on their sales. They outlined some tactics they used to increase their sales of low-sugar beverages as these - as a result of the policy - paid less tax and were cheaper to produce than other beverages. These tactics included expanding their low-sugar beverage portfolio, reducing portion sizes, new alliances with health professionals to promote the sales of their products, and the commissioning of research studies. The latter strategy is important as the resulting articles systematically underestimate the true health effects of SSB, undermining policy efforts to reduce consumption (Litman et al., 2018). Industry participants also explained that their tactics looked for improving their corporate image as they wanted consumers to see them as part of the solution rather than the cause of their health problems. The industry's strategies to promote their products and lessen the effect of public health efforts attempting to reduce sugar and SSB consumption are known as the commercial determinants of oral health (see Chapter 2, section 2.3). These tactics highlight the urgent need for strong regulation and legislation, and the importance of developing clear and transparent policies to shield dental research and oral health policy from undue industry influence (Watt et al., 2019).

Table 40. Integration of main findings – Objective 2: to describe changes in SSB consumption levels after the Chilean SSB Tax policy implementation

Study findings			Mixed-methods fit of integration
Systematic review (Chapter 4)	**Survey analysis (Chapter 5)**	**Qualitative case study (Chapters 6 & 7)**	
(No relevant findings)	- The most popular product households reported spending money on in both surveys was carbonated beverages followed by juices and mineral water. Per capita mean expenditure increased for carbonated beverages and plain mineral water across quintile groups compared to powdered juices, which expenditure went down in most income groups but the middle one. - Overall, SSB consumption volume increased from 175 ml/day to 211 ml/day after the policy. - The % of moderate-level consumers was similar in both surveys (around 40%). In contrast, the % of low-level consumers fell from 23% to 16%, and high-level consumers increased from 23% to 31%. - There was a positive social gradient in high-level consumption (i.e. prevalence of high-level consumption increased with affluence) and a negative social gradient in zero-level consumption (i.e. prevalence of zero-level consumption decreased with affluence). - In each income group, there was a net movement of people from the lower levels to the higher levels. The most significant SSB consumption increase was in high-level consumers and there was only a slight increase in non-consumers among the poorest and the richest quintiles.	- Participants believed that the socio-cultural context was an important determinant for SSB consumption. Many factors were identified, such as cultural practices, SES, gender, age, public health panorama, and food environment [Theme 1]: "The industry's marketing has made this product very aspirational especially for people from low-SES wanting to arise by buying sugary drinks, as a sign of status." (ACA_003). - Industry participants explained that as they wanted to be considered part of the solution rather than the cause of health problems, they expanded their low-sugar beverages portfolio, reduced portions sizes, and made alliances with health professionals to promote the sales of low-sugar beverages. Whilst these marketing strategies were perceived to be perverse by most non-industry participants, industry participants explained that these were employed because low-sugar beverages paid less tax, were cheaper to produce and improved their corporate image [Theme 3]. - The Sugar Tax was considered an effective approach to reduce SSB consumption; however, some factors were perceived to have a strong influence on its effectiveness. First, its fiscal nature was perceived as incompatible with the public health objective, as one intends to increase revenue from SSB purchases and the other aims the opposite. Second, it was believed that the policy missed the opportunity to further impact consumption by not incorporating an evidence base design, a citizen consultation stage, and a communicational campaign. Third, the low priority given to the Sugar Tax during the policymaking process and the lack of debate in the civil society resulted in low awareness of its existence [Theme 4].	- Quantitative study findings **confirm** the perception of some participants about the high levels and increase SSB consumption and the lack of policy's effectiveness. - Participant perceptions **expanded** the quantitative study findings by providing a series of factors related to the policymaking process, the cultural-context and the industry tactics that may have affected the policy outcome.

8.2.3 Objective 3: To increase understanding of Chile's Sugar Tax policy's policymaking process and explore the policy implications on oral health

I conducted the qualitative case study to obtain insights and contextualise the complex phenomenon of the Sugar Tax policymaking process and to explore the implications of oral health problems during the process from the points of view of different policy actors who were involved in the process.

Interview participants generally believed that the Sugar Tax's prominence on the political agenda was due to two main reasons: the national obesity epidemic and the introduction of the national tax reform. However, government participants who were directly involved in the design of the Sugar Tax explained that developing the idea of increasing SSB taxes was essentially accidental, following on from an existing alcohol tax, which to their surprise, already included non-alcoholic beverages. Others mentioned further reasons of political expediency: introducing small taxes on varied items was more politically acceptable than big taxes; modifying an existing tax was more manageable than creating a new one; and it would attract more support for wider tax reform as it was a corrective tax. Indeed, a study about SSB taxes in the Western Pacific region found that although governments were ultimately concerned with raising revenue, framing the tax around health promotion assisted in getting the policies onto the policy agenda (Thow et al., 2011).

Participants believed that once the Tax Reform was presented to Congress, the Sugar Tax had very little priority in the discussions due to its limited capacity to generate revenue. They also believed that, in consequence, the initial proposal was made behind closed doors without consulting the evidence or health experts as policymakers were only looking for political and industry support for the wider Tax Reform and because there was limited time and resources. However, experience from other countries shows that the active involvement of health officials in the policymaking process is of great importance to gain support from the government and the general public to initiate the policies and their approval (Tamir et al., 2018).

Participants explained that some legislators tried to frame the Sugar Tax as a public health policy at a later stage during the discussion in Congress, which they believed helped to gain support to approve the wider Tax Reform. However, participants commonly believed that oral health was not included in the debate and was unlikely to have been considered in the Sugar Tax design, as it was a topic that was unsuccessful in gaining support from the government.

Participants described many factors that might have influenced the debate once the policy was presented in Congress. These included the lack of participation from the Ministry of Health, civil groups and academia, as well as political and industry opposition. They explained that the latter often arises due to partisan politics where opposition parties simply like to oppose frequently due to different ideologies (the right is generally more resistant to taxes that interfere with personal liberty and 'freely' chosen behaviours or that will interfere with the market) or because there are conflicts of interest (political donations or attempts to attract business/manufacturers into the region/country); and industry lobbying. The SSB industry was perceived as a central actor in the Sugar Tax's policymaking process, as participants believed the industry deployed a powerful lobby to prevent the policy's approval. A similar scenario happened in the Danish 'Fat Tax' where the industry was deeply involved in the policymaking process, which secured political opposition to the tax once it had been implemented; however, unlike Chile's Sugar Tax, the policy was dropped less than a year after (Bodker et al., 2015). The role of the political support and opposition is key in the policy design and implementation of tax policies (Wright et al., 2017). In the state of New York in the United States, for example, political opposition to a proposed SSB tax in 2009 contributed to the tax proposal being withdrawn before its implementation (Isett et al., 2015), while in contrast, the strong advocacy efforts in Mexico to combat multi-stakeholder opposition led to Mexico's tax being successfully approved (Donaldson, 2015).

Most participants perceived that the lack of a communication campaign alongside the Sugar Tax implementation was an important factor missing in the policymaking process that could have helped counterbalance the industry's opposition. While some participants believed that this was due to the fiscal rather than health frame of the wider Tax Reform, others explained that these campaigns are usually too expensive and there was no funding available. A common consequence of the lack of communication campaign perceived by participants was the insufficient knowledge of the policy in the general public. Studies show that communication campaigns and media coverage of proposed or already implemented health taxes effectively shape the public's opinion and help to increase advocacy efforts to achieve broader societal change (Wright et al., 2017; Watt et al., 2019). Mexico's SSB tax provides a good example of this, where public health advocates successfully raised support from the general public and government to approve the policy (Alvarez-Sanchez, 2018).

Table 41. Integration of main findings – Objective 3: To increase the understanding of Chile's SSB Tax policy's policymaking process

Study findings			Mixed-methods fit of integration
Systematic review (Chapter 4)	**Survey analysis (Chapter 5)**	**Qualitative case study (Chapters 6 & 7)**	
(No relevant findings)	(No relevant findings)	- Most participants believed that the Sugar Tax advanced up political agenda for two reasons: the obesity epidemic and the introduction of the Tax Reform. However, government participants who were directly involved in the policy formulation explained that the idea of increasing SSB taxes was accidental, relating to revision of the existing Alcohol Law, which already included SSB. Other reasons included: introducing small taxes on varied items was more politically acceptable than big taxes, modifying an existing tax was easier than creating new ones, and given the corrective nature, it would attract more votes to approve the Tax Reform [Theme 2]. - The majority believed that the policy was drafted without consulting the evidence or health officials, and was subsequently rushed into Congress. Some believed that policymakers were looking for political and industry acceptance, while others blamed the wider Tax Reform in which the policy was formulated, the low priority it was given compared to other taxes in terms of revenue generation, and the lack of time and resources. They all compared the Sugar Tax's formulation process with the Labelling Policy, which unlike the Sugar Tax, was designed in a public health framework, considering the evidence and citizen's opinion [Theme 2]. - Factors described that might have influenced the debate in Congress and led to the final Sugar Tax design included the lack of participation of civil groups, academia and Ministry of Health, industry lobbying, partisan politics and low priority within the wider Tax Reform. To approve the Sugar Tax, some legislators demanded the creation of an 8% gap tax between high and low-sugar beverages, which was agreed together with the creation of two commissions of experts to study the effectiveness of this policy [Theme 2]. - There was a common belief that oral health was unlikely to have been considered in the design and formulation of the Sugar Tax, as one participant pointed out [Theme 2]: "The political pressure is completely proportional to your ability to mobilise voters. […] Cavities are not going to do the political trick, despite their social value, and high costs." (GOV_004) - Participants raised concerns about the lack of a communicational campaign alongside the Sugar Tax implementation. Whilst some participants believed that this was due to the fiscal aim of the Tax Reform, others explained that these are "expensive, and resources are not available for this type of topics." (GOV_005) They believed that, in consequence, just a few know the existence of the policy [Theme 2]. - The SSB industry was identified as a central actor in the Sugar Tax's policymaking process. Participants believed the industry deployed a powerful lobby to prevent the policy's approval or at least influence the design as they were reformulating their products according to the policy's threshold, which too low would have affected the taste of their products [Themes 2 and 3].	The effect of the policy might be explained by sub-optimal design resulting from a policymaking process that was more focused on raising revenue than improving population health, and which lacked transparency, public awareness and a clear evidence base.

8.2.4 Thesis overall aim: To assess the effect of the Sugar Tax on oral health

To address the thesis overall aim I integrated the findings from the three studies. First, I combined the findings from the systematic review with the findings from the survey analysis (see Chapter 5, section 5.5), which showed changes in consumption levels after the policy implementation and the likely risk associated in terms of dental caries and tooth erosion. Second, I integrated these findings with the perceptions of policy actors who were involved in the policymaking process to explore their views on the policy and its likely effect on oral health.

Although obesity was regarded as a more urgent health problem than any oral health problem by the majority of participants, most of them believed that the Sugar Tax was, in general, an appropriate intervention to push the industry to reformulate their products, reduce SSB consumption and the risk of oral diseases; however, they were not sure if the policy had been effective in reducing the risk of oral health problems in the population. The systematic review and quantitative study combined results supported this opinion. As I described in Chapter 5, section 5.5, the volume of SSB consumption increased from 2011/12 to 2016/17 with a net movement from low to high consumption levels for all deprivation groups, thereby suggesting that it is likely that population risk for caries and erosion increased after the implementation of the Sugar Tax in 2014, depending on length of exposure to higher levels of consumption. From the systematic review, it is likely that the risk for the population moving from low to moderate level consumption is associated with 0.82 more DMFT/dmft on average, 1.52 more odds of having caries and 1.70 odds of having erosion; and for the population moving from moderate to high level consumption the likely increased risk is associated with 1.16 more DMFT/dmft on average, 1.48 more odds of having caries and 2.67 more odds of having erosion.

While product reformulation was perceived as a positive policy outcome, shifting consumption from high to low or zero-sugar beverages still represents a risk for oral diseases. There is robust evidence supporting that artificially-sweetened beverages are also harmful to teeth as they are still acidic (Tahmassebi and BaniHani, 2020; Stephan and Miller, 1943). The harmful effect of SSB acidity on oral health is therefore an important factor to consider when designing SSB taxation policies.

There was a common belief among non-industry participants that in order to have a positive oral health impact, the Sugar Tax policy needed to undergo a re-design process and seven suggestions were proposed in the interviews. First, the Sugar Tax

needed to be reframed as a public health policy. As I previously discussed, although the tax was widely framed as health-related, it was designed as a revenue collection tool. The evidence shows that policy framing strategies could have important implications for public and government acceptability of SSB taxes, as policy-acceptance is generally lower when there are doubts about the true purpose of a tax (Eykelenboom et al., 2019).

Second, policy effectiveness and acceptability to policymakers could be increased by allocating revenue to general and oral health promotion strategies. Experience from other countries shows that the use of tax revenue to health-related strategies enhances support of SSB taxes in the general public and government (Tamir et al., 2018). However, as government participants explained, tax earmarking is not permitted in Chile.

Third, non-industry participants thought the tax increase was not enough to have evident pass through in prices. This is supported in Caro et al (2017) study, which concluded that as the modifications of the Sugar Tax were small, changes in prices and purchases after the tax were also small, and this was unlikely to promote large enough changes in SSB purchases to reduce health problems. Interview participants proposed a rise in the tax rate, as the evidence from modelling suggests that SSB prices need to be increased at least by 20% to significantly impact oral health (Sowa et al., 2019).

Fourth, participants with a health-economics background suggested that the tax would be more effective in reducing SSB consumption if it was specific rather than ad-valorem. Wright et al. (2017), in their systematic review, found that specific taxes (i.e. a fixed value based on the quantity, size or weight of the product) were associated with more robust health benefits than ad-valorem taxes. A consequence of the latter, which is how Chile's Sugar Tax is applied, is that as this tax is proportionate to the product price, more expensive products result in higher taxes, providing scope for consumers to buy cheaper brands or other unhealthy options. This was another criticism raised by non-industry participants, who thought that the final design of the policy led to consumers substituting taxed products for similar, lowered-taxed alternatives which were not necessarily healthier.

Fifth, there was a common belief that the Sugar Tax should be complemented with water consumption incentives to nudge people to move from SSB to water rather than another unhealthy beverage. The evidence shows that the combination of taxes

and subsidies can have large behavioural and health impacts and offset the regressive nature of taxes (Wright et al., 2017). Participants acknowledged that plain water was the best substitute for SSB and oral health improvement in the population as unlike SSB, water does not contain sugar, has a neutral pH, and at least in Chile, fluoridated water is widely available for the vast majority of the population. This perception aligns with the evidence, which shows that the combination of water consumption with low SSB consumption is associated with lower total energy intake (Shamah-Levy et al., 2016). Furthermore, due to fluoridation, water consumption helps to ameliorate the association between SSB and dental caries (Armfield et al., 2013).

However, participants commented that substituting SSB for water was challenging due to the policy's differential tax design. Instead, they perceived the final design of the policy to be an incentive to move consumption from high- to low-sugar beverages rather than water, which was exacerbated by the industry's efforts to maintain consumers' loyalty to SSB rather than water as SSB are more profitable than water as industry participants explained. Non-industry participants believed the industry was also responsible for the lack of effectiveness of the policy on oral health as they were reducing the amount of sugar just below the threshold instead of completely removing them from their products. This has been documented in other countries with food taxes. For example, in Hungary, although a few industry manufacturers removed the taxed ingredient completely, the majority instead reduced it below the taxed threshold (ECSIP, 2014).

The sixth suggestion relates to strong industry regulatory measures. Non-industry participants believed that the government needed to employ a comprehensive package of upstream and midstream interventions regulating access, availability and marketing of SSB. However, some participants explained that this was covered with the Labelling and Marketing policy introduced in Chile the following year of the Sugar Tax. These policies were brought up in almost all interviews as participants compared their policymaking process with the Sugar Tax. They highlighted the communication campaign that, unlike the case of the Sugar Tax, was widely deployed during the formulation and implementation of these policies, increasing advocacy and support for the policy in government and increased the awareness in the population. Communication campaigns provide an opportunity for the kind of effective advocacy required for successful health and oral health interventions and create increased awareness of the importance of oral health in the population more generally. However, these kind of campaigns can also fail, hence the need for using levers like taxes.

Table 42. Integration of main findings – Thesis overall aim: To assess the potential effect of the Sugar Tax on oral health

Study findings			Mixed-methods fit of integration
Systematic review (Chapter 4)	**Survey analysis (Chapter 5)**	**Qualitative case study (Chapters 6 & 7)**	
- Combined findings from the systematic review and the quantitative study suggest that there was a net movement from low to higher level SSB consumption between 2011/12 and 2016/17 for all deprivation groups, and this is likely to have increased population risk for caries and erosion, depending on length of exposure to higher levels of consumption. - Moving from low to moderate level consumption is associated with 0.82 more DMFT/dmft on average, and increases odds of caries by 52% and erosion by 70%. - Moving from moderate to high level consumption is associated with 1.16 more DMFT/dmft on average, and increases odds of caries by 48% and erosion by 167%.		- There was a general perception that obesity and other general health problems were more urgent and relevant than oral health when the implications of the Sugar Tax were discussed. However, participants believed that the Sugar Tax was in general, an effective tool to reduce the risk of oral diseases [Theme 4]: "If the effectiveness of the tax reduces the consumption of sugars, then it should affect the incidence and prevalence of dental diseases." (ACA_005) - Participants recognised water as a valuable substitute for SSB and oral health improvement in the population. Many highlighted Chile's unique condition where the vast majority have access to drinking and fluoridated water. However, they commented that this substitution was challenging due to the policy's differential tax design, which was believed to be an incentive to move consumption from high- to low-sugar beverages instead of water, and to the industry's efforts to maintain consumers' loyalty to SSB rather than water as SSB are more profitable than water [Themes 1, 3 and 4]: "We care that people have water as an alternative, but keep sugary drinks as the main refreshment. [...] the logistic and operational cost of water is much higher […] We are going to try to delay it as much as possible with other healthy products." (BEV_001) - Participants expressed concern about the industry tactic of reducing the amount of sugar just below the threshold instead of removing sugars from their products [Theme 3]. - Participants believed that the Sugar Tax needed to undergo a re-design process within a public health framework, complemented with a comprehensive package of strategies. Suggestions to improve the current Sugar Tax included: higher tax rates; change in the mode of application based on evidence; the introduction of water consumption incentives; improvement of awareness of oral health risk of SSB consumption through education and communicational campaigns; new regulations for access, availability and marketing of SSB; and cultural change [Theme 4].	- Participants' perception about the ineffectiveness of the Sugar Tax on oral health was **confirmed** with the findings from the combined analysis from the systematic review and quantitative study. However, these findings are **discordant** with some evidence from modelling studies which assumed different levels of taxation. - The qualitative findings **expanded** on the quantitative results by providing a series of suggestions to improve the Sugar Tax policy and increase its effectiveness.

8.3 Summary of integrated findings and thesis contribution

The overall aim of my PhD thesis was to generate an in-depth understanding of the potential effect of the Chilean Sugar Tax on oral health. For this I conducted a convergent mixed methods study that included three studies:

- a systematic review to quantify the relationship between SSB consumption levels and dental caries and erosion;
- a survey analysis to describe changes of SSB consumption from before and after the policy implementation in Chile;
- a qualitative case study to increase the understanding of the policymaking process and its implications on oral health to better explore the effect of the policy on oral health in Chile.

The following integrated findings therefore take into account national perceptions and circumstances. They revealed that in Chile levels of SSB consumption were extremely high by international standards prior to implementation of the Sugar Tax, and increased further afterwards suggesting that the policy was not effective in reducing SSB consumption. The findings also showed that SSB consumption and dental caries and erosion are positively associated and follow a dose-response relationship, and the continuing high SSB consumption levels in Chile therefore are likely to expose the population to serious dental risk. Policy actors' accounts supported these findings and provided further explanations for the high SSB consumption and the low perceived effectiveness of the Sugar Tax policy on oral health.

Although the quantitative study revealed that there was a net movement of people from low to high consumption levels for all deprivation groups, thereby suggesting that it is likely that population risk for caries and erosion increased after the implementation of the Sugar Tax in 2014, depending on length of exposure to higher levels of consumption, interview participants, in general, described the policy as a useful public health strategy to push the industry to reformulate their products and a necessary approach to reduce SSB consumption in the population. However, they thought that many aspects of the policymaking process were flawed and the final design of the policy was sub-optimal, and went on to provide a series of recommendations to complement the policy and improve its design to enhance its effectiveness in general and oral health. Among many, these included to re-frame the

Sugar Tax as a public health policy, increase the tax rate, use the evidence in the design and deploy a mass communicational campaign.

The findings also revealed that the Sugar Tax policymaking process was the result of political expediency, lacked transparency and there was no apparent option for appealing against the decisions taken. Lack of transparency in policy processes generates distrust from the general public, making them less receptive to government initiatives, especially when these do not fit the interests and needs of the population (Piotrowski and Van Ryzin, 2007). In contrast, transparency in policymaking can contribute to the enhancement of government accountability to its citizens making them more responsive to new policies (Bauhr and Grimes, 2014). Likewise, it can expand the collaboration between government and other non-government groups to improve advocacy efforts to support the implementation and the impact of policies, and help to reduce the information asymmetry between beverage consumers and producers.

The qualitative case study findings also shed light on perceived low public awareness of the detrimental effects of SSB consumption on oral health and the potential impact of the Sugar Tax policy on dental public health. Corrective taxes present an opportunity to publicly educate consumers with the powerful message conveyed on the damaging effects associated with SSB consumption (Alvarez-Sanchez, 2018); however, as the implementation of the Sugar Tax was not successfully communicated to the population, this opportunity was missed. Unlike obesity, which was regarded as the primary health problem related to the policy and SSB consumption, oral health was not considered by itself to have sufficient political weight to influence policymakers. This is unfortunate and surprising given the social and economic consequences of oral health problems on societies and governments (Bagramian, Garcia-Godoy and Volpe, 2009; Peres et al., 2019).

It is important to highlight the role of the acidic pH that is present in both natural and artificially-sweetened beverages. As the Sugar Tax is a two-tiered policy, which imposes a tax on both types of beverages (BCN, 2015), even if the Sugar Tax successfully resulted in product reformulation and a shift in people's consumption from high to low-sugar beverages, the risks of having oral health problems is likely to continue unless people start replacing SSB for water (Tahmassebi and BaniHani, 2020).

This thesis provides new evidence about the potential effect of SSB taxes on oral health, drawing attention to the key factors that need to be considered when

designing this policy and the different elements regarding the local context that underpin the process and the later effect. This thesis also contributes new knowledge to dental public health, particularly to those concerned with the design and implementation of oral health strategies at structural and commercial levels, offering new insights into the low level of relevance of oral health problems in the formulation of policies.

The integrated findings suggest that taxation policy remains a potentially useful tool for improving dental public health, but a more public health oriented and evidence-informed policymaking process is required, which combines taxation changes with complementary public health approaches. Using upstream strategies at the policy level to restrict SSB consumption contrasts with many of the existing approaches employed by governments, which continue to focus on implementing strategies at the individual level, such as dental treatment and education (Watt et al., 2019). This research draws attention to the importance of tackling SSB consumption at the policy levels by focusing on the structural and commercial determinants of oral health and its inequalities. It expands our understandings of the relationships between the environment and the cultural context and people's personal choice.

8.4 Integrated findings in the context of the current evidence

Most of the findings of this thesis are consistent with existing related evidence and many aspects that I discussed in this chapter relate to other corrective taxes, such as alcohol and tobacco taxes (Moodie et al., 2013; Thomson et al., 2018); however, there are some findings that need further discussion.

The quantitative findings of this thesis differ in part with the findings of the recently published policy evaluation of the Mexican SSB tax conducted by Hernandez and colleagues (2021) that estimated changes in oral health using empirical data. The researchers found statistically significant reductions in the probability of having experienced dental caries for all age groups, except for children under 5 years old and in the number of teeth with caries. However, unlike my research, this study considered the impact of both SSB and unhealthy food taxes as they were implemented simultaneously in Mexico in January 2014.

Other studies have also found a positive impact of SSB tax policies on oral health (Briggs et al., 2017; Schwendicke et al., 2016; Sowa et al., 2019; Jevdjevic et al., 2019; Urwannachotima et al., 2020); however, it should be noted that these studies

are modelling and simulation-based studies based on estimated taxation rates that are higher than the actual rates implemented.

Existing studies show that increasing taxes on items that are detrimental to health leads to reduced SSB consumption and can also be a valuable source of revenue for the government. Although my thesis did not support this in the case of the Sugar Tax in Chile, many factors relating to the design of taxation policy, including its primary purpose and the tax rate, were identified by most participants and have been documented in the literature that are key for its success (Wright et al., 2017).

Existing research also suggests that SSB taxes can impose a progressive way to rebalance the regressive health impacts of SSB as SSB taxes produce greater reductions in consumption in low-SES groups given their higher response to price changes (Powell et al., 2013; Backholer et al., 2016; Wright et al., 2017). However, my findings demonstrated that the per capita consumption increase was seen for all socioeconomic groups after the policy implementation. It is important to note that people may have shifted from high- to low-sugar beverages and it was not possible to differentiate between these using the EPF surveys. Another possible explanation for this finding could be the social status desirability of SSB among low-SES groups described by the interview participants (see Chapter 7, section 7.3.1).

8.5 Strengths and limitations of this thesis

Using both quantitative and qualitative methods is the main strength of this PhD thesis as each of the methods I employed provided their own merits and integrating findings enabled me to present a comprehensive view of the potential effect of the Sugar Tax on oral health. This thesis is, to my knowledge, the first research study to provide a broad overview of the policymaking process of the Chilean Sugar Tax and its potential effect on oral health. However, there are some limitations related to the data sources that need consideration.

The systematic review included general populations from different countries and their SSB consumption did not take into account the length of consumption. The quantitative analysis was based on two cross-sectional surveys from Chile. For these reasons, the combined findings cannot conclude that individuals indeed increased their SSB consumption and thus their oral health risks after the policy implementation. Instead, the findings suggest the likely effect of the policy on population risk of dental caries and tooth erosion. Furthermore, as the Sugar Tax covered the whole country,

the analyses did not consider a comparison group or counterfactual, i.e., what would have happened without the policy in the same time period. It is possible that SSB consumption could have increased by more without the policy.

Further research strengths and limitations inherent to each study need some attention, which I discuss in the following sub-sections.

8.5.1 Systematic review

The systematic review has many strengths, principally that it is the first review study to quantify the association between SSB and dental caries and tooth erosion, providing a dose-response relationship and comparing different levels of consumption. Additionally, the search strategy I used was highly comprehensive, including a wide range of search terms and different searching engines with no language and date restrictions. This allowed me to identify and include all relevant studies published until early 2021. Furthermore, I used robust methods to synthesise the evidence from a variety of countries and I provided a detailed assessment of the characteristics of the included studies showing the quality and certainty levels of the evidence. I assessed the latter for each outcome using the GRADE approach, rated strong for dental caries and most of the erosion subgroup meta-analyses and moderate for the subgroup analyses using DMFT scores. These certainty levels were shaped by the strong effects found in the analyses, the low risk of bias in the majority of the studies and the lack of publication bias. These levels assure that the findings of this review are robust and can inform future public health policies regarding SSB consumption and oral health.

I must, however, note some limitations of this study. I only included studies written in English and Spanish, which may limit the generalisability of the findings. Many of the included studies had very small sample sizes and some did not justify the sample sizes that were used. Therefore, these studies may have underpowered the findings from the study. Additionally, I did not adjust the data extracted from the studies for potential confounders, as only a few studies provided additional information about contextual factors, such as SES and fluoridated water. Some studies did not differentiate between the type of beverage, e.g., sparkling juices or sports drinks, instead reported combined data for all carbonated beverages, which could have introduced some measurement bias as different beverages have different pH levels added sugar. Finally, the actual doses of sugar and acid in the portions of SSB were not reported, which could have led to some degree of misclassification as some

beverages categorised as sugar-sweetened beverages may have contained natural sweeteners.

8.5.2 Quantitative study

The survey analysis has many strengths. First, using data from the EPF survey, a large and nationally representative survey, I was able to conduct a comprehensive analysis of household SSB consumption expenditure at the national level. Second, this dataset allowed me to take into account variations according to SES. Third, as the survey is repeated over time and follow OECD standards for data collection and reporting, I was able to investigate in detail the data comparing the two surveys.

However, certain limitations of this study may reduce the robustness of the conclusions drawn from the findings. First, although the surveys allowed me to make before and after data comparisons, this evaluation design is inherently vulnerable to threats to internal validity (Shadish et al., 2002). For example, the cross-sectional design of the surveys provided a snapshot of SSB consumption expenditure data in two-time points without considering other demographic, seasonal or budgetary factors that may have taken place in the time interval. This represents a history threat to the study's internal validity and could have led to a misestimating of the policy effect (Grimshaw et al., 2000). Additionally, the surveys included two different samples, which although the descriptive analyses showed that they had similar demographics, they still may have differed in other ways representing alternative explanations for the observed effect (Shadish et al., 2002). Third, the SSB consumption expenditure data was recorded at the household level only. Although I was able to make per capita calculations using age-standardised scales, this limited the analysis at the individual level as the demographic information of household members could not be taken into account. Third, I needed to use data from another study to estimate consumption levels as the EPF survey provided expenditure data, which could have underestimated or overestimated the real SSB consumption levels in Chile. Finally, the beverage classification used in the EPF surveys was not optimal as it did not distinguish between sugar and non-sugar beverages. This is an important limitation to highlight given the two-tiered design of the Sugar Tax policy and the possible differential effect of these two SSB types on dental caries and erosion due to the presence or absence of sugar.

8.5.3 Qualitative case study

The qualitative case study also has many strengths. It contributes to a greater understanding of the Sugar Tax policymaking process through the triangulation of

different policy actors' perspectives, which increased the trustworthiness of the research. As I interviewed policy actors from different sectors, the credibility of the findings was enriched as the diverse points of view of the policymaking process served to corroborate the evidence and show opposing perceptions. Additionally, the study fills a gap in the current evidence base by adopting a wider exploratory approach and providing a detailed exploration of the implications of taxation policies in the field of dental public health. These implications are important amidst a background of the increasing prevalence of dental diseases around the globe and the current trend of implementing SSB taxes to reduce SSB consumption. The case study methodology also enabled me to explore policy-relevant questions useful to policymakers contemplating the introduction of SSB tax policies. As I described in detail the processes I undertook in this study in Chapter 6, I provided evidence of the research quality and credibility. The analytical process I followed ensured comprehensiveness in the study findings. It enhanced their accuracy by using two thematic analysis approaches (thematic analysis and framework analysis) and checking the interview coding with a second researcher. As described in Chapter 6, I used a combination of techniques to ensure the highest rigour and to enhance the trustworthiness and credibility of this study. With a rigorous and transparent approach, I provided a reflexive account of my position as a researcher and I presented a detailed description of the methods and findings following recommendations of renowned researchers (Creswell and Poth, 2018; Mays and Pope, 2006; Patton, 1999; Yin, 2018). Lastly, I maintained the confidentiality of the participants' data and their anonymity at all times. This is particularly important in studies where a limited group of people can provide the necessary information given their key roles or level of involvement in the policy process (Lancaster, 2017).

However, there are some limitations to consider. First, the accounts represented in this study are specific to its 23 participants. Although their positions as leaders in their fields make them appropriate representatives of their sectors, given the qualitative nature of the study, their views may not reflect the perspectives of all policy actors. In addition, the views expressed in the interviews may have been biased by social desirability. I tried to limit such bias by instructing the participants before their interview to express their views from their professional role rather than their personal opinions. Second, as I conducted the data collection, I may have influenced the dynamics of the interviews and participants' responses given my dental background. This is important to consider, as participants' attitudes and answers could have been

different with a researcher from a different field. Additionally, as I conducted the analysis and interpretation, I may have introduced some bias to the analysis due to my previous knowledge and assumptions in the topic. However, the consistency of findings across the interviews and with the literature reflects on the trustworthiness of my research.

8.6 Implications and recommendations

8.6.1 Future research

The findings of this PhD thesis highlighted further areas that may need more research in order to reveal more about the potential impact of SSB taxes on oral health outcomes. First, the current evidence base on SSB taxes and oral health mostly relies on modelling and simulation studies. This may be explained by the relatively recent implementation of the tax policies, by the complex association between SSB consumption and oral health outcomes, or by the relatively low importance given to oral health problems in policy research (Watt et al., 2019). For policymakers to make evidence-based decisions about policy implementation, they need reliable data on the effectiveness of policies and the effect of confounders. Therefore, further research is needed using rigorously designed quasi-experimental studies, taking into account a comparison group or time period as similar as possible to the group with the intervention or similar in terms of baselines characteristics that reflect the counterfactual (i.e., outcomes if the intervention had not been implemented) to increase the confidence that the effect estimates can be attributed to the intervention (Shadish et al., 2002).

Second, concerning the Sugar Tax in Chile, as I needed to use the findings from the systematic review in order to assess the impact of the policy on oral health given the lack of oral health data available in the country, further research is needed using local oral health data instead of averages from other populations. This would capture the impact of the policy on oral health considering the local factors and controlling for confounders that might influence the association between SSB consumption and oral health.

Third, as I described in the systematic review (Chapter 4), previous studies investigating the association between SSB consumption and oral health outcomes used a cross-sectional study design, a large variety of SSB and tooth erosion measurement methods, and small samples sizes. Hence, it is important that future

studies use well-designed longitudinal studies exploring the effect of different types of SSB, in different age groups, especially in older age groups as caries and erosion are cumulative diseases, using larger sample sizes and taking into account important confounders such as SES. Additionally, there is a need for a standardised method to quantify and measure SSB consumption, as has been implemented in alcohol consumption research (Mongan, 2015) to facilitate future research in this area and enable public health officials to use this evidence to develop guidelines and intake recommendations across populations.

Fourth, as tooth erosion can be caused by extrinsic acids from the diet as it was explored in the systematic review, but also by intrinsic acids from other health conditions (e.g. bulimia and gastro-oesophageal reflux) (Rytomaa et al., 1998), it is associated with other forms of mechanical tooth wear (Piangprach et al., 2009), and other factors may influence the relationship found in the review, such as salivary flow and buffer capacity, its aetiological factors need to be clearly understood in order to establish strategies to reduce or prevent the development of this condition. The systematic review fills part of this gap, although further research should be undertaken to explore to what extent these factors influence the relationship that was found.

Fifth, another research priority is the further investigation of the voices of the general population, which are limited in the qualitative study. More research is needed to further our understanding of the general public's views from different age and SES groups about SSB consumption, the policy, and the implications on oral health as they are targeted when policies are implemented. What was clear from the qualitative study is that the lack of transparency of the policymaking process and the absence of a communicational campaign complementing the Sugar Tax implementation resulted in a general lack of awareness of the policy existence. Therefore, learning more about the views from people in the general population can be highlighted as an area for future research.

8.6.2 Policy implications

The findings from this mixed methods thesis revealed important implications for policymakers and policy in general. It addressed a series of questions that policy actors considering health taxes need to contemplate before designing a new SSB tax policy.

The integrated findings provided a strong argument for taking action on reducing SSB consumption by using strategies at the policy level. However, policies such as the Sugar Tax can be structured and implemented in varied ways, and their

impact on health will depend on the policy design, implementation strategy and the local context. My thesis' findings ultimately suggested that Chile's Sugar Tax has great potential as a public health strategy; however, its design and some aspects of its implementation may have limited its success.

The findings also shed light on the importance of setting clear objectives when designing SSB tax policies, as some objectives may conflict. If the purpose of the tax is to improve health via behavioural change, it must be set at a sufficiently high level at least 20% of the sale price to be effective in improving the oral health status of the population (Sowa et al., 2019). In contrast, if the tax aim is to raise revenue (whether these are earmarked for health purposes or not), then taxes set at a rate that is high enough to incentivise behavioural changes may be less desirable since this will reduce the stability of associated revenues, and a lower rate may be more appropriate (Wright et al., 2017).

This case study provided evidence about the importance of transparency in the early stages of the policymaking process of this type of policies. It showed the need for stronger leadership from health officials and early participation of potential allies to the policy, such as academics, civil society and advocacy groups, who have proved to be important players in the approval of health policies in other countries counterbalancing the opposition from the industry. Moreover, the case of Chile's Sugar Tax demonstrated the need for strong communicational campaigns to increase awareness and advocacy of such policies among non-government groups which would ultimately help to engage the general public in the debate and increase their receptiveness towards the policy. This is important as public support for SSB taxes is significantly higher when appropriate communicational campaigns explaining the policy's purpose and the associated risks of SSB consumption on health are employed (Wright et al., 2017; Alvarez-Sanchez, 2018). Therefore, policymakers should consider this to increase public support for an SSB tax.

Although I discussed that the tax revenue would be best to be directed to health promotion or subsidies of healthier products, which could also be used as a tool for reducing health inequalities, in countries such as Chile where tax earmarking is not possible as it is unconstitutional, governments should still communicate transparently to the public about the true destination of the tax to prevent government and policy mistrust. Additionally, this would also encourage support from the public health

community (e.g., non-governmental organisations, civil society, researchers and practitioners) which may help offset the influence of industry interests.

The tax revenue also represents an opportunity in dental public health to subsidise fluoride toothpaste and make it more affordable as even in high income countries some families are unable to access them (Wordley et al., 2017). There is robust evidence from systematic reviews supporting the effectiveness of daily use of fluoride in oral health prevention (Iheozor-Ejiofor et al., 2015; Welsh et al., 2019); therefore, affordable toothpaste can be a cost-effective strategy to lessen the impact of the current oral health disease epidemic.

SSB tax policies alone may not be totally effective in reducing SSB consumption. Instead, a comprehensive package of upstream, midstream and downstream strategies should be adopted (Watt et al., 2019). Apart from well-designed interventions regulating the access, price, availability and marketing of SSB, innovative and powerful oral health communication and mass educational initiatives should be part of this package as they have shown to be effective in improving oral health hygiene in the population (Thomson et al., 2018). Parents and caregivers need to fully understand the potential damaging effect of SSB consumption on teeth. This is important as the evidence shows that eating and drinking behaviours during adulthood start in early years as a result of the influence of peers and parents (Krukowski et al., 2014). Likewise, cultural practices, beliefs and contextual characteristics are further factors that need to be considered when designing policies. This will help policymakers target their policies to enable people to make healthier choices.

8.7 Conclusion

Within the limitations of currently available data sources and methodologies, the integrated findings showed that in Chile levels of SSB consumption were extremely high by international standards, and increased further after the Sugar Tax implementation as there was a net movement from low to high consumption levels for all deprivation groups in the population. This finding suggests that the continuing high SSB consumption levels in Chile are likely to expose the population to serious dental risk, depending on length of exposure, as SSB consumption and dental caries and erosion are positively associated and follow a dose-response relationship.

Interview participants, in general, believed the policy was an appropriate public health strategy and necessary tool given the high levels of SSB consumption in Chile.

The qualitative findings also suggested that the apparent failure of the policy might be explained by sub-optimal design resulting from a policymaking process that was more focused on raising revenue than improving population health. The findings also suggest that the Sugar Tax was the result of political expediency, lacked transparency, public awareness, a clear evidence base and the option to appeal against the decisions that were taken.

Although more research is needed to fully understand the actual effectiveness of SSB tax policies on reducing oral health diseases and inequalities, the findings of this thesis provide a comprehensive account of the factors that need to be considered at the time of designing such policies. If the policy aims to reduce SSB consumption, then the evidence supports the implementation of taxes that increase the price of products by 20% or more. Hence, policymakers need to be clear about the policy's purpose and frame the tax accordingly, which may also help to survive the opposition from powerful industry lobbying. Moreover, in countries where revenue earmarking is possible, policymakers should consider this action as it tends to increase public support. Factors such as the policy frame, the magnitude of the tax, pass through rates, policymaking transparency, public awareness and understanding of the true purpose of the policy need to be carefully considered by policymakers to have a successful impact on dental public health policy.

In summary, Chile's Sugar Tax had the potential to reduce SSB consumption and lower the population risk of oral disease, but policy implementation was flawed. Using taxation policies remains a potentially useful intervention to reduce SSB consumption and improving public dental health. However, as illustrated by the findings reported in this thesis, taxation policy alone might not be enough to change consumption behaviours and a comprehensive package of public health oriented policies and evidence-informed policymaking process is required tackling the structural and commercial determinants of oral diseases.

Appendices

Appendix 1. (A-F) Search strategies

Appendix 1.A Embase 1974 to 2017 October 13 (16/10/2017)

Searches		Results	Update
1.	exp carbonated beverage/ or exp sugar-sweetened beverage/	3422	5390
2.	exp fruit juice/	10452	13334
3.	(fruit$ adj3 juice$).ab,ti	4756	6164
4.	((carbonated or calori$ or fizzy or soft or soda or energy or sugar$ or sweet$) adj3 (beverage$ or drink$)).ab,ti.	11692	16777
5.	SSB$.ab,ti.	6806	9240
6.	soda.ab,ti.	4215	5209
7.	dental health.ab,ti.	7630	8165
8.	dental caries.ab,ti.	15347	17849
9.	oral health.ab,ti.	19557	29128
10.	(dmf or dmft or dmfs or dft or deft or defs).ab,ti.	34485	55691
11.	exp DMF index/	321	1289
12.	exp tooth disease/	206547	222841
13.	(tooth or teeth or dental).ab,ti.	293145	335458
14.	tooth erosi$.ab,ti.	142	169
15.	(erosi$ adj3 wear).ab,ti.	288	534
16.	or/1-6	33953	44867
17.	or/7-15	435397	500275
18.	16 and 17	**1637**	**2228**

Appendix 1.B Cochrane Library (Wiley) (16/10/2017)

Searches		Results	Update
1.	MeSH descriptor: [Carbonated Beverages] explode all trees	153	285
2.	((carbonated or calori* or fizzy or soft or soda or energy or sugar* or sweet*) near (beverage* or drink*)):ab,ti	1221	2646
3.	SSB*:ab,ti	229	489
4.	(fruit* juice*):ab,ti	412	758
5.	MeSH descriptor: [Oral Health] explode all trees	321	32872
6.	(“oral health” or “dental health” or “dental caries” or tooth or teeth or dental):ab,ti	15856	29558
7.	MeSH descriptor: [Tooth Diseases] explode all trees	8573	2208
8.	MeSH descriptor: [DMF index] explode all trees	-	616
9.	((dmf or dmft or dmfs or dft or deft or defs) next index):ab,ti	42	108
10.	(tooth erosi*):ab,ti	68	231
11.	MeSH descriptor: [Tooth Erosion] explode all trees	193	407
12.	(erosi* near wear):ab,ti	-	58
13.	#1 or #2 or #3 or #4	1801	3671
14.	#5 or #6 or #7 or #8 or #9 or #10 or #11 or #12	19010	56470
15.	#13 and #14	**122**	**259**

Appendix 1.C SciELO (Web of Science) (16/10/2017)

Searches		Results	Update
1.	TS=((carbonated OR calori* OR fizzy OR soft OR soda OR energy OR sugar* OR sweet*) NEAR (beverage* OR drink*))	590	903
2.	TS=(fruit* NEAR juice*)	443	558
3.	TS=SSB*	2	64
4.	TS=soda*	427	587
5.	TS=(oral health)	2833	4259
6.	TS=(dental OR tooth OR teeth)	8986	12904
7.	TS=caries	1366	1970
8.	TS=(dmf or dmft or dmfs or dft or deft or defs)	798	1173
9.	TS=(tooth NEAR (erosi* OR wear*))	154	215
10.	#1 OR #2 OR #3 OR #4	1372	1969
11.	#5 OR #6 OR #7 OR #8 OR #9	10951	15780
12.	#10 AND #11	**57**	**84**

Appendix 1.D LILACS (VHL) 16.10.17

Searches		Results	Update
1.	(tw:("oral health" OR dental OR teeth OR tooth)) AND (tw:(((carbonated OR calori$ OR fizzy OR soft OR soda OR energy OR sugar$ OR sweet$) AND (beverage$ OR drink$)) OR (“sugar-sweetened beverage” OR “fruit juice$”)))	158 (Title, abstract, subject)	212

Appendix 1.E Open Grey 17.10.17

Searches		Results	Update
1.	abstract:((((carbonated OR calori* OR fizzy OR soft OR soda OR energy OR sugar* OR sweet*) AND (beverage* OR drink*)) OR (“sugar-sweetened beverage” OR “fruit juice*”))) AND ("oral health" OR dental OR teeth OR tooth))	8	0

Appendix 1.F HMIC Health Management Information Consortium 1979 to July 2017 (17.10.17)

Searches		Results	Update
1.	exp Soft drinks/	222	222
2.	exp Fruit juice/	15	15
3.	((carbonated or calori$ or fizzy or soft or soda or energy or sugar$ or sweet$) adj3 (beverage$ or drink$)).ab,ti.	274	275
4.	(fruit$ adj3 juice$).ab,ti	43	43
5.	SSB$.ab,ti.	48	48
6.	soda.ab,ti.	34	34
7.	exp Oral health/	536	536
8.	exp Dental health/	192	192
9.	exp Dental caries/	156	156
10.	exp Dental diseases/	281	281
11.	dental health.ab,ti.	388	388
12.	dental caries.ab,ti.	119	119
13.	oral health.ab,ti.	469	469
14.	(dmf or dmft or dmfs or dft or deft or defs).ab,ti.	51	51
15.	(tooth or teeth or dental).ab,ti.	3909	3909
16.	tooth erosi$.ab,ti.	1	1
17.	(erosi$ adj3 wear).ab,ti.	2	2
18.	1 or 2 or 3 or 4 or 5 or 6	434	434
19.	7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17	4153	4153
20.	18 and 19	**21**	**22**

Appendix 2. Data extraction form

Study ID	**Researcher**	**Date**
General Information		
Title		
Author		
Year		
Journal		
Country		
Study characteristics		
Aim/objectives		
Study design		
Eligibility criteria	Inclusion	Exclusion
Recruitment procedure		
Sample size		
Sample characteristics		
	Age	Gender
Any other characteristic		
Exposure & Setting		
Setting		
Type of SSB		
Method of assessment		
Measurement levels (freq/amount)		
Number of participants in each exposure level		
Outcome		
Oral health outcome	Caries	Erosion
Method of assessment		
Number of participants	Outcome (+)	Outcome (-)
Type of analysis		
Confounders		

Appendix 3. NIH's Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (modified version)

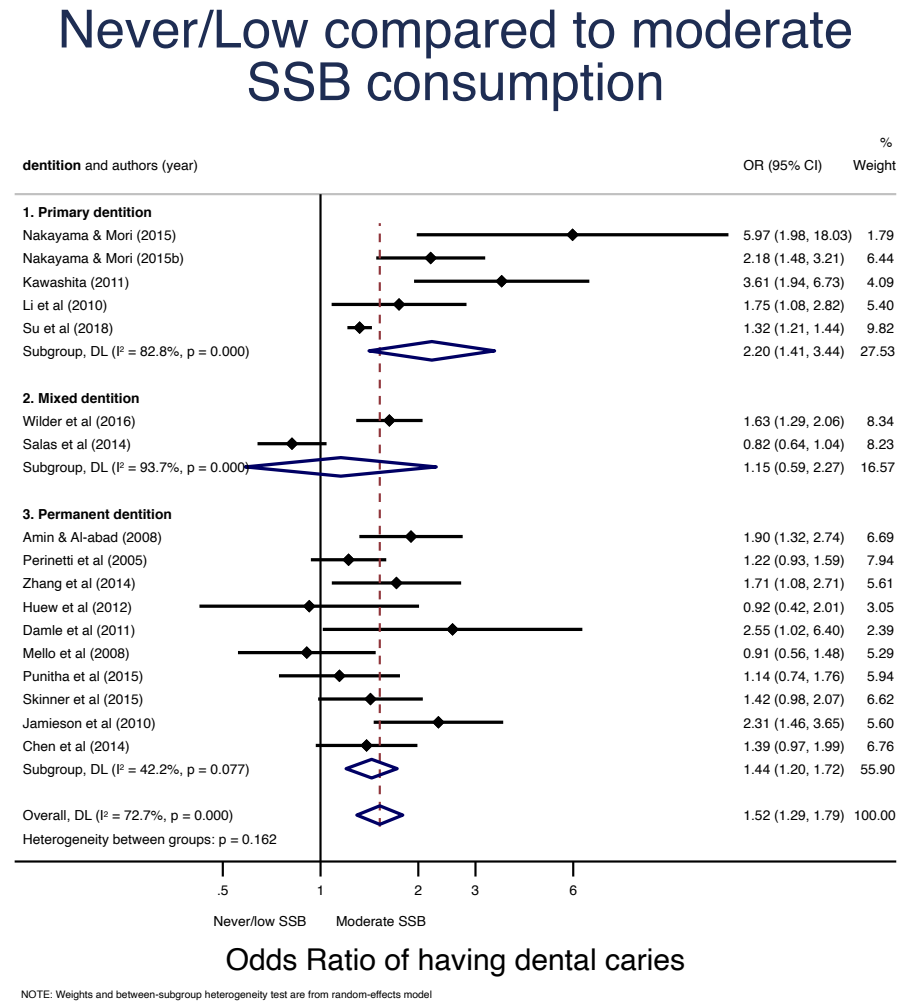
Study ID/ Author	**Assessed by**	**Date**		
Criteria		**Yes**	**No**	**Other (CD, NR, NA)**
1. Was the research question or objective in this paper clearly stated?				
2. Was the study population clearly specified and defined?				
3. Was the participation rate of eligible persons at least 50%?				
4. Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study pre-specified and applied uniformly to all participants?				
5. Was a sample size justification, power description, or variance and effect estimates provided?				
6. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?				
7. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?				
8. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?				
9. Were the outcome assessors blinded to the exposure status of participants?				
10. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?				

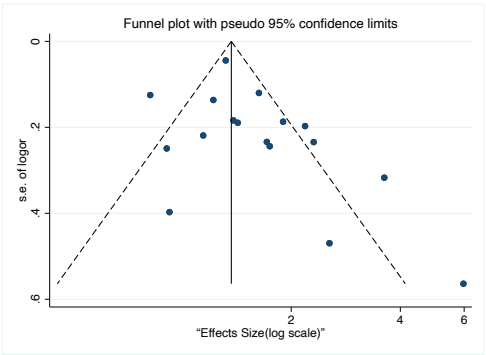
Quality Rating (Good, Fair, or Poor) (see guidance)
Rater #1 initials:
Rater #2 initials:
Additional Comments (If POOR, please state why):

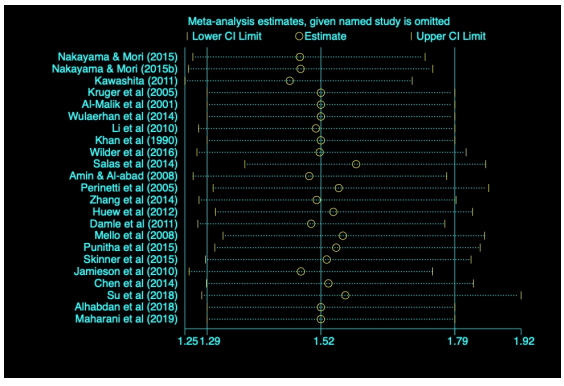
*CD, cannot determine; NA, not applicable; NR, not reported

Appendix 4. (A-D) Forest, Funnel and influence analysis plots

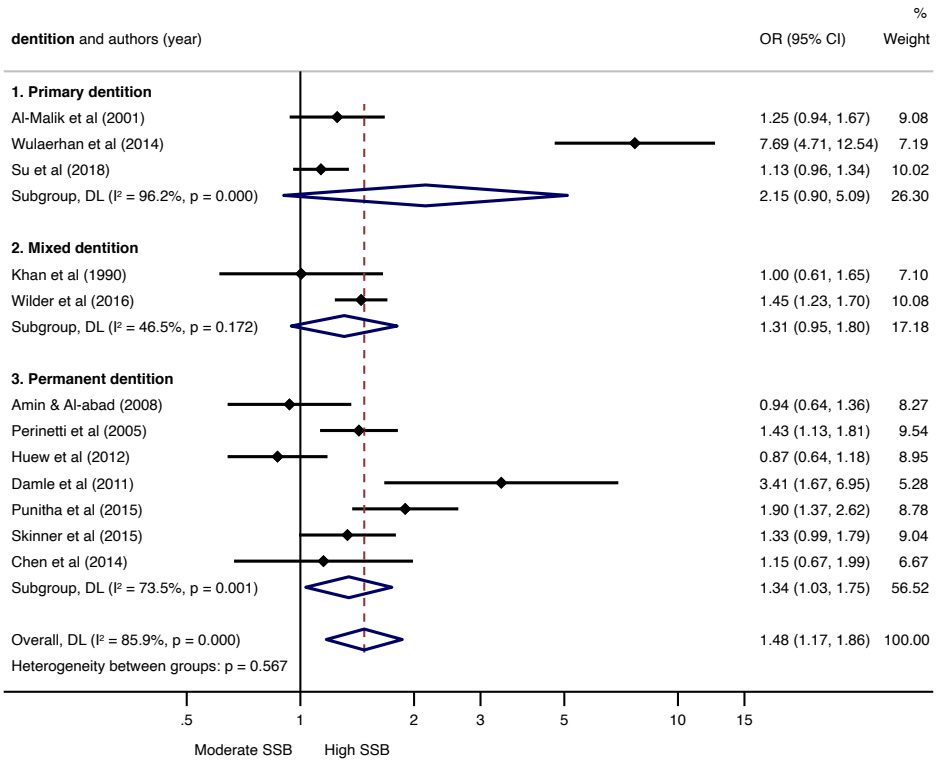
Appendix 4.A Forest, Funnel and influence analysis plots of the odds-ratio of having dental caries between different levels of SSB consumption.



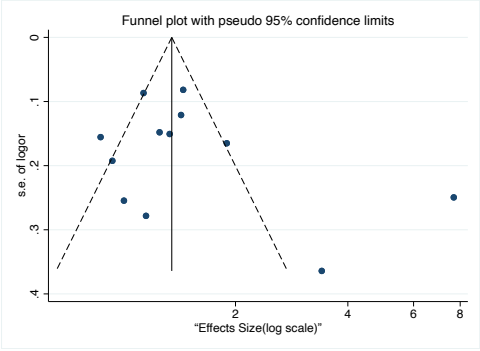


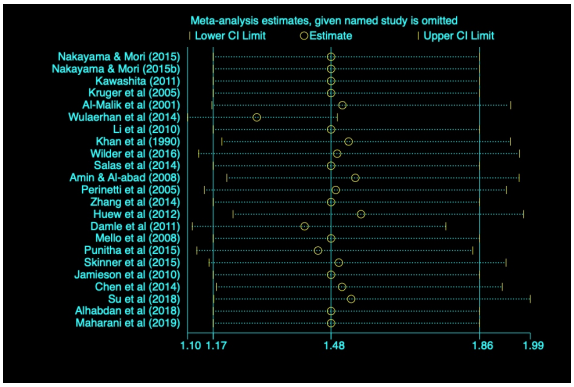


Moderate compared to high SSB consumption

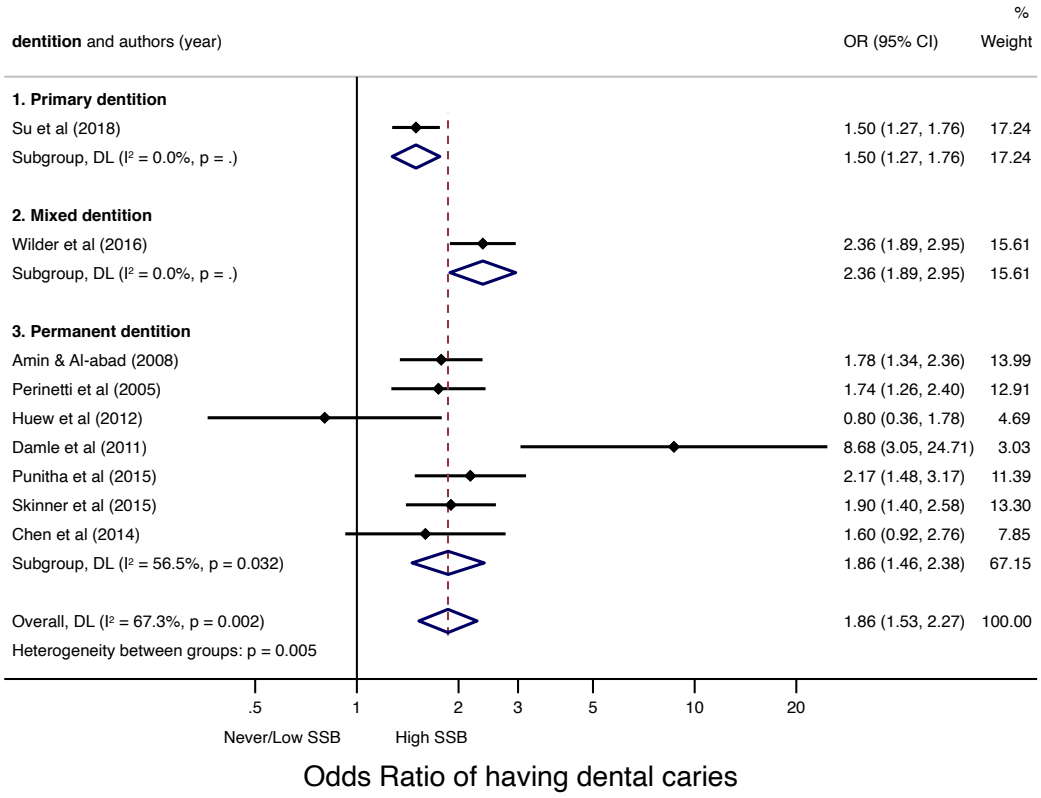


NOTE: Weights and between-subgroup heterogeneity test are from random-effects model

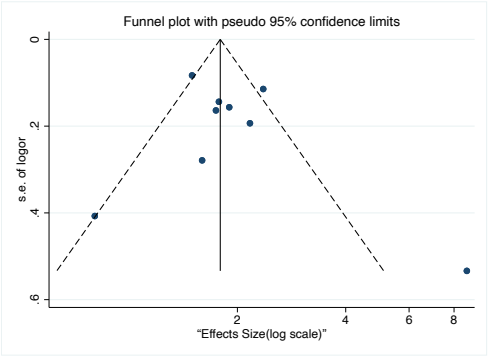


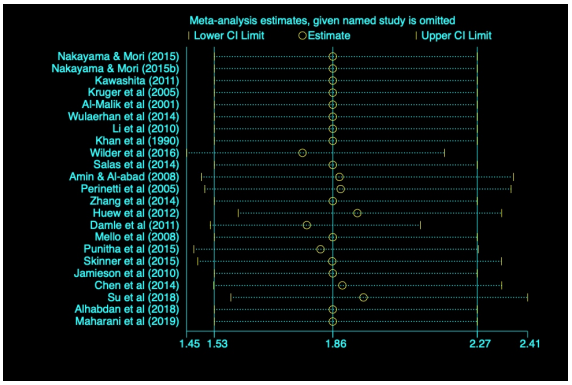


Never/Low compared to high SSB consumption

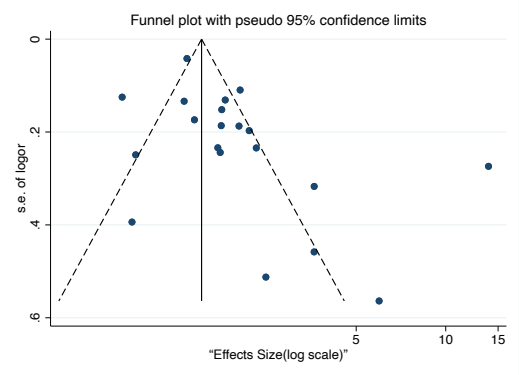


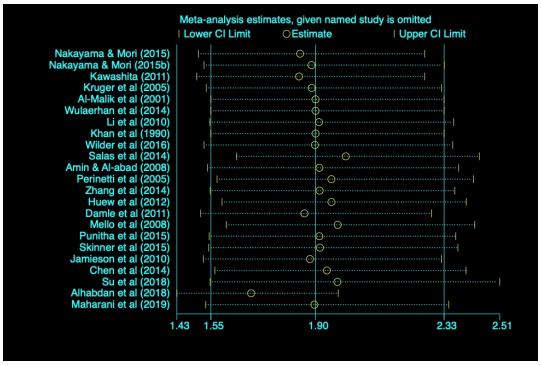
NOTE: Weights and between-subgroup heterogeneity test are from random-effects model



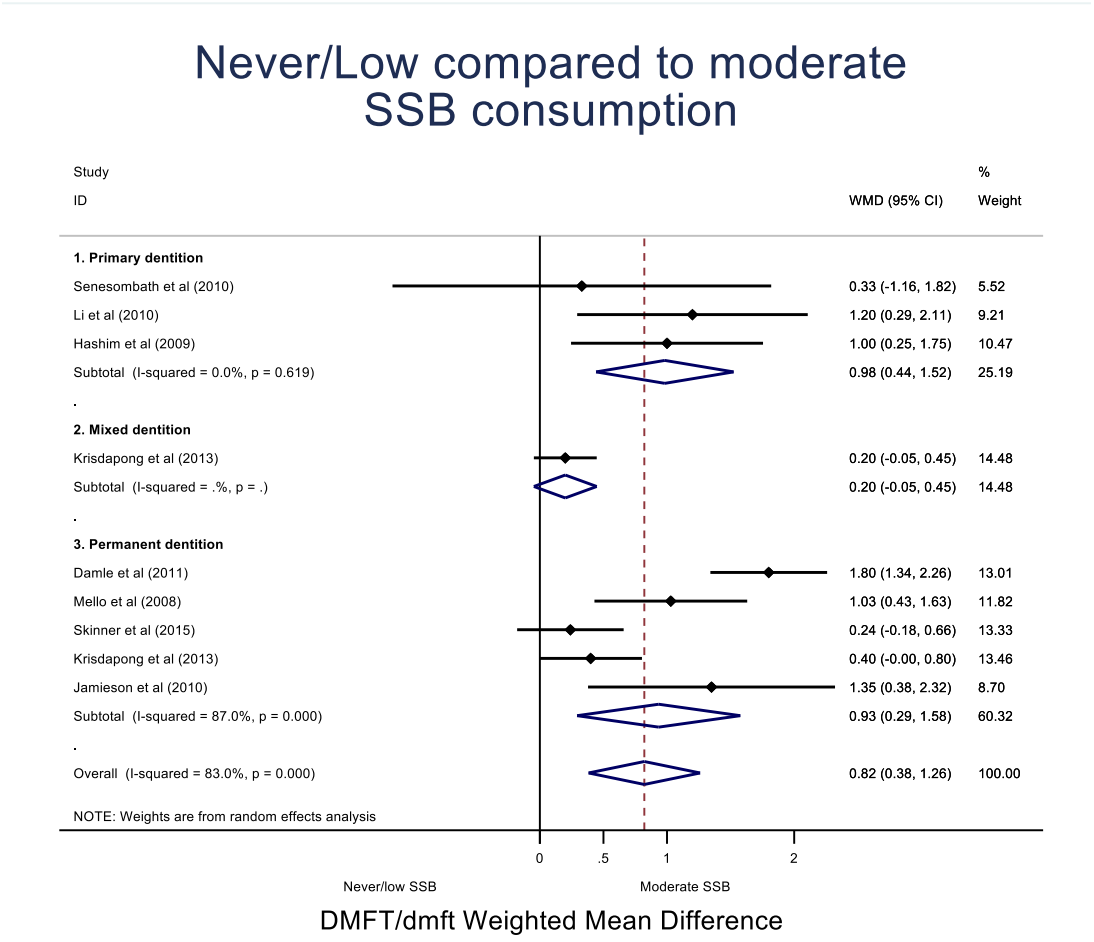


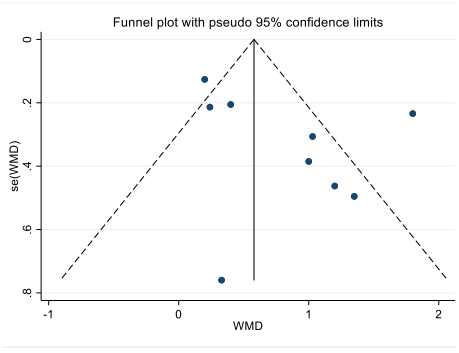
Never/Low compared to Moderate/High SSB consumption (Graph in the main text)

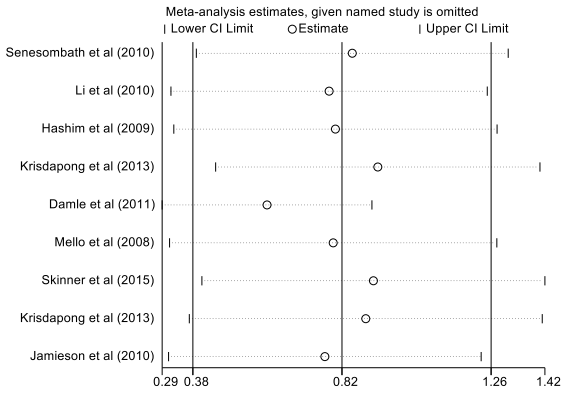




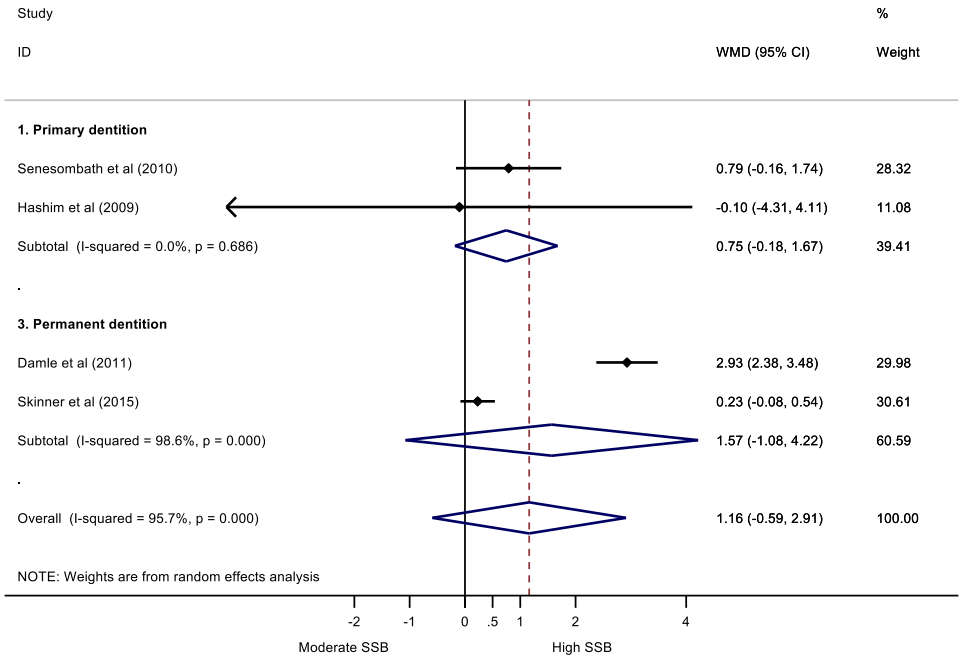
Appendix 4. B Forest, Funnel and influence analysis plots of the DMFT/dmft mean difference between different levels of SSB consumption.

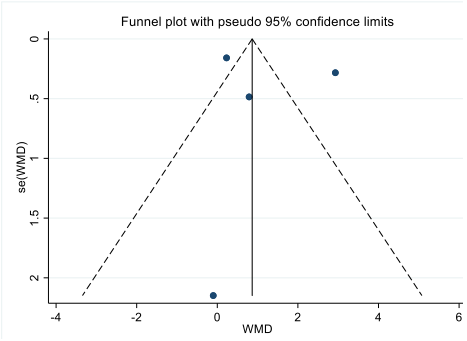


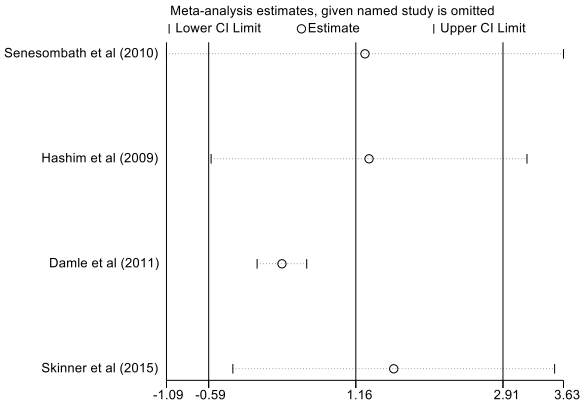




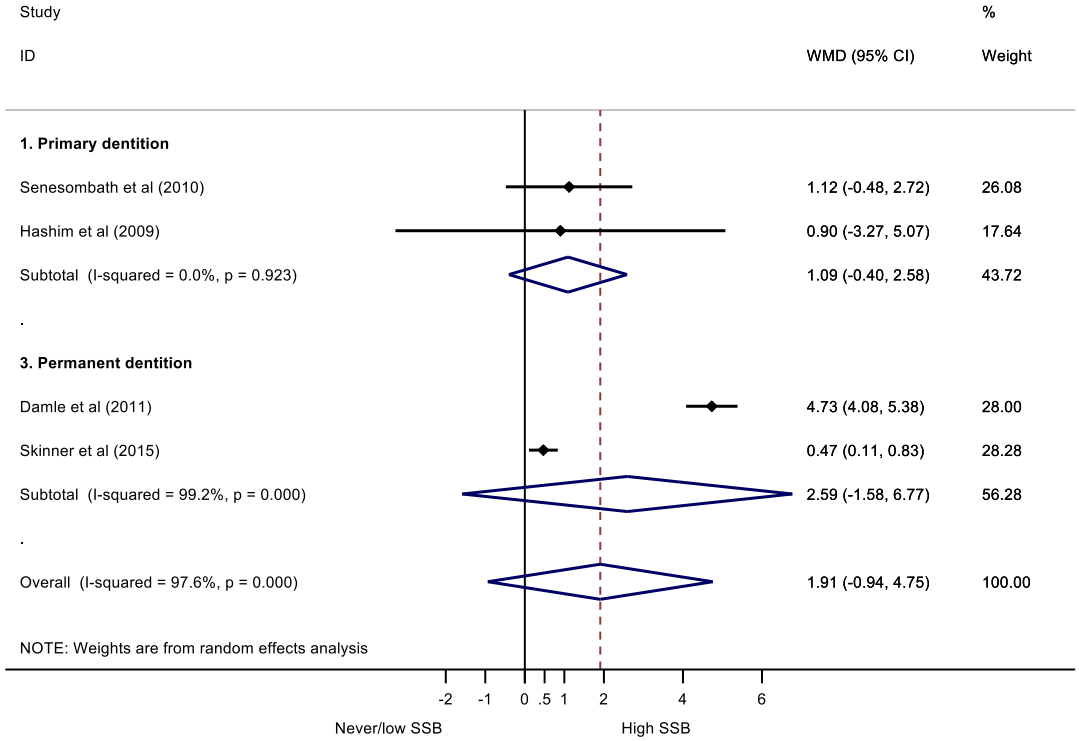
Moderate compared to high SSB consumption

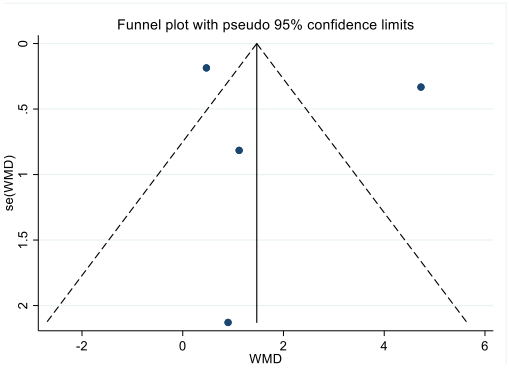


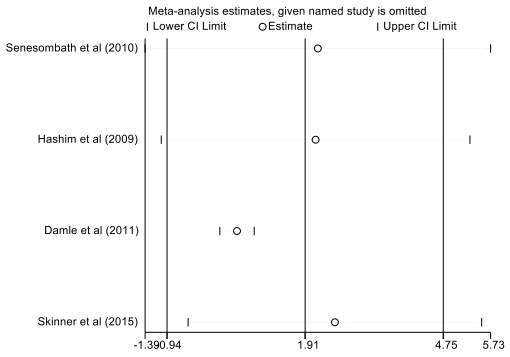




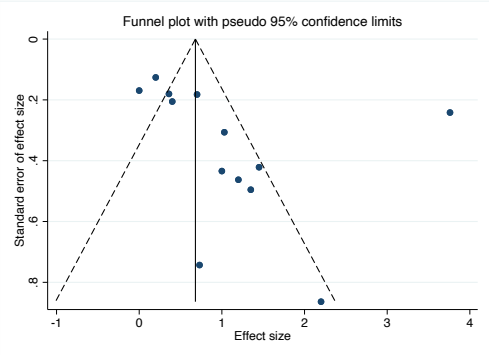
Never/Low compared to high SSB consumption

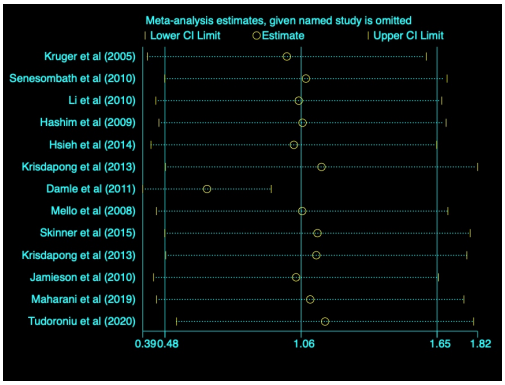






Never/Low compared to Moderate/High SSB consumption (Graph in the main text)

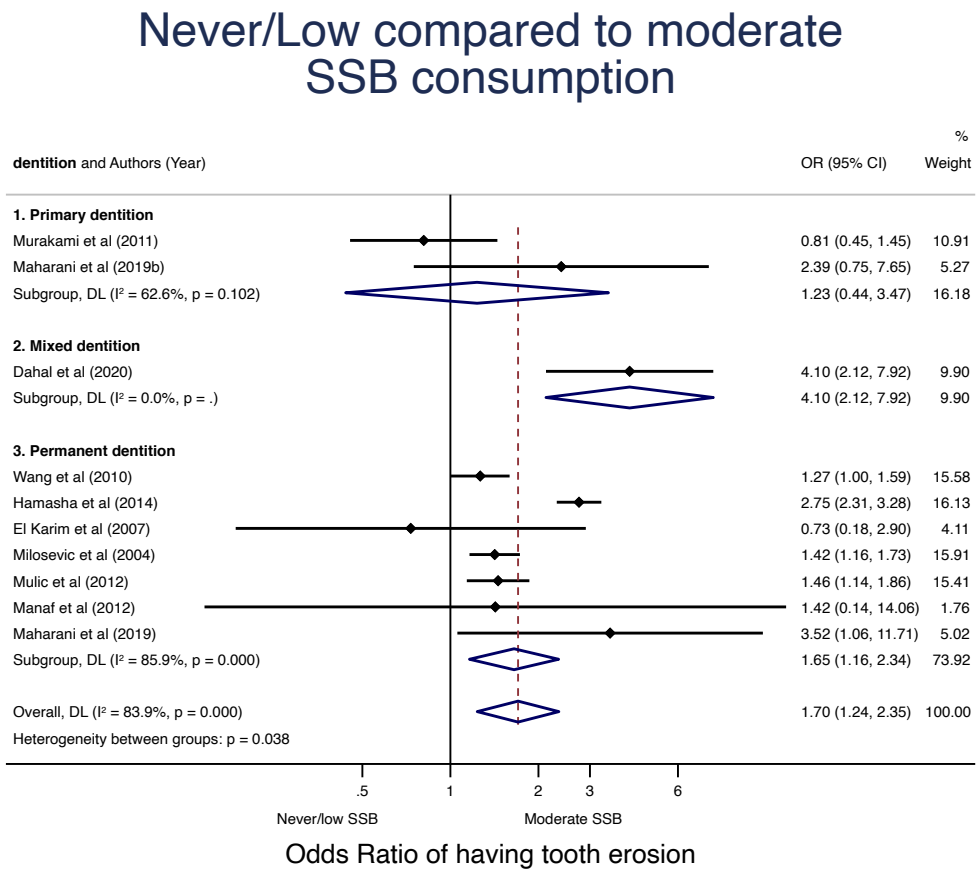


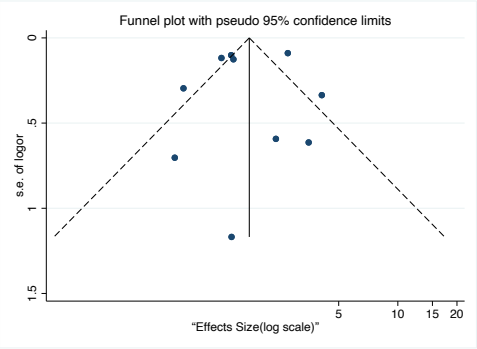


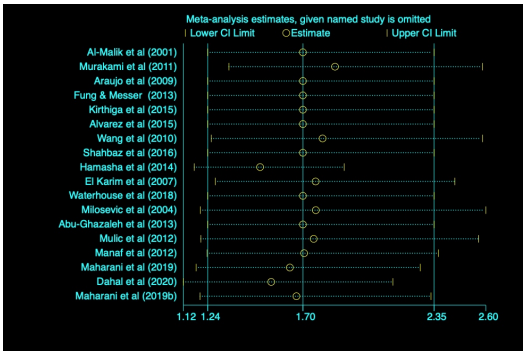
Appendix 4.C Detailed information of the dose-response relationship between risk estimate of having caries and amount of SSB consumed daily.

SSB dosage (mL/day)	Risk Ratio	(95% CI)
0	1.00	(1.00-1.00)
4	1.01	(1.01-1.01)
36	1.06	(1.05-1.08)
71	1.12	(1.09-1.16)
89	1.15	(1.11-1.20)
98	1.16	(1.12-1.21)
125	1.20	(1.14-1.25)
128	1.20	(1.15-1.25)
143	1.21	(1.16-1.27)
161	1.23	(1.17-1.29)
250	1.29	(1.23-1.35)
277	1.30	(1.24-1.36)
300	1.31	(1.25-1.37)
428	1.38	(1.30-1.46)
500	1.42	(1.33-1.51)
600	1.48	(1.38-1.59)
750	1.59	(1.48-1.71)
1000	1.79	(1.66-1.94)
1200	1.98	(1.81-2.18)
1500	2.31	(2.01-2.64)

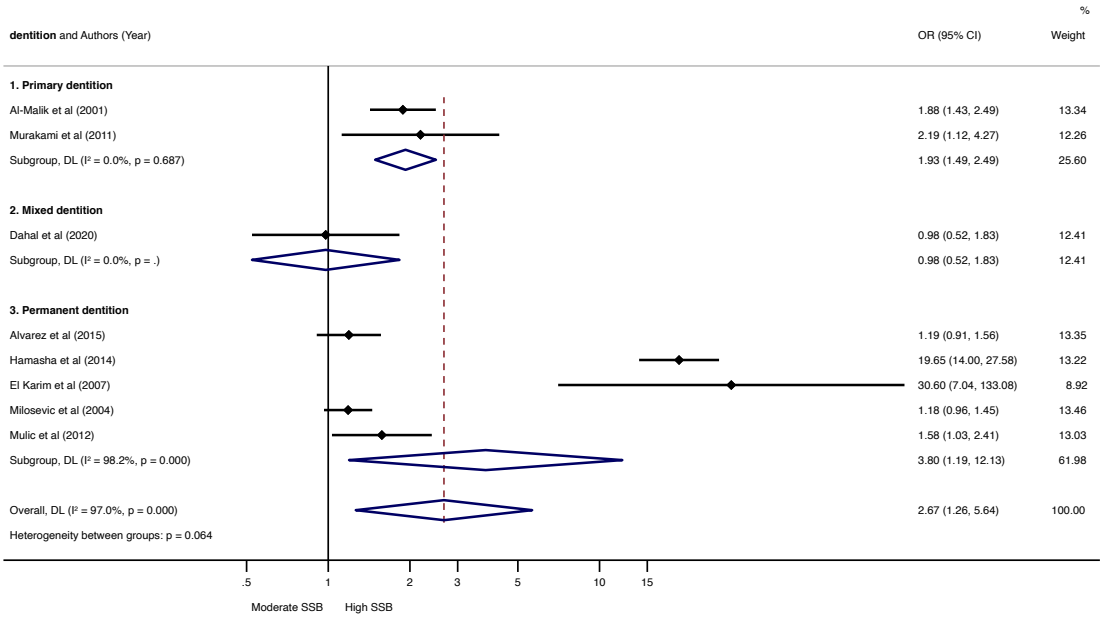
Appendix 4.D Forest, Funnel and influence analysis plots of the odds-ratio of having dental erosion between different levels of SSB consumption.





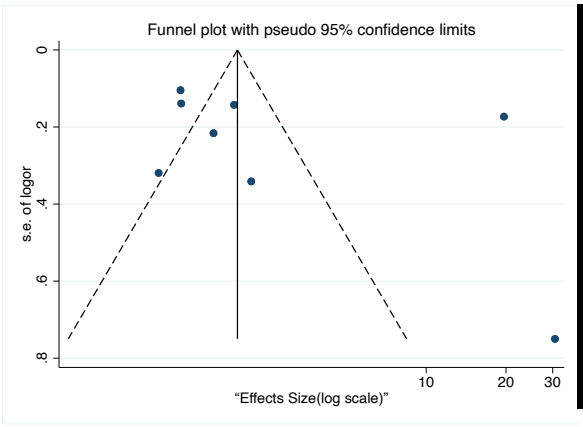


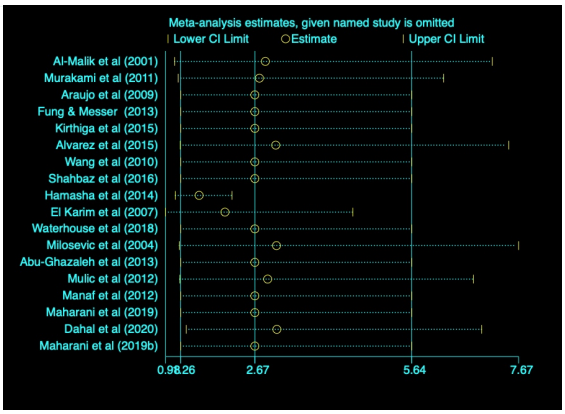
Moderate compared to high SSB consumption



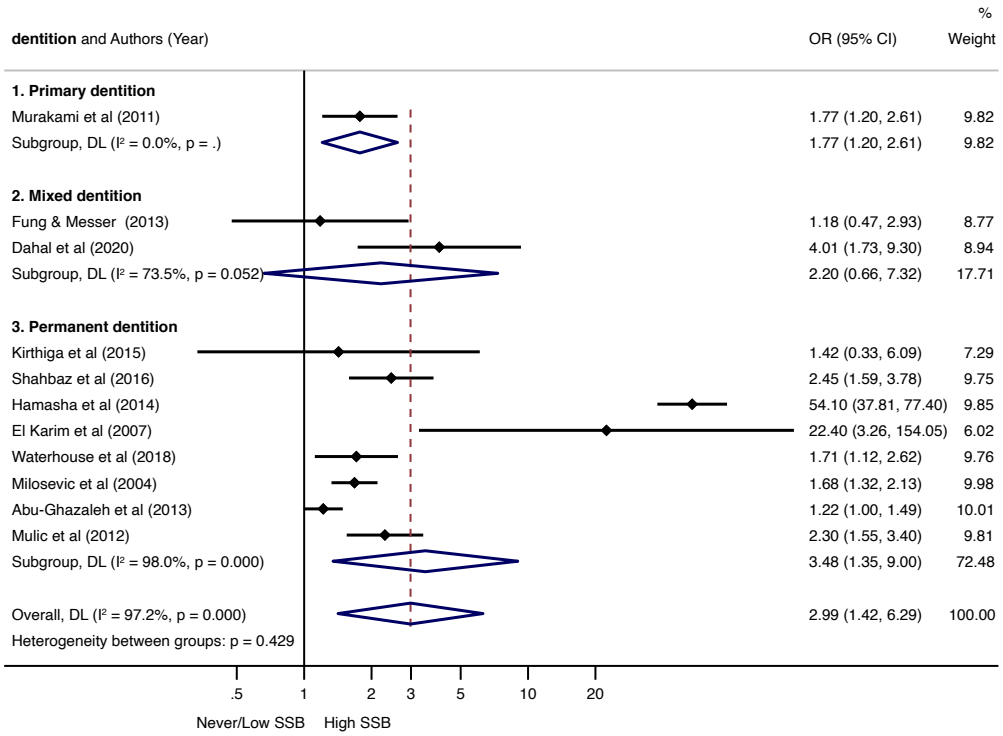
Odds Ratio of having tooth erosion

NOTE: Weights and between-subgroup heterogeneity test are from random-effects model

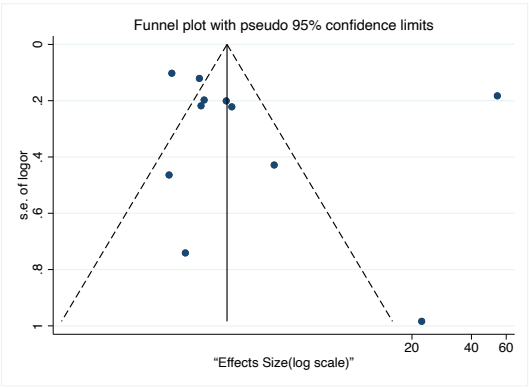


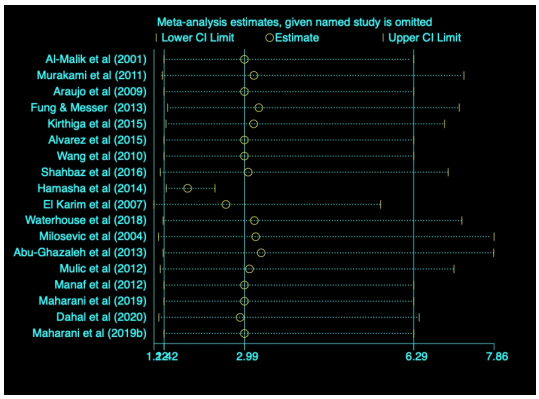


Never/Low compared to high SSB consumption

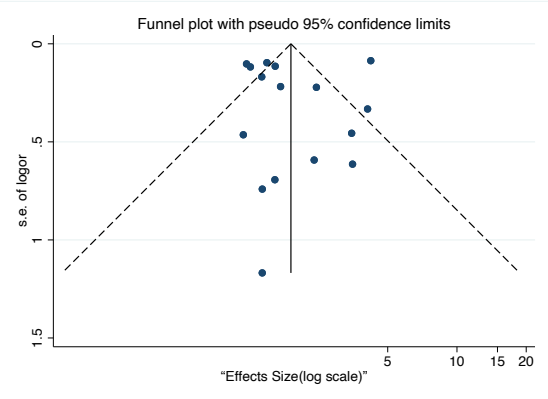


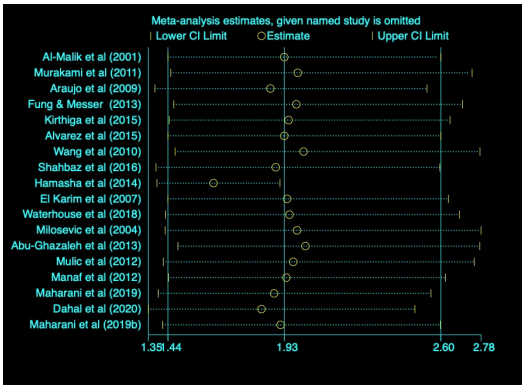
NOTE: Weights and between-subgroup heterogeneity test are from random-effects model





Never/Low compared to Moderate/High SSB consumption (Graph in the main text)





Appendix 5. Description of selected variables from the VII and VII waves of the EPF survey.

Variable group	Variable name	Description	Question asked	Original codes	Re-codification
Consumption expenditure[a]	Total household expenditure	Includes expenditure of goods and services. Imputed as hot-deck. Without imputed rent.	How much did you spend in goods and services in the last month?	N/A (continuous)	N/A (continuous)
	Total per capita expenditure				
	Beverage household expenditure	Beverages included: concentrates, isotonic beverages, energy beverages, flavoured water, mineral water, powdered juices, liquid juices and carbonated beverages.	How much did you spend in each of these products in the last month?	N/A (continuous)	N/A (continuous)
	Beverage expenditure per capita				
Disposable income[b]	Total household disposable income (without rent imputed)	Corresponds to the total income minus deposits, donations, taxes, fines, penalties, health and pension. Imputed as hot-deck. Without imputed rent.	How much did you earn in the last month?	N/A (continuous)	N/A (continuous)
	Total per capita disposable income (without rent imputed)				
	Household and per capita income quintiles			N/A (continuous)	(1) Most deprived, (2), (3), (4), (5) Most affluent
	Per capita income quintile				
Socio-demographics	Marital status	Categorical variable	What is your marital status?	(1) Married; (2) not legally (3) married; (4) divorced; (5) widowed; (6) single	(1) Married; (2) separated; (3) divorced; (4) widowed; (5) single
	Sex	Dichotomous variable	Are you male or female?	(1) male; (2) female	(1) male; (2) female
	Age (continuous)	Continuous variable	What is your age?	N/A (continuous)	N/A (continuous)
	Age (groups)				(1) 5 years or under, (2) 6-12 years, (3) 13-18 years, (4) 19 years or above
	Educational level	Categorical – identifies the	What is the highest	(1) None; (2) none finished; (3) special education; (4)	(1) Nursery; (2) primary; (3)

		highest educational level of each household member	educational level that you have approved?	baby nursery; (5) toddlers' nursery; (6) pre-school, (7) primary school, (8) primary school (old system), (9) secondary school in sciences and humanities, (10) Technical-professional secondary school, (11) Secondary school in sciences and humanities (old system), (12) Technical education (old system), (13) Tertiary education (1 to 3 years), (14) higher education (4 years or more), (15) Postgraduate title, (16) Master, (17) PhD.	secondary; (4) tertiary; (5) other
	Employment status	Categorical – Adapted version of the International Classification of Status in Employment (ICSE-93). Only considers population over 15 years.	What is your current job or employment status?	(1) Employees, (2), employers, (3) own-account workers, (4) members of producers' cooperatives, (5) contributing family workers, (6) workers not classifiable by status	(1) employer; (2) own-account worker; (3) private sector employee; (4) public sector employee; (5) domestic employee; (6) non-remunerated employee
	Occupation	Categorical – variable based on the International Standard Classification of Occupations (ICSO-88). It is constructed from other variables that collected information about the job and the tasks carried out during the job.	Constructed form two questions: 1. What was your main job in the last week? 2. What tasks did you do in this job?	(1) Legislators, senior officials and managers, (2) professionals, (3) technicians and associate professionals, (4) clerks, (5) service workers and shop and market sales workers, (6) skill agricultural and fishery workers, (7) craft and related workers, (8) plant and machine operators and assemblers, (9) elementary occupations, (10) armed forces.	(1) Skilled; (2) unskilled; (3) other

[a] Final consumption expenditure:

Household *final* consumption expenditure may have a monetary and non-monetary origin. The first covers all cash payments, whereas the second includes services of owner-occupied dwellings (measured as an input rental) and income in kind (e.g. goods and services received as income in kind by employees, or as outputs of incorporated enterprises owned by households that are retained for consumption by members of the household, such as food and

other agricultural goods, housing services by owner-occupiers and household services produced by employing paid staff like servants, cooks and gardeners).

The final consumption expenditure considers the following expenses:

- The contracting of services and purchases of durable and semi-durable goods[10], which are collected through the criterion of acquisitions. These goods and services must be for final consumption and not for productive activities. The recorded expenditure corresponds to the moment in which the household acquires ownership over a good or the right to the provision of a service, regardless of whether the consumption or payment of that good was carried out during the survey's reference period. For goods and services purchased by credit, the total value was recorded as if the purchaser would have paid in a cash transaction, irrespective of whether they were purchased in instalments. This is because, in general, information on interests and other types of charges associated with credit payments are unknown to the respondent.

- Payments to public authorities and government, such as driving licences, certificates and passports.

- Taxes levied on goods and services.

- House rentals.

- Payments to domestic servants.

- Materials and workforce used in small dwelling’s refurbishments and maintenance.

- Subscriptions to clubs and societies.

- Goods acquired to be given away to another household.

- Finally, expenses such as the value of own-produced goods, goods and services produced by a household member and the imputed rent of an owned dwelling, are included.

The following expenses are not considered in the final consumer expenditure:

- Investments and significant home repairs.

- The acquisition of valuables and financial assets. Fixed assets in the form of dwellings or valuable objects are excluded and expenses on intermediate consumption. The latter corresponds to goods and services that households acquire for the development of their productive activities. Only those goods and services purchased for non-productive activities are part of the final consumption expenditure.

- Goods gifted by another household.

- Life insurance premiums as they are considered an investment.

- Some taxes and fees paid to public authorities and government, such as payments for licenses to own or use vehicles or boats.

- Interest and administrative charges associated with the delay of payment, either for purchases made on a credit or late payment of household bills (arrears).

- Public services, including defence and justice, among others.

[10] Durable and semi-durable goods are products that do not need to be purchased often as their value last for a relatively long time. In contrast, non-durable goods are products that are consumed immediately or during the first year of acquisition (INE, 2018).

- Domestic services produced and consumed by members of the household that are not paid.

- Consumer goods for productive activities.

[b] Household income:

Household total income is constructed by the primary income that corresponds to the salary/wages income, property income, income derived from the self-provision of goods produced by the household; and money transfers received. Salary/wages income corresponds to any type of income generated by economic work activity. Property income refers to resources generated from financial assets. It includes the return of such assets (interests earned from deposits), receipts of investment income and other regular payments of life insurance and private pension funds, in addition to the net income received by the lease of non-financial assets, such as natural resources, land, buildings, equipment, patents or copyrights. Rents received by property owners, the net income is recorded in the survey, i.e. after deduction of tax, repayment of interest and costs for the maintenance and repair of rented dwelling. The imputed rent corresponds to the estimated value of the accommodation in the homes occupied by their owners.

Income recorded in the EPF surveys were earnings received, or that should have been received during the previous month at the time of the interview. Money coming from games of chance were not taken into account, since this would have created extreme values in the case of big wins.

The amount of taxes and compulsory social contributions were not entered on the expenditure data, but they were deducted from income. This considered the fact that the income is intended to represent the household's resources to consume and save.

Received transfers are nonreciprocal transfers that include retirement, pensions, other cash benefits associated with social security or employment, government social assistance benefits, transfers from other households (inside and outside the country) and cash transfers received from NPISH. This type of transfers excludes social transfers in kind made by the Government and NPISH.

Emitted transfers are money outflows, such as income tax, social security contributions, alimony payment, payments to other households (inside and outside the country) and transfers to NPISH such as donations, fines and penalties payable by households.

Appendix 6. Consolidated criteria for reporting qualitative research (COREQ) (Tong et al., 2007)

No.	Item	Guide questions/description	Reference or comment (all sections are from Chapter 6)
Domain 1: Research team and reflexivity			
Personal Characteristics			
1.	Interviewer/facilitator	Which author/s conducted the interview or focus group?	MJV
2.	Credentials	What were the researcher's credentials? *E.g. PhD, MD*	BDS, MPH
3.	Occupation	What was their occupation at the time of the study?	PhD student
4.	Gender	Was the researcher male or female?	Female
5.	Experience and training	What experience or training did the researcher have?	See section 6.4.1 Reflexivity
Relationship with participants			
6.	Relationship established	Was a relationship established prior to study commencement?	NA – no relationship with participants
7.	Participant knowledge of the interviewer	What did the participants know about the researcher? e.*g. personal goals, reasons for doing the research*	NA – participants did not know the researcher
8.	Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? e.g. *Bias, assumptions, reasons and interests in the research topic*	See section 6.4.1 Reflexivity
Domain 2: study design			
Theoretical framework			
9.	Methodological orientation and Theory	What methodological orientation was stated to underpin the study? *e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis*	See sections 6.2.1 and 6.2.2 Qualitative case study approach and pragmatism paradigm
Participant selection			
10.	Sampling	How were participants selected? *e.g. purposive, convenience, consecutive, snowball*	See section 6.3.1 Sampling strategy
11.	Method of approach	How were participants approached? e.*g. face-to-face, telephone, mail, email*	See section 6.3.3 Data collection
12.	Sample size	How many participants were in the study?	Twenty-three in total
13.	Non-participation	How many people refused to participate or dropped out? Reasons?	See section 6.3.2 Recruitment
Setting			
14.	Setting of data collection	Where was the data collected? e.*g. home, clinic, workplace*	See section 6.3.3 Data collection and Chapter 7
15.	Presence of non-participants	Was anyone else present besides the participants and researchers?	No
16.	Description of sample	What are the important characteristics of the sample? *e.g. demographic data, date*	See Chapter 7
Data collection			
17.	Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	See section 6.3.3.1 Developing and piloting the topic guide
18.	Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19.	Audio/visual recording	Did the research use audio or visual recording to collect the data?	Yes – See section 6.3.3 Data collection
20.	Field notes	Were field notes made during and/or after the interview or focus group?	Yes - See section 6.3.3 Data collection

21.	Duration	What was the duration of the interviews or focus group?	18 – 68 minutes
22.	Data saturation	Was data saturation discussed?	See section 6.3.1 Sampling strategy
23.	Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No
Domain 3: analysis and findings			
Data analysis			
24.	Number of data coders	How many data coders coded the data?	See section 6.3.4 Data analysis
25.	Description of the coding tree	Did authors provide a description of the coding tree?	See appendices 13-15
26.	Derivation of themes	Were themes identified in advance or derived from the data?	See section 6.3.4 Data analysis
27.	Software	What software, if applicable, was used to manage the data?	See section 6.3.4 Data analysis
28.	Participant checking	Did participants provide feedback on the findings?	No
Reporting			
29.	Quotations presented	Were participant quotations presented to illustrate the themes / findings? Was each quotation identified? e*.g. participant number*	Yes, see Chapter 7
30.	Data and findings consistent	Was there consistency between the data presented and the findings?	See Chapter 7
31.	Clarity of major themes	Were major themes clearly presented in the findings?	See Chapter 7
32.	Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	See Chapters 7 and 8

Appendix 7. Information sheet

UNIVERSITY of York

The Department of Health Sciences

The Sugar Tax policymaking and its implications to oral health in Chile: a qualitative study

Participant Information Sheet

I would like to invite you to take part in the **Sugar tax policymaking and oral health** study but before you decide, please read carefully the following information.

What is the purpose of this study?

This study aims to improve the understanding of the policymaking process of the ad-valorem tax imposed to sugar-sweetened beverages (Sugar Tax) in Chile, and to explore the importance of oral health in the agenda setting and formulation of fiscal policies. This study will clarify the decision-making of the policy, raise awareness among policymakers on dental health prevention strategies and set the context for future policy evaluations.

Who is doing the study?

My name is Maria Josefina Valenzuela, I am a PhD student in Health Sciences from the University of York in the United Kingdom. This research forms part of my doctoral thesis project, supervised by Prof Tim Doran and Prof Karen Bloor (contact details can be found at https://www.york.ac.uk/healthsciences/our-staff/), and funded by CONICYT Becas-Chile PhD Scholarship.

Why have I been asked to participate?

You have been invited to participate in this study because you were identified as a key actor, whose knowledge may provide a unique insight of the 'back stage' of the Sugar Tax policymaking process in Chile.

Do I have to take part?

Your participation in this study is entirely voluntary. You will be asked to sign a consent form at the beginning of the interview.

What will be involved if I take part in this study?

If you agree to participate, face-to-face interviews, of around 45 minutes, will be undertaken at your most convenient place.

What are the advantages/benefits and disadvantages/risks of taking part?

There will be no reimbursement for participating in this study, however you will be benefited by advancing the scientific literature and knowledge base in the area of health policy. Your contribution will bridge a current gap that needs to be addressed and will set the base for future research.

Can I withdraw from the study at any time?

You can stop the interview at any time, and you are free to withdraw from the study up to four weeks after the interview has taken place without providing a reason. If you withdraw from the study, your data will not be included in the analysis, and will be erased.

Will the information I give be kept confidential?

All information provided will remain confidential, and your identity will be anonymised. Every stage of this study, data collection, storage and analysis will comply with the requirements of the Data Protection Act (1998) and the Health Sciences' data management policies for data confidentiality. Your personal information and your specific job position will be never disclosed to prevent your identification.

The interview will be audio recorded and then transcribed into a written format for analysis. Electronic data will be kept encrypted and secured under two passwords, and paper data will be kept in a locked cabinet in a locked office. The access to data will be limited to the main researcher (Maria Josefina Valenzuela), both supervisors (Prof Tim Doran and Prof Karen Bloor) and researchers that might collaborate in this project, for example members of the Thesis Advisory Panel (Prof Richard Cookson and Dr Vishal Aggarwal). The data will be destroyed after three years post PhD thesis submission.

What will happen to the results of the study?

Results from this study will form part of my doctoral thesis, and may be disseminated in peer-reviewed journals and scientific conferences. You will be sent a brief report of the findings (fully anonymised) and any article published containing part of the data you gave.

Who has reviewed this study?

The Research Governance Committee (HSRGC) of the Department of Health Sciences from the University of York granted ethical approval for this research. More information of this committee can be found at https://www.york.ac.uk/healthsciences/research-information/rsg/.

Who do I contact in the event of a complaint?

Please contact my supervisors if there is any complaint:

- Prof Tim Doran - tim.doran@york.ac.uk
- Prof Karen Bloor - karen.bloor@york.ac.uk

If you agree to take part, would like more information or have any questions or concerns about the study please contact Maria Josefina Valenzuela, PhD student in Health Sciences at the University of York, York, United Kingdom. Email address: mjv507@york.ac.uk.

Thank you for taking the time to read this information sheet.

Appendix 8. Participant consent form

UNIVERSITY of York

The Department of Health Sciences

Participant Consent Form

Title of Study: The Sugar Tax policymaking and its implications to oral health in Chile: a qualitative study

	Please confirm agreement to the statements by putting your initials in the boxes below
I have read and understood the participant information sheet [date 14/09/2017, version 1.]	
I have had the opportunity to ask questions and discuss this study	
I have received satisfactory answers to all of my questions	
I have received enough information about the study	
I understand my participation in the study is voluntary and that I am free to withdraw from the study: 1 At any time, up to four weeks post-interview 2 Without having to give a reason for withdrawing 3 In case of withdrawing, your data will not be included in the data analysis, and will be destroyed	
I understand that my interview will be audio-recorded.	
I understand that relevant sections of the data collected during the study may be looked at by researchers.	
I understand that any information I provide, including personal details, will be kept confidential, stored securely and only accessed by those carrying out the study.	
I understand that any information I give may be included in published documents but all information will be anonymised.	
I agree to take part in this study	
Participant Signature ……	Date
Name of Participant	
Researcher Signature ……..	Date
Name of Researcher	

Appendix 9. Original invitation letter

Dear (participant's name),

I hope this email finds you well.

My name is Josefina Valenzuela, a dentist and a PhD student from the Health Sciences Department at the University of York, UK. This is an invitation for you to participate in my research.

My PhD thesis aims to assess the impact of public policies on oral health; specifically, the Tax policy on sugar-sweetened beverages that was implemented in Chile in 2014. My project includes a qualitative study for which I need to interview policy actors that may have influenced or had knowledge about the policy's policymaking process, including those from the beverage industry, academia and government and non-government organisations.

I'm travelling to Chile in December and I would like to know whether you would be interested in participating in my study and if so, when could we meet? It would be around 45 minutes. Your identify would be kept confidential and anonymised at all times.

If you are interested, please see the attached document with the study aim and objectives, the confidentiality framework and the Ethics Committee authorization letter from the University of York.

I would be very grateful if you could help me with your knowledge and experience in this topic.

Kind regards,

Josefina Valenzuela

--

Maria Josefina Valenzuela, BDS, MPH

Ph.D. Student

Department of Health Sciences

University of York

+44 7580 141085

Web Profile

Appendix 10. Revised invitation letter

Dear (participant's name),

I hope this email finds you well.

My name is Josefina Valenzuela, a PhD student from the Health Sciences Department at the University of York, UK. This is an invitation for you to participate in my research. (participant name) kindly shared your contact details.

My PhD thesis aims to assess the impact of public policies on health; specifically, the 2014 tax policy on sugar-sweetened beverages. I believe your knowledge and experience in public policy could be a great contribution to my study to capture in political context and the decision making process between the government and other groups.

Your participation would consist on a 30 minutes' interview. Your identity, contact details and job position would be anonymised at all times and the collected data would be kept secured and safely.

Please see the attached document with the study aim and objectives, the confidentiality framework and the Ethics Committee authorization letter from the University of York.

I would be very grateful if you could help me.

Please let me know where and when we could arrange a meeting for the interview. I will be available from XX to XX.

Kind regards,

Josefina Valenzuela

--

Maria Josefina Valenzuela, BDS, MPH

Ph.D. Student

Department of Health Sciences

University of York

+44 7580 141085

Appendix 11. Topic Guide (initial version)

Sugar tax policymaking and oral health in Chile – Topic Guide

I. Introduction

- Introduce myself, and the study's aim. Explain why the interviewee was invited to participate.
- Thank the participant for agreeing to be interviewed.
- Make sure the participant reads the information sheet, and understands it well to be able to sign the consent form.
- Reassure that the data will be kept confidential.
- Give two copies of the consent form to the participant to read and sign. One copy to be kept by him/her, and the second by the researcher.
- Ask for audio recording permission. If not, the participant can still take part in the study.

II. Opening question

- Could you state who you are and briefly outline your experience with the Sugar Tax?

III. Policymaking questions

- Could you tell me your understanding/ knowledge of the Sugar Tax policy in Chile?
- What do you think was the rationale/ aim/ nature of the policy? What are the expected outcomes?
- How did it get onto the political agenda?
- What actors and how were involved in the policymaking process?
- How was the role of the beverage industry in this context?
- What factors, do you think had influenced the decision-making of this policy? How?
- How important is the use of evidence when fiscal policies are designed? Why? Do you think it was considered for this policy?
- Were there barriers or opponents to the policy? Who were the main supporters of this policy?
- How was the communication strategy of this policy?
- Could you tell me some strengths and weaknesses of the policy?
- From your point of view, do you think there is need for policy change? Is there an interest on modifying the policy?
- How has this policy been monitored, and how will its impact be evaluated?
- In your experience, do you expect any unintended consequence from this policy?
- How will the revenue be spent?

IV. Oral health questions

- Could you briefly explain what health policy is?
- Do you think that the Sugar Tax could be considered a health policy? Why?
- From your perspective, how important are oral health problems in health policy? Do you think they get enough attention in the political agenda?
- Knowing that sugars are the main risk factor for oral diseases, do you think this is a good approach to help improving the dental health of the population? Why?
- The evidence shows that the tax rate should be at least 20% in order to get a significant impact on health outcomes. From your point of view, how relevant is this evidence for policy change?
- In the case of the Sugar Tax policy, do you think that dental health problems were considered in any stage of the policymaking process?

V. Exit questions

- Would you like to add anything else different to what we have already discussed?
- Now that you are more acquainted with my research, who else would you recommend me to speak with about these matters?

Appendix 12. Topic Guide (revised version)

Sugar tax policymaking and oral health in Chile - Topic Guide

I. Introduction

- Introduce myself, and the study's aim. Explain why the interviewee was invited to participate.
- Thank the participant for agreeing to be interviewed.
- Make sure the participant reads the information sheet, and understands it well to be able to sign the consent form.
- Reassure that the data will be kept confidential.
- Give two copies of the consent form to the participant to read and sign. One copy to be kept by him/her, and the second by the researcher.
- Ask for audio recording permission. If not, the participant can still take part in the study.

II. Opening question

- Could you state who you are?

III. Policymaking questions

- What is your understanding of Chile's Sugar Tax?
- Why was this policy introduced? What was expected to be achieved?
- What was your role in the policy and its implementation?
- How did it get onto the political agenda?
- What actors/ministries were involved in the policymaking process?
- How was the role of the beverage industry in this context?
- What factors, do you think had influenced the decision-making of this policy? How?
- How were the health implications of the Sugar Tax considered?
- What evidence was used for the policy design?
- How were the tax rates and sugar levels set?
- Were there barriers or opponents to the policy? Who were the main supporters of this policy?
- Was there a communication strategy?
- Could you tell me some strengths and weaknesses of the policy?
- Is the policy having the desired effect?
- From your point of view, do you think there is need for policy change? Is there an interest on modifying the policy?
- How has this policy been monitored, and how will its impact be evaluated?
- In your experience, do you expect any unintended consequence from this policy?
- How will the revenue be spent?

IV. Oral health questions

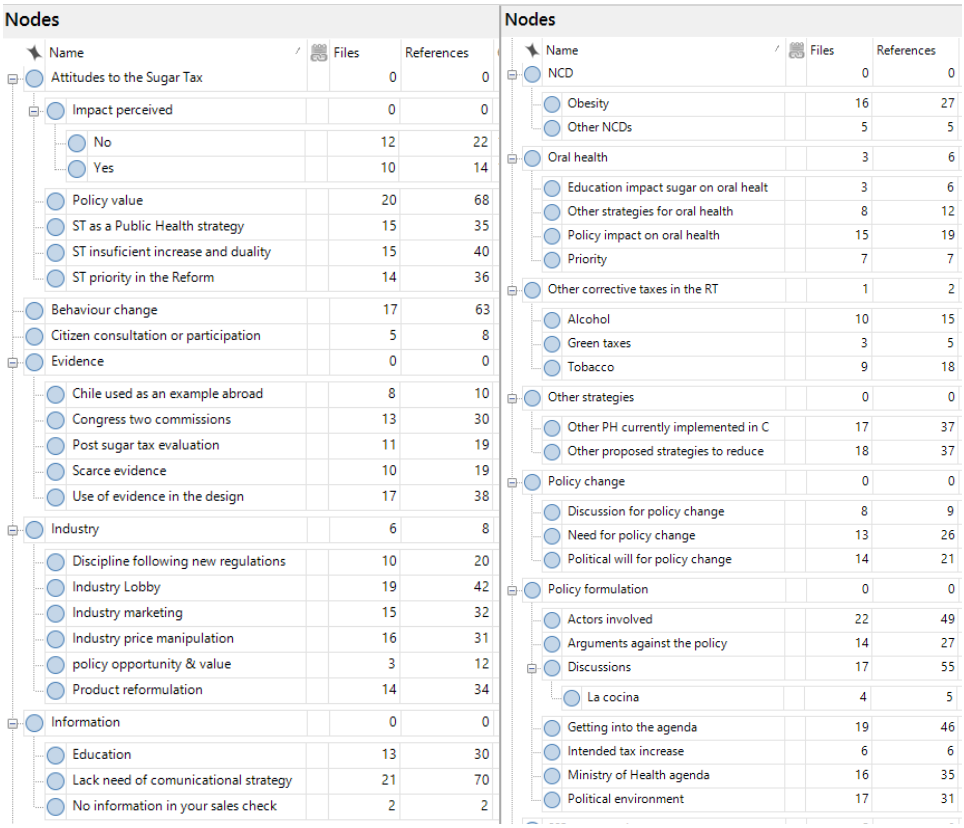
- What are the implications for oral health?
- Do you think this is a good approach to help improving oral health? Why? What other strategy could be a good idea?
- The evidence shows that the tax increase should be at least 20% in order to get a significant impact on health outcomes. From your point of view, how relevant is this evidence for policy change?

V. Exit questions

- Would you like to add anything else different to what we have already discussed?
- I am looking for more participants. Now that you are aware of my research, would you recommend me another participant?

Appendix 13. Initial coding mind-map example

Appendix 14. Coding Framework created in NVivo Pro



Nodes

Name	Files	References
Attitudes to the Sugar Tax	0	0
Impact perceived	0	0
No	12	22
Yes	10	14
Policy value	20	68
ST as a Public Health strategy	15	35
ST insuficient increase and duality	15	40
ST priority in the Reform	14	36
Behaviour change	17	63
Citizen consultation or participation	5	8
Evidence	0	0
Chile used as an example abroad	8	10
Congress two commissions	13	30
Post sugar tax evaluation	11	19
Scarce evidence	10	19
Use of evidence in the design	17	38
Industry	6	8
Discipline following new regulations	10	20
Industry Lobby	19	42
Industry marketing	15	32
Industry price manipulation	16	31
policy opportunity & value	3	12
Product reformulation	14	34
Information	0	0
Education	13	30
Lack need of comunicational strategy	21	70
No information in your sales check	2	2

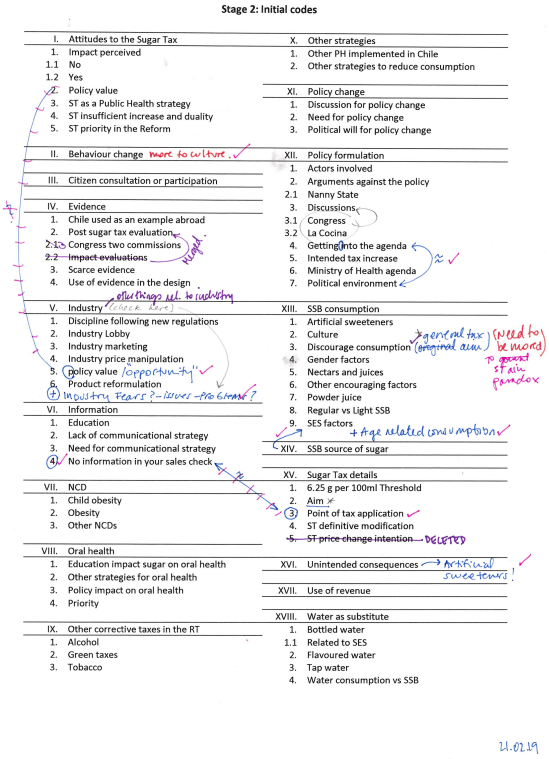
Nodes

Name	Files	References
NCD	0	0
Obesity	16	27
Other NCDs	5	5
Oral health	3	6
Education impact sugar on oral healt	3	6
Other strategies for oral health	8	12
Policy impact on oral health	15	19
Priority	7	7
Other corrective taxes in the RT	1	2
Alcohol	10	15
Green taxes	3	5
Tobacco	9	18
Other strategies	0	0
Other PH currently implemented in C	17	37
Other proposed strategies to reduce	18	37
Policy change	0	0
Discussion for policy change	8	9
Need for policy change	13	26
Political will for policy change	14	21
Policy formulation	0	0
Actors involved	22	49
Arguments against the policy	14	27
Discussions	17	55
La cocina	4	5
Getting into the agenda	19	46
Intended tax increase	6	6
Ministry of Health agenda	16	35
Political environment	17	31

Nodes

Name	Files	References
Political environment	17	31
SSB consumption	5	8
Age related consumption	6	12
Artificial sweeteners	12	13
Culture	15	38
Gender factors	3	5
Nectars and juices	4	4
Other encouraging factors	3	3
Regular vs Light SSB	10	28
SES factors	15	32
SSB source of sugar	5	5
Sugar Tax details	0	0
6.25 g per 100ml Threshold	10	15
Aim	19	59
Point of tax application	10	18
ST definitive modification	10	13
Unintended consequences	8	10
Use of revenue	9	9
Water as substitute	7	11
Bottled water	10	12
Flavoured water	6	6
Tap water	9	15
Water consumption vs SSB	18	37

Appendix 15. Process of reviewing, reorganising, merging and renaming codes into initial themes and sub-themes



Stage 2: Initial codes

I. Attitudes to the Sugar Tax
1. Impact perceived
1.1 No
1.2 Yes
2. Policy value
3. ST as a Public Health strategy
4. ST insufficient increase and duality
5. ST priority in the Reform

II. Behaviour change

III. Citizen consultation or participation

IV. Evidence
1. Chile used as an example abroad
2. Post sugar tax evaluation
2.1 Congress two commissions
2.2 Impact evaluations
3. Scarce evidence
4. Use of evidence in the design

V. Industry
1. Discipline following new regulations
2. Industry Lobby
3. Industry marketing
4. Industry price manipulation
5. Policy value
6. Product reformulation

VI. Information
1. Education
2. Lack of communicational strategy
3. Need for communicational strategy
4. No information in your sales check

VII. NCD
1. Child obesity
2. Obesity
3. Other NCDs

VIII. Oral health
1. Education impact sugar on oral health
2. Other strategies for oral health
3. Policy impact on oral health
4. Priority

IX. Other corrective taxes in the RT
1. Alcohol
2. Green taxes
3. Tobacco

X. Other strategies
1. Other PH implemented in Chile
2. Other strategies to reduce consumption

XI. Policy change
1. Discussion for policy change
2. Need for policy change
3. Political will for policy change

XII. Policy formulation
1. Actors involved
2. Arguments against the policy
2.1 Nanny State
3. Discussions
3.1 Congress
3.2 La Cocina
4. Getting into the agenda
5. Intended tax increase
6. Ministry of Health agenda
7. Political environment

XIII. SSB consumption
1. Artificial sweeteners
2. Culture
3. Discourage consumption
4. Gender factors
5. Nectars and juices
6. Other encouraging factors
7. Powder juice
8. Regular vs Light SSB
9. SES factors

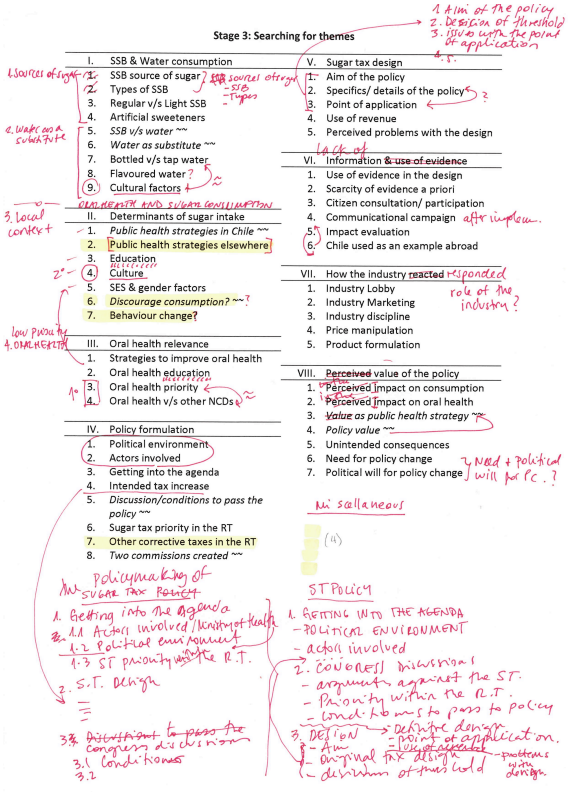
XIV. SSB source of sugar

XV. Sugar Tax details
1. 6.25 g per 100ml Threshold
2. Aim
3. Point of tax application
4. ST definitive modification
5. ST price change intention

XVI. Unintended consequences

XVII. Use of revenue

XVIII. Water as substitute
1. Bottled water
1.1 Related to SES
2. Flavoured water
3. Tap water
4. Water consumption vs SSB



Stage 3: Searching for themes

I. SSB & Water consumption
1. SSB source of sugar
2. Types of SSB
3. Regular v/s Light SSB
4. Artificial sweeteners
5. *SSB v/s water*
6. *Water as substitute*
7. Bottled v/s tap water
8. Flavoured water
9. Cultural factors

II. Determinants of sugar intake
1. *Public health strategies in Chile*
2. Public health strategies elsewhere
3. Education
4. Culture
5. SES & gender factors
6. *Discourage consumption?*
7. Behaviour change?

III. Oral health relevance
1. Strategies to improve oral health
2. Oral health education
3. Oral health priority
4. Oral health v/s other NCDs

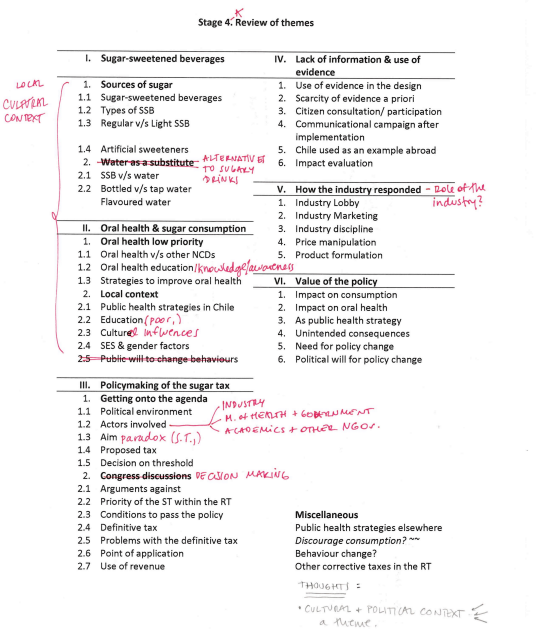
IV. Policy formulation
1. Political environment
2. Actors involved
3. Getting into the agenda
4. Intended tax increase
5. *Discussion/conditions to pass the policy*
6. Sugar tax priority in the RT
7. Other corrective taxes in the RT
8. *Two commissions created*

V. Sugar tax design
1. Aim of the policy
2. Specifics/ details of the policy
3. Point of application
4. Use of revenue
5. Perceived problems with the design

VI. Information & use of evidence
1. Use of evidence in the design
2. Scarcity of evidence a priori
3. Citizen consultation/ participation
4. Communicational campaign
5. Impact evaluation
6. Chile used as an example abroad

VII. How the industry reacted
1. Industry Lobby
2. Industry Marketing
3. Industry discipline
4. Price manipulation
5. Product formulation

VIII. Perceived value of the policy
1. Perceived impact on consumption
2. Perceived impact on oral health
3. *Value as public health strategy*
4. *Policy value*
5. Unintended consequences
6. Need for policy change
7. Political will for policy change



Stage 4. Review of themes

I. Sugar-sweetened beverages
1. Sources of sugar
1.1 Sugar-sweetened beverages
1.2 Types of SSB
1.3 Regular v/s Light SSB
1.4 Artificial sweeteners
2. Water as a substitute
2.1 SSB v/s water
2.2 Bottled v/s tap water
Flavoured water

II. Oral health & sugar consumption
1. Oral health low priority
1.1 Oral health v/s other NCDs
1.2 Oral health education
1.3 Strategies to improve oral health
2. Local context
2.1 Public health strategies in Chile
2.2 Education
2.3 Culture
2.4 SES & gender factors
2.5 Public will to change behaviours

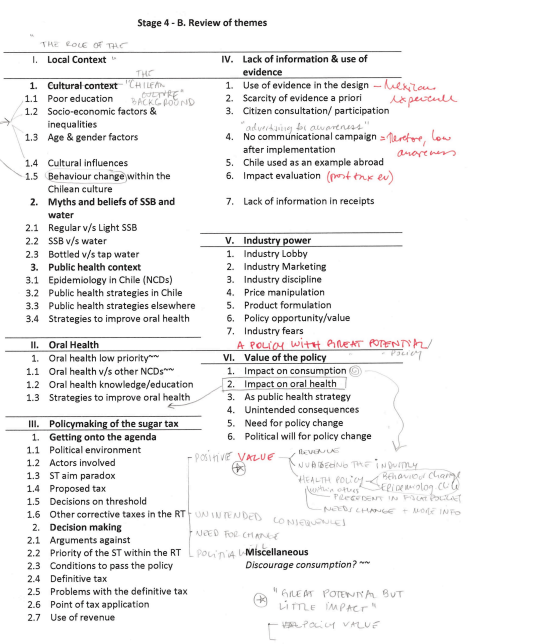
III. Policymaking of the sugar tax
1. Getting onto the agenda
1.1 Political environment
1.2 Actors involved
1.3 Aim
2. Congress discussions
2.1 Arguments against
2.2 Priority of the ST within the RT
2.3 Conditions to pass the policy
2.4 Definitive tax
2.5 Problems with the definitive tax
2.6 Point of application
2.7 Use of revenue

IV. Lack of information & use of evidence
1. Use of evidence in the design
2. Scarcity of evidence a priori
3. Citizen consultation/ participation
4. Communicational campaign after implementation
5. Chile used as an example abroad
6. Impact evaluation

V. How the industry responded
1. Industry Lobby
2. Industry Marketing
3. Industry discipline
4. Price manipulation
5. Product formulation

VI. Value of the policy
1. Impact on consumption
2. Impact on oral health
3. As public health strategy
4. Unintended consequences
5. Need for policy change
6. Political will for policy change

Miscellaneous
Public health strategies elsewhere
Discourage consumption?
Behaviour change?
Other corrective taxes in the RT



Stage 4 - B. Review of themes

I. Local Context
1. Cultural context
1.1 Poor education
1.2 Socio-economic factors & inequalities
1.3 Age & gender factors
1.4 Cultural influences
1.5 Behaviour change within the Chilean culture
2. Myths and beliefs of SSB and water
2.1 Regular v/s Light SSB
2.2 SSB v/s water
2.3 Bottled v/s tap water
3. Public health context
3.1 Epidemiology in Chile (NCDs)
3.2 Public health strategies in Chile
3.3 Public health strategies elsewhere
3.4 Strategies to improve oral health

II. Oral Health
1. Oral health low priority
1.1 Oral health v/s other NCDs
1.2 Oral health knowledge/education
1.3 Strategies to improve oral health

III. Policymaking of the sugar tax
1. Getting onto the agenda
1.1 Political environment
1.2 Actors involved
1.3 ST aim paradox
1.4 Proposed tax
1.5 Decisions on threshold
1.6 Other corrective taxes in the RT
2. Decision making
2.1 Arguments against
2.2 Priority of the ST within the RT
2.3 Conditions to pass the policy
2.4 Definitive tax
2.5 Problems with the definitive tax
2.6 Point of tax application
2.7 Use of revenue

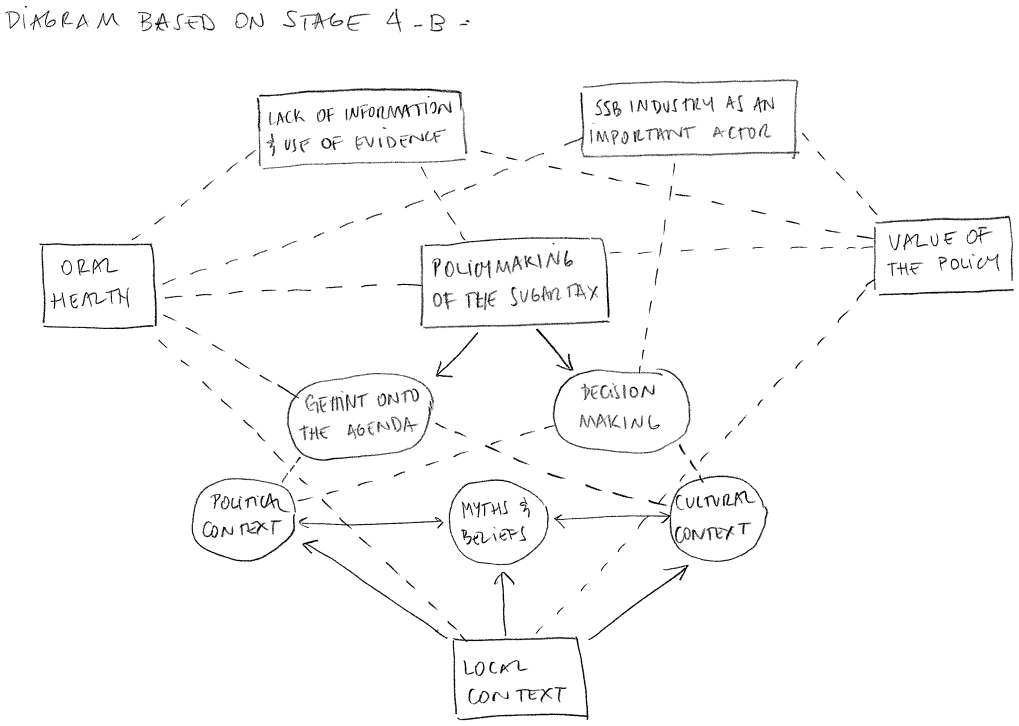
IV. Lack of information & use of evidence
1. Use of evidence in the design
2. Scarcity of evidence a priori
3. Citizen consultation/ participation
4. No communicational campaign after implementation
5. Chile used as an example abroad
6. Impact evaluation
7. Lack of information in receipts

V. Industry power
1. Industry Lobby
2. Industry Marketing
3. Industry discipline
4. Price manipulation
5. Product formulation
6. Policy opportunity/value
7. Industry fears

VI. Value of the policy
1. Impact on consumption
2. Impact on oral health
3. As public health strategy
4. Unintended consequences
5. Need for policy change
6. Political will for policy change

Miscellaneous
Discourage consumption?

Appendix 16. Mind-map of initial themes



Appendix 17. Example of quotations from Theme 1 in English and Spanish

Sub-theme	Participant ID	Quotes in English	Quotes in Spanish
Culture	ORG_003	"In cultures like ours, where the consumption of sugary drinks is so deeply rooted as a cultural practice, not only to quench thirst, but also as a cultural practice of coexistence, for parties, for family reunion, for indulgence. […] because it's the Chilean culture, you're invited to a house in a vulnerable situation, and it is a regular Coke, or regular Fanta, or regular Sprite. It's part of the culture, the Chilean indulgence. I mean if I want to make a good impression and receive you properly [...]."	"[…] en culturas como las nuestras, donde está tan arraigado como práctica cultual el consumo de bebida azucarada no solamente como una práctica de consumo para saciar la sed, sino que como práctica cultural de convivencia, de fiestas, de reunión familiar, de agasajo. Es la cultura chilena, te reciben en una casa en situación de vulnerabilidad, es una Coca-Cola normal, o Fanta normal, o Sprite normal. Es parte de la cultura. El agasajo chileno, o sea si yo te quiero recibir bien […]."
	GOV_001	"Before, everyone drank tap water, I mean… when I was a girl, lunchtime was with tap water, and you drank a glass of sugary drink only in the weekend. Nowadays, you can't find a house in Chile where you open the refrigerator and there isn't a bottle of sugary drink. Children, despite everything we've worked for with recommendations of zero sugar consumption before the first 1000 days of life, you can see them on the street with their bottles filled with Coca-Cola."	"Antes se tomaba de la llave, o sea … cuando chica, el almuerzo era con agua de la llave, los fin de semanas no más uno tomaba un vaso de bebida. Hoy en día no hay casa en Chile donde tú no abras el refrigerador y no haya una botella de bebida. Niños, a pesar de todo lo que hemos trabajado por lo menos en el control de salud infantil de que no pueden comer azúcar antes de los primeros 1000 días, es cuestión de ver en la calle como pasan mamaderas con Coca-Cola los niños."
	ACA_001	"There are groups, for example adult men over 18 years-old, who don't change because there are myths and tales… many say that low-sugary drinks are associated with women who are on a diet, so when they see a male friend drinking a low-sugar beverage they bully them. […] If you see for example in construction sites, if you go to a supermarket at lunchtime, the construction workers are buying a roast	"Hay grupos por ejemplo hombre adultos, desde 18 años para arriba, no lo cambia porque hay cuetos mitos… muchos dicen que las bebidas Light se asocian a las mujeres que están cuidando, entonces si los amigos los ven tomando bebidas Light les hacen bullying. Si tú ves por ejemplo en la construcción, si vas a un supermercado a la hora de almuerzo, toda la gente de la construcción se está comprando un pollo asado con papas fritas y una

		chicken with french fries and a high-sugar beverage, the classic two litres bottle with sugar."	bebida no Light, la clásica con azúcar, de 2 litros. Entonces esos grupos fundamentalmente masculinos, no han cambiado.”
	BEV_003	“In the most affluent parts of Santiago, […] people drink Light, Coca-Cola Light. You can give them a Pepsi Light, and they don’t drink it. If there is no Coca-Cola Light, they don’t buy anything else. [...] If you go the outskirt areas […], that guy consumes a lot of sugar, a lot of oil [...] they like Coca-Cola with sugar and that's the only beverage they buy.”	“En el sector oriente, […], la gente toma Light, Coca-Cola light. Le pones una Pepsi Light, y no se la toma. Si no hay Coca-Cola light no compra otra cosa. […] Si tú te vas a zonas más periféricas […], ese gallo sigue consumiendo mucha azúcar, mucho aceite […] le gusta la Coca-Cola con azúcar y esa es la que compra no más.”
	ORG_003	“[...] given that SSB consumption is not just an act of consumption, but of identity construction, of social practices, of coexistence, even of status. Bringing a sugar-sweetened beverage bottle to your table, it’s a sign of income.”	“[…] dado que el consumo de SSB no es solo un acto de consumo, sino que, de construcción de identidad, de prácticas social de convivencia, incluso de status. Cuando tu llevas bebida a tu mesa es un signo de ingresos.”
	ACA_001	“And also, because the fact of drinking sugar-sweetened beverages instead of water it is culturally associated with improving your socioeconomic status. These beverages somehow matched people, it’s like I went up, I have more money, I can drink sugar-sweetened beverages.”	“Y además que culturalmente se asocia a mejoría en tu escala socioeconómica el hecho de tomar bebida y no tomar agua. Las bebidas como que igualó a la gente, como que subí de nivel, tengo más plata, tomo bebida.”

Appendix 18. Health Sciences Research Governance Committee approval letter

DEPARTMENT OF HEALTH SCIENCES

c/o Department of Philosophy
Heslington
York YO10 5DD

Telephone (01904) 323253
Fax (01904) 321383
E-mail smh12@york.ac.uk

Dr Stephen Holland
Chair, Health Sciences Research Governance Committee

www.york.ac.uk/healthsciences

6 October 2017

Mrs M J Valenzuela

Department of Health Sciences

University of York

York

YO10 5DD

Dear Josefina

Sugar tax policymaking and oral health in Chile

Thank you for submitting the above project to the Health Sciences Research Governance Committee for approval. Your application was considered by the committee at its meeting on Monday, 2 October 2017.

I am pleased to report that the committee approved the project. I was asked to feedback the following point:

- Section 6 states that no other ethics committee approval is required for this study. The committee reiterated that it is the researcher's responsibility to ensure that all in-country research ethics/governance requirements are met. If you are in any doubt about this, please discuss it with your supervisors and/or myself.

If you have any queries regarding the decision, or make any substantial amendments to the study, please contact me.

Yours sincerely

Stephen Holland

Chair: HSRGC

cc. Prof Karen Bloor

Appendix 19. Latin American School of Social Sciences (FLACSO-Chile) letter

April, 16th. 2018

To whom it may concern,

In order to commence qualitative research to senior stakeholders in Chile, it is the researcher's responsibility to make sure that the research project obtains approval by the Ethics Committee from the corresponding sponsoring institution, and that each participant signs an Informed Consent Form. In consideration of this, Maria Valenzuela's research project meets these requirements by having obtained approval from the Research Governance Committee at the University of York.

Yours sincerely,

Eduardo Menz Queirolo

Academic

FLACSO-Chile

Abbreviations

AES	Adult Equivalence Scale
CI	Confidence Interval
COICOP	Classification of Individual Consumption by Purpose
COREQ	Consolidated criteria for reporting qualitative research
DMFS	Decayed, missing and filled surfaces in permanent teeth
Dmfs	Decayed, missing and filled surfaces in primary teeth
DMFT	Decayed, missing and filled permanent teeth
Dmft	Decayed, missing and filled primary teeth
ECC	Early Childhood Caries
EPF	Household Budget Survey (Encuesta de Presupuestos Familiares in Spanish)
FOP	Front-of-Package
GRADE	Grading of Recommendations, Assessment, Development and Evaluations
HMIC	Health Management Information Consortium
IABA	*Impuesto Adicional a las Bebidas Azucaradas (in Spanish)*
LILACS	Latin American and Caribbean Health Sciences Literature
MeSH	Medical Subject Heading
NCD	Non-communicable diseases
NPISH	Non-profit institutions serving households
OECD	Organisation for Economic Co-operation and Development
OR	Odds-Ratio
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RT	Tax Reform
SciELO	Scientific Electronic Library Online
SES	Socioeconomic status
SSB	Sugar-sweetened beverages
UK	United Kingdom
UN	United Nations
US	United States
WHO	World Health Organisation
WMD	Weighted Mean Difference

References

Ab Halim, N., Esa, R., Chew, H. P. (2018). General and erosive tooth wear of 16-year-old adolescents in Kuantan, Malaysia: prevalence and association with dental caries. *BMC Oral Health*, 18(1):11.

Abu-Ghazaleh, S. B., Burnside, G. and Milosevic, A. (2013). The prevalence and associated risk factors for tooth wear and dental erosion in 15- to 16-year-old schoolchildren in Amman, Jordan. *European Archives of Paediatric Dentistry*, 14: 21-27.

Al-Amer, R., Ramjan, L., Glew, P. Darwish, M., Salamonson, Y. (2014). Translation of interviews from a source language to a target language: examining issues in cross-cultural health care research. *Journal of Clinical Nursing*, 24:1151–1162.

Al-Malik, M. I., Holt, R. D. and Bedi, R. (2001). The relationship between erosion, caries and rampant caries and dietary habits in preschool children in Saudi Arabia. *International Journal of Paediatric Dentistry*, 11: 430–439.

Alhabdan, Y. A., Albeshr, A. G., Yenugadhati, N., Jradi, H. (2018). Prevalence of dental caries and associated factors among primary school children: a population-based cross-sectional study in Riyadh, Saudi Arabia. *Environmental Health and Preventive Medicine*, 23(1):60.

Allcott, H., Lockwood, B., Taubinsky, D. (2019). Should We Tax Sugar-Sweetened Beverages? An Overview of Theory and Evidence. *Journal of Economic Perspective*, 33(3):202-227.

Alvarez, L. L., Fabruccini, F. A., Alves, L. S., Alvarez, V. R. and Maltz, M. (2015). Erosive tooth wear among 12-year-old schoolchildren: a population-based cross-sectional study in Montevideo, Uruguay. *Caries Research*, 49:216-225.

Álvarez-Sánchez, C. (2018). *Mexicans' Consumption of Taxed Sugar-Sweetened Beverages and the Psychosocial Determinants of Consumption in the Context of the 2014 Sugar-Sweetened Beverage Tax—A Mixed Methods Study* [Dissertation]. New York City: Columbia University.

Amin, T. T. and Al-Abad, B. M. (2008). Oral hygiene practices, dental knowledge, dietary habits and their relation to caries among male primary school children in Al Hassa, Saudi Arabia. *International Journal of Dental Hygiene*, 6; 361–370.

Andreyeva, T., Long, M. W. and Brownell, K. D. (2010). The impact of food prices on consumption: a systematic review of research on the price elasticity of demand for food. *American journal of public health*, 100(2): 216-222.

Araral, E., Fritzen, S., Howlett, M., Ramesh M. and Wu, X. (2013). *Routledge Handbook of Public Policy*. London: Routledge.

Araújo, N. C., de Lima, A. C., Massoni, T., Tornisiello, C. R. and Rosenblatt, A. (2009). Dental erosion and consumption of industrialized beverages in a group of children in Recife/Pernambuco, Brazil. *Revista Odonto Ciência*, 24(2):120-123.

Armfield, J. M., Spencer, A. J., Roberts-Thomson, K. F., and Plastow, K. (2013). Water fluoridation and the association of sugar-sweetened beverage consumption and dental caries in Australian children. *American journal of public health*, 103(3), 494–500.

Arthur, S., Mitchell, M., Lewis, J. and McNaughton Nicholls, C. (2014). *Designing fieldwork*. In: Ritchie, J., Lewis, J., McNaughton Nicholls, C. and Ormston, R. (Eds.) Qualitative research

practice: a guide for social science students and researchers. 2nd ed. London: Sage, pp. 147-176.

Atalah, S. E. (2012). Epidemiología de la obesidad en Chile. *Revista Médica Clínica Las Condes*, 23(2), 117-123.

Auad, S. and Moynihan, P. (2007). Diet and dental erosion. Quintessence International, 38(2):130–3.

Azad, M. B., Abou-Setta, A. M., Chauhan, B. F., Rabbani, R., Lys, J., Copstein, L., Mann, A., Jeyaraman, M. M., Reid, A.E., Fiander, M., MacKay, D. S., McGavock, J., Wicklow, B., Zarychanski, R. (2017). Nonnutritive sweeteners and cardiometabolic health: a systematic review and meta-analysis of randomized controlled trials and prospective cohort studies. *The Canadian Medical Association Journal*, 189(28): E929-E939.

Backholer, K., Sarink, D., Beauchamp, A., Keating, C., Loh, V., Ball, K., Martin, J., Peeters, A. (2016). The impact of a tax on sugar-sweetened beverages according to socio-economic position: a systematic review of the evidence. *Public Health Nutrition*, 19(17):3070-3084.

Bagramian, R. A., Garcia-Godoy, F. and Volpe, A. R. (2009). The global increase in dental caries. A pending public health crisis. *American Journal of Dentistry*, 22(1), 3-8.

BaniHani, A., Deery, C., Toumba, J., Munyombwe, T., and Duggal, M. (2018). The impact of dental caries and its treatment by conventional or biological approaches on the oral health-related quality of life of children and carers. *International Journal of Paediatric Dentistry*, 28(2): 266–276.

Barquera, S., Hernández-Barrera, L., Tolentino, M.L., Espinosa, J., Ng, S., Rivera, J., and Popkin, B. (2008). Energy intake from beverages is increasing among Mexican adolescents and adults. *The Journal of nutrition*, 138(12): 2454-61.

Barrientos-Gutierrez, T., Zepeda-Tello, R., Rodrigues, E. R., Colchero, M. A., Rojas-Martinez, R., Lazcano-Ponce, E., Hernandez-Avila, M., Rivera-Dommarco, J., Meza, R. (2017). Expected population weight and diabetes impact of the 1-peso-per-litre tax to sugar sweetened beverages in Mexico. *PLoS One*, 12(5):e0176336.

Bauhr, M. and Grimes, M. (2014). Indignation or Resignation. *Governance*, 27: 291-320.

Baumgartner, F. and Leech, B. (1998). *Basic interests: the importance of groups in politics and in political science.* Princeton, NJ: Princeton University Press.

BCN (2014). *Ley No. 20.780*. Santiago, Biblioteca del Congreso Nacional de Chile. [Online]. Available at: https://www.bcn.cl/historiadelaley [Accessed 20 May 2018].

BCN (2015). *Ley No. 19.966*. Santiago, Biblioteca del Congreso Nacional de Chile. [Online]. Available at: http://www.leychile.cl/Navegar?idNorma=229834 [Accessed 20 May 2016].

Bedi R. (2018). The Sugar Tax: A Leadership Issue for the Dental Profession and An Opportunity to Demonstrate that Oral Health is Part of General Health. *Contemporary clinical dentistry*, 9(2), 149–150.

Bedos, C., Apelian, N., Vergnes, J.N. (2017). Time to develop social dentistry. JDR *Clinical and Translational Research*, 3:109-1010.

Benzian, H., Hobdell, M., Holmgren, C., Yee, R., Monse, B., Barnard, J. T., van Palenstein Helderman, W. (2011). Political priority of global oral health: an analysis of reasons for international neglect. *International dental journal*, 61(3), 124-130.

Berlin, J. A., Longnecker, M. P. and Greenland, S. (1993). Meta-analysis of epidemiologic dose-response data. *Epidemiology*, 4(3):218-228.

Birbili, M. (2000). *Translating from one language to another. Social Research Update issue 31*. [Online] Available at: http://sru.soc.surrey.ac.uk/ SRU31.html [Accessed December 2016]

Birch, L., Savage, J. S., & Ventura, A. (2007). Influences on the Development of Children's Eating Behaviours: From Infancy to Adolescence. *Canadian journal of dietetic practice and research: a publication of Dietitians of Canada = Revue canadienne de la pratique et de la recherche en dietetique : une publication des Dietetistes du Canada,* 68(1), s1–s56.

Bleich, S. and Vercammen, K.A. (2018). The negative impact of sugar-sweetened beverages on children's health: an update of the literature. *BMC Obesity*, 5:6.

Bodker, M., Pisinger, C., Toft, U., Jorgensen, T. (2015) The rise and fall of the world's first fat tax. *Health Policy*, 119:737–42

Bolt-Evensen, K., Vik, F.N., Stea, T.H. et al. (2018). Consumption of sugar-sweetened beverages and artificially sweetened beverages from childhood to adulthood in relation to socioeconomic status – 15 years follow-up in Norway. *International Journal of Behavioral Nutrition and Physical Activity* 15(1):8.

Borenstein, M., Hedges, L.V., Higgins, J.P.T. and Rothstein (2009). *Introduction to Meta-Analysis*. West Sussex: John Wiley & Sons.

Bowling, A. (2009). *Research Methods in Health: investigating health and health services.* 3rd edition. Maidenhead: Open University Press.

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2): 77-101.

Braun, V. and Clarke, V. (2013). *Successful qualitative research: a practical guide for beginners*. London: Sage.

Braun, V. and Clarke, V. (2019) To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. *Qualitative Research in Sport, Exercise and Health*, 13(2):201-216

Braun, V., and Clarke, V. (2019b). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, 11(4), 589-597.

Bray, G. and Popkin, B. M. (2013). Calorie-sweetened beverages and fructose: what have we learned 10 years later. *Pediatric obesity*, 8(4), 242-248.

Brennenstuhl, S., Quesnel-Vallée, A., McDonough, P. (2012) Welfare regimes, population health and health inequalities: a research synthesis. *Journal of Epidemioly and Community Health*, 66(5):397–409.

Briggs, A.D.M., Mytton, O.T., Kehlbacher, A., Tiffin, R., Elhussein, A., Rayner, M., et al. (2017) Health impact assessment of the UK soft drinks industry levy: a comparative risk assessment modelling study. *Lancet Public Health*, 2(1):e15–22.

British Soft Drink Association, BSDA (2016). *Leading the Way. UK soft drinks annual report.* [Online] Available at: https://www.britishsoftdrinks.com/write/MediaUploads/Publications/BSDA_Annual_report_2016.pdf [Accessed 15 March 2021].

Brown, Susan L., Wendy D. Manning and J. Bart Stykes (2015). Family structure and child well-being: Integrating family complexity. *Journal of Marriage and Family*, 11(1):177- 190.

Brownell, K. D., Farley, T., Willett, W. C., Popkin, B. M., Chaloupka, F. J., Thompson, J. W., & Ludwig, D. S. (2009). The public health and economic benefits of taxing sugar-sweetened beverages. *The New England journal of medicine*, 361(16), 1599–1605.

Bryman, A. (2006). Integrating Quantitative and Qualitative Research: How Is It Done? *Qualitative Inquiry*, 6 (1): 97–113.

Bryman, A. (2008). *Social research methods*. 3rd ed. Oxford: Oxford University Press.

Burrows, J. (2008). Inequalities and healthcare reform in Chile: equity of what? *Journal of Medical Ethics*, 34: e13.

Caro, J.C., Corvalán, C., Reyes, M., Silva, A., Popkin, B., and Taillie, L. S. (2018). Chile's 2014 sugar-sweetened beverage tax and changes in prices and purchases of sugar-sweetened beverages: An observational study in an urban environment. *PLoS medicine*, 15(7):e1002597. [Online] Available at: https://doi.org/10.1371/journal.pmed.1002597

Cawley, J. and Meyerhoefer, C. (2012). The medical care costs of obesity: an instrumental variables approach. *Journal of health economics*, 31(1), 219-230.

Cawley, J., Thow, A.M., Wen, K., Frisvold, D. (2019). The Economics of Taxes on Sugar-Sweetened Beverages: A Review of the Effects on Prices, Sales, Cross-Border Shopping, and Consumption. *Annual Review of Nutrition*, 21;39:317-338.

Centre for Reviews and Dissemination, CRD (2009). *Systematic Reviews: CRD's guidance for undertaking reviews in health care*. University of York, York, UK.

Chen, X., Liu, Y., Yu, Q., Zheng, L., Hong, X., Yan, F. and Yu, H. (2014). Dental caries status and oral health behavior among civilian pilots. *Aviation space environmental medicine journal*, 85:999 – 1004.

Chouinard, H.H., Davis, D.E., LaFrance, J.T., Perloff, J.M. (2007). Fat taxes: big money for small change. Forum Health Econ Policy. *Forum for Health Economics & Policy*, De Gruyter, 10(2): 1-30.

Chowdhury, C.R., Shahnawaz, K., Kumari, P.D., et al. (2018). Highly acidic pH values of carbonated sweet drinks, fruit juices, mineral waters and unregulated fluoride levels in oral care products and drinks in India: a public health concern. *Perspectives in Public Health*, 1:1–9.

Clarke, V. and Braun, V. (2018). Using thematic analysis in counselling and psychotherapy research: a critical reflection. *Counselling and Psychotherapy Research,* 18(2): 107-110

Çolak, H., Dülgergil, Ç. T., Dalli, M., and Hamidi, M. M. (2013). Early childhood caries update: A review of causes, diagnoses, and treatments. *Journal of Natural Science, Biology, and Medicine*, 4(1), 29–38.

Colchero, M. A., et al. (2016). Beverage purchases from stores in Mexico under the excise tax on sugar sweetened beverages: observational study. *BMJ*, 352:h6704.

Colchero, M.A., Salgado, J.C., Unar-Munguía, M., Molina, M., Ng, S., Rivera-Dommarco, J.A. (2015). Changes in Prices After an Excise Tax to Sweetened Sugar Beverages Was Implemented in Mexico: Evidence from Urban Areas. *PLoS ONE*, 10(12): e0144408.

Commission on Social Determinants of Health, CSDH (2008). *Closing the gap in a generation. Health equity through action on the social determinants of health*. Geneva: World Health Organization.

Corbin, J. and Strauss, A. (2008) *Basics of qualitative research*. (3rd ed) Thousand Oaks: Sage Publications.

Corvalán, C., Reyes, M., Garmendia, M.L., Uauy, R. (2018). Structural responses to the obesity and non-communicable diseases epidemic: Update on the Chilean law of food labelling and advertising. *Obesity Reviews*, 20(3):367-374.

Creswell, J.W. (2014). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*. 4th edition. London: Sage.

Creswell, J.W. and Plano Clark, V. (2018). *Designing and conducting mixed methods research.* 3rd ed. California: Sage.

Creswell, J.W. and Poth, C.N. (2018). *Qualitative Inquiry and Research Design. Choosing among five approaches*. 4th edition. California: Sage Publications.

Crippa, A. and Orsini, N. (2016). Dose-response meta-analysis of differences in means. *BMC Medical Research Methodology*, 2;16:91.

Cummings, J. and Stephen, A. (2007). Carbohydrate terminology and classification. European *Journal of Clinical Nutrition*, 61, S5-S18.

Dahal, S., Poudel, P., Pradhan, M., Mainali, B. (2021). Tooth Wear and Associated Factors in School Children with Primary Dentition in Kathmandu Valley. *Journal of Nepal Health Research Council,* 18(4):637-643.

Dahlgren, G. and Whitehead, M. (1991). *Policies and Strategies to Promote Social Equity in Health*. Stockholm, Sweden: Institute for Futures Studies.

Daly, B., Watt, R., Batchelor, P., Treasure, E. (2013). *Essential dental public health* (2nd ed). Oxford: Oxford University Press.

Damle, S.D., Bector, A. and Saini, S. (2011). The Effect of Consumption of Carbonated Beverages on the Oral Health of Children: A Study in Real Life Situation. *Pesquisa Brasileira em Odontopediatria e Clínica Integrada*, 11(1):35-40.

Deaton A. and Paxson C. (1998). Economies of Scale, Household Size, and the Demand for Food. *The Journal of Political Economy*, 106(5):897-930.

Della Corte, K., Fife, J., Gardner, A., Murphy, B. L., Kleis, L., Della Corte, D., Schwingshackl, L., LeCheminant, J. D., Buyken, A. E. (2021). World trends in sugar-sweetened beverage and dietary sugar intakes in children and adolescents: a systematic review. *Nutrition Reviews*, 79(3):274–288.

Denzin, N.K. (1978). *The Research Act: a Theoretical Introduction to Sociological Methods.* 2nd ed. New York: McGraw-Hill.

DerSimonian, R. and Laird, N. (1986). Meta-analysis in clinical trials. *Controlled Clinical Trials*, 7(3):177-88.

Dexter, A. L. (2012). *Elite and specialised interviewing*. Colchester: ECPR Press.

Dey, I. (1999). *Grounding Grounded Theory*. San Francisco, CA: Academic Press.

Do, L. G. (2012). Distribution of Caries in Children: Variations between and within Populations. *Journal of Dental Research*, 91(6), 536-543.

Donaldson, E. (2015) *Advocating for sugar-sweetened beverage taxation: a case study of Mexico* [Online]. Baltimore: Johns Hopkins Bloomberg School of Public Health. [Online]

Available at: https://ncdalliance.org/news-events/news/advocating-for-sugar-sweetened-beverage-taxation-a-case-study-of-mexico [Accessed on 15 May 2021]

Drewnowski, A. and Darmon, N. (2005). Food choices and diet costs: an economic analysis. *The Journal of Nutrition*, 135(4), 900-904.

Drury, T.F., Horowitz, A.M., Ismail, A.I., Maertens, M.P., Rozier, R.G. and Selwitz, R.H. (1999). Diagnosing and reporting early childhood caries for research purposes. A report of a workshop sponsored by the National Institute of Dental and Craniofacial Research, the Health Resources and Services Administration, and the Health Care Financing Administration. *Journal of Public Health Dentistry*, 59(3):192-7.

Du, Y. (2014). *Sugar sweetened beverages and childhood dental caries: a systematic review.* (Thesis). University of Hong Kong, Pokfulam, Hong Kong SAR.

Duffey, K. J. and Popkin, B. M. (2007). Shifts in patterns and consumption of beverages between 1965 and 2002. *Obesity*, 15(11), 2739-2747.

Duffey, K. J. and Popkin, B. M. (2008). High-fructose corn syrup: is this what's for dinner? *The American Journal of Clinical Nutrition*, 88(6), 1722S-1732S.

Dugmore, C.R. and Rock, W.P. (2004). A multifactorial analysis of factors associated with dental erosion. *British Dental Journal*, 196(5):283–6.

Egger, M., Davey Smith, G., Schneider, M., and Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ*, 315: 629–634.

El Karim, I.A., Sanhouri, N.M., Hashim, N.T. and Ziada, H.M. (2007). Dental erosion among 12-14 year old school children in Khartoum: A pilot study. *Community Dental Health*, 24, 176-180.

Elliott, S. S., et al. (2002). Fructose, weight gain, and the insulin resistance syndrome. *The American journal of clinical nutrition*, 76(5), 911-922.

Equator Network (2013). *The quality of mixed methods studies in health services research*. [Online]. Available at: https://www.equator-network.org/reporting-guidelines/the-quality-ofmixed-methods-studies-in-health-services-research/. [Accessed 27 May 2021].

Escalona E. (2014). Historia de los impuestos al consumo en Chile desde 1920 y al valor agregado. *Revista Estudios Tributarios*, 10:9–49.

Esposito, N. (2001). From meaning to meaning: the influence of translation techniques on non-English focus group research. *Quality Healthcare Research*, 11:568–579.

EUROSTAT (2003). *Household Budget Surveys in the EU. Methodology and recommendations for harmonisation*. Luxembourg: Office for Official Publications of the European Communities.

Eykelenboom, M., van Stralen, M.M., Olthof, M.R. et al. (2019). Political and public acceptability of a sugar-sweetened beverages tax: a mixed-method systematic review and meta-analysis. Internatio*nal Journal of Behavioral Nutrition and Physical Activity*, 16: 78.

Fabregues, S. and Molina-Azorin, J. F. (2017). Addressing quality in mixed methods research: A review and recommendations for a future agenda. *Quality and quantity*, 51:2847–2863.

Featherstone, J. (2008). Dental caries: a dynamic disease process. *Australian dental journal*, 53(3), 286-291.

Feilzer, Y. M. (2010). Doing Mixed Methods Research Pragmatically: Implications for the Rediscovery of Pragmatism as a Research Paradigm. *Journal of Mixed Methods Research*, 4(1):6-16.

Fetters, M. D., Curry, L. A., and Creswell, J. W. (2013). Achieving Integration in Mixed Methods Designs—Principles and Practices. *Health Services Research,* 48.6pt2: 2134-156.

Flegal, K. M., Carroll, M. D., Ogden, C. L., Johnson, C. L. (2000). Prevalence and trends in obesity among US adults, 1999–2000. *JAMA*, 288:1723–7.

Fleiss, J. L., Levin, B. and Cho Paik, M. (2003). *The Measurement of Interrater Agreement*. In: Statistical Methods for Rates and Proportions, Third Edition. New Jersey: John Wiley & Sons, Inc.

Fung, A. and Messer, B. (2013). Tooth wear and associated risk factors in a sample of Australian primary school children. *Australian Dental Journal*, 58: 235–245.

Gattini, C. and Álvarez Leiva, J. (2011). *Panorama de la situación de salud y del sistema de salud en Chile. Serie Análisis de Situación*—PWR CHI/11/HA/01 OPS/OMS, Santiago.

GBD, Disease and Injury Incidence and Prevalence Collaborators. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*, 392(10159):1789-1858.

Gerring, J. (2017). *Case study research: principles and practices*. 2nd ed. Cambridge: Cambridge University Press.

Glaser, B.G. and Strauss, A.L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Chicago: Aldine Transaction.

Glied, S. and Smith, P. C. (2011). *The Oxford handbook of health economics*: Oxford University Press.

Gómez, S., Fernández, O. (2010). Fluoración del Agua Potable, Experiencia en Chile. En: Gómez Soler G, editor. *Fluorterapia en Odontologia Fundamentos y Aplicaciones Clínicas*, 162-77.

Great Britain (2018). *The Data Protection Act 2018. London: Stationery Office*. [Online] Available at: https://www.legislation.gov.uk/ukpga/2018/12/contents/enacted. [Accessed 19th January 2021].

Greenland, S. and Longnecker, M. P. (1992). Methods for Trend Estimation from Summarized Dose-Response Data, with Applications to Meta-Analysis. *American Journal of Epidemiology*, 135(11):1301–1309.

Grimm, G.C., Harnack, L., Story, M. (2004). Factors associated with soft drink consumption in school-aged children. *Journal of the American Dietetic Association*, 104(8):1244–9.

Grimshaw, J., Campbell, M., Eccles, M. and Steen, N. (2000). Experimental and quasi-experimental designs for evaluating guideline implementation strategies. *Family Practice*, 17: S11–S18.

Groves, R. M., and Couper, M. P. (1998). *Nonresponse in Household Interview Surveys*. New York: Wiley.

Guarnizo-Herreño, C. C., Frazão P., Capel Narvai, P. (2021). *Epidemiology, Politics, and Dental Public Health*. In: Peres M. A., Antunes J. L. F., Watt R. G. (eds) Oral Epidemiology. Textbooks in Contemporary Dentistry. Springer, Cham.

Guba, E.G. (1990). *The alternative paradigm dialog*. In EG Guba (Ed), The paradigm dialog (p. 17-30). Newbury Park, CA: Sage.

Gubrium, J. F. and Holstein, J. A. (2001). *Handbook of Interview Research: Context and Method.* London: Sage.

Guerrero-López, C. M., Molina, M., Colchero, M. A. (2017). Employment changes associated with the introduction of taxes on sugar-sweetened beverages and nonessential energy-dense food in Mexico. *Preventive Medicine Journal,* 105S:S43-S49.

Guetterman, T. C., Fetters, M. D., Creswell, J. W. (2015). Integrating Quantitative and Qualitative Results in Health Science Mixed Methods Research Through Joint Displays. *Annals Family Medicine*, 13(6):554-61.

Hamasha, A. A., Zawaideh, F. I. and Al-Hadithy, R. T. (2014). Risk indicators associated with dental erosion among Jordanian school children aged 12–14 years of age. *International Journal of Paediatric Dentistry*, 24:56–68.

Hammersley, M. (1992). *What's Wrong with Ethnography?: Methodological Explorations.* Psychology Press. London: Routledge.

Han, E., Powell, L. M. (2013) Consumption patterns of sugar-sweetened beverages in the United States. *Journal of the Academy of Nutrition and Dietetics*, 113(1):43–53.

Hangoma, P., Bulawayo, M., Chewe, M., et al. (2020). The potential health and revenue effects of a tax on sugar sweetened beverages in Zambia. *BMJ Global Health*, 5:e001968.

Harnack, L., Stang, J. and Story, M. (1999). Soft drink consumption among US children and adolescents: nutritional consequences. *Journal of the American Dietetic Association*, 99(4): 436-441.

Harris, J. L., Fleming-Milici, F., Kibwana-Jaff, A. and Phaneuf, L. (2020). *Sugary Drink Facts 2020 – Sugary drink advertising to youth: Continued barrier to public health progress. UConn Rudd Center for Food Policy & Obesity*. [Online] Available at: https://www.sugarydrinkfacts.org/resources/Sugary%20Drink%20FACTS%202020/Sugary_Drink_FACTS_Full%20Report_final.pdf. [Accessed 21 May 2021].

Hashim, R., Williams, S. M. and Thomson, W. M. (2009). Diet and caries experience among preschool children in Ajman, United Arab Emirates. *European Journal of Oral Sciences,* 117: 734–740.

Hawkes, C., Jewell, J. and Allen, K. (2013). A food policy package for healthy diets and the prevention of obesity and diet-related non-communicable diseases: the NOURISHING framework. *Obesity reviews*, 14(S2), 159-168.

Heilmann, A., Machuca Vargas, C., Watt, R. G. (2021). *Sugar Consumption and Oral Health.* In: Peres, M. A., Antunes, J. L. F., Watt, R. G. (eds) Oral Epidemiology. Textbooks in Contemporary Dentistry. Switzerland: Springer.

Hendrie, G.A, D. Baird, R.K. Golley, M. Noakes (2017). The CSIRO Healthy Diet Score: an Online survey to estimate compliance with the Australian Dietary Guidelines. *Nutrients*, 9:47.

Henríquez-Tejo, R. and Flores, R. (2016). Evidence-based practice and public oral health policy in Chile, a broken link. *Journal of Oral Research*, 5(5), 182-183.

Higgins, J.P.T. and Green, S. (2011). *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0.* The Cochrane Collaboration. [Online]. Available at: http://handbook.cochrane.org [Accessed 24/01/2019].

Hill, M. and Varone, F. (2017). *The Public Policy Process* (7th ed). London and New York: Routledge.

Hilton, S., Buckton, C. H., Patterson, C., Katikireddi, S. V., Lloyd-Williams, F., Hyseni, L., Elliott-Green, A., & Capewell, S. (2019). Following in the footsteps of tobacco and alcohol? Stakeholder discourse in UK newspaper coverage of the Soft Drinks Industry Levy. *Public health nutrition*, 22(12), 2317–2328.

Howlett, M. and Geist, S. (2013). *The policy making process*. In: Araral, E., Fritzen, S., Howlett, M., Ramesh, M. and Wu, X. (eds). Routledge Handbook of Public Policy, London: Routledge, pp.17-28.

Hsieh, H., Huang, S., Tsai, C., Chiou, M. and Liao, C. (2014). Oral Hygiene Risk Indicators Among 6- to 9-Year-Old Taiwanese Aboriginal Children. Asia-Pacific *Journal of Public Health*, 26(3):248– 259.

Hu, F. B. (2013). Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. *Obesity reviews*, 14(8), 606-619.

Huew, R., Waterhouse, P., Moynihan, P., Kometa, S. and Maguire, A. (2012). Dental caries and its association with diet and dental erosion in Libyan schoolchildren. *International Journal of Paediatric Dentistry*, 22:68–76.

Iheozor-Ejiofor, Z., Worthington, H.V., Walsh, T., O'Malley, L., Clarkson, J.E., Macey, R., Alam, R., Tugwell, P., Welch, V., Glenny, A.M. (2015) Water fluoridation for the prevention of dental caries. *Cochrane Database Systematic Reviews*, (6):CD010856.

Imamura, F., O'Connor, L., Ye, Z., Mursu, J., Hayashino, Y., et al. (2015) Consumption of sugar sweetened beverages, artificially sweetened beverages, and fruit juice and incidence of type 2 diabetes: systematic review, meta-analysis, and estimation of population attributable fraction. *BMJ*, 21:h3576.

Instituto Nacional de Estadísticas, INE (2013). *Metodología – VII Encuesta de Presupuestos Familiares. Instituto Nacional de Estadísticas, Santiago*. [Online] Available at: https://www.ine.cl/estadisticas/sociales/ingresos-y-gastos/encuesta-de-presupuestos-familiares [Accessed 18 June 2018].

Instituto Nacional de Estadísticas, INE (2014). *Documento de trabajo: Medición y análisis de la falta de respuesta total en la VIII Encuesta de Presupuestos Familiares. Subdirección técnica. Santiago, Chile*. [Online] Available at: https://www.ine.cl/estadisticas/sociales/ingresos-y-gastos/encuesta-de-presupuestos-familiares [Accessed 18 June 2018].

Instituto Nacional de Estadísticas, INE (2018). *Metodología – VIII Encuesta de Presupuestos Familiares. Instituto Nacional de Estadísticas, Santiago*. [Online] Available at: https://www.ine.cl/estadisticas/sociales/ingresos-y-gastos/encuesta-de-presupuestos-familiares [Accessed 18 June 2018].

Instituto Nacional de Estadísticas, INE (2021). *Encuesta de Presupuestos Familiares*. [Online] Available at: https://www.ine.cl/estadisticas/sociales/ingresos-y-gastos/encuesta-de-presupuestos-familiares. [Accessed on 05/01/2021].

Instituto Nacional de Estadísticas, INE (2021b) *Censo*. [Online] Available at: https://www.ine.cl/ine-ciudadano/definiciones-estadisticas/censo. [Accessed on 24/12/2021].

International Monetary Fund, IMF (2016). *Chile: Gross domestic product per capita, current prices (U.S. dollars). International Monetary Fund*. [Online]. Available at:

http://www.imf.org/external/pubs/ft/weo/2016/01/weodata/weorept.aspx?pr.x=34&pr.y=10&sy=2010&ey=2021&scsm=1&ssd=1&sort=country&ds=.&br=1&c=228&s=NGDPD%2CNGDPDPC&grp=0&a= [Accessed 16 June 2016].

Isett, K. R., Laugesen, M. J., Cloud, D. H. (2015). Learning from New York City: a case study of public health policy practice in the Bloomberg administration. *Journal of Public Health Management and Practice*, 21:313–22.

Jamieson, L.M., Roberts-Thomson, K.F. and Sayers, S.M. (2010). Dental caries risk indicators among Australian Aboriginal young adults. *Community Dentistry and Oral Epidemiology Journal*, 38: 213–221.

Jayedi, A., Emadi, A., Shab-Bidar, S. (2018). Dietary Inflammatory Index and Site-Specific Cancer Risk: A Systematic Review and Dose-Response Meta-Analysis. *Advances in Nutrition*, 9(4):388-403.

Jevdjevic, M., Trescher, A. L., Rovers, M., Listl, S. (2019). The caries-related cost and effects of a tax on sugar-sweetened beverages. *Public Health*, 169:125–32.

Johnson, B. and Onwuegbuzie, A. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, 33(7): 14 – 26.

Johnson, B., Onwuegbuzie, A. and Turner, L. (2007). Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research*, 1: 112-133.

Johnson, R. E., Grove, A. L. and Clarke, A. (2019). Pillar Integration Process: A Joint Display Technique to Integrate Data in Mixed Methods Research. *Journal of Mixed Methods Research*, 13(3):301–320.

Joshi, M., Joshi, N., Kathariya, R., Angadi, P., and Raikar, S. (2016). Techniques to Evaluate Dental Erosion: A Systematic Review of Literature. *Journal of Clinical and Diagnostic Research*, 10(10), ZE01–ZE07.

Jou, J., Niederdeppe, J., Barry, C. L., Gollust, S. E. (2014). Strategic messaging to promote taxation of sugar-sweetened beverages: lessons from recent political campaigns. *American Journal of Public Health*, 104(5):847–53.

Kawashita, Y., Fukuda, H., Kawasaki, K., Kitamura, M., Hayashida, H., Furugen, R., Fukumoto, E., Iijima, Y. and Saito, T. (2011). Pediatrician-recommended use of sports drinks and dental caries in 3-year-old children. *Community Dental Health*, 28, 29–33.

Khan, M. U., Abu-Zeid, H. A. H. and Eid, O. (1990) Factors Influencing Development of Caries Teeth. *Indian Journal of Pediatrics*, 57: 109-113.

Kickbusch, I., Allen, L., Franz, C. (2016) The commercial determinants of health. *Lancet Global Health*, 4: e895–96.

Kirthiga, M., Poornima, P., Praveen, R., Sakeena, B. and Disha, P. (2015). Dental Erosion and its Associated Factors in 11-16-Year Old School Children. *The Journal of Clinical Pediatric Dentistry*, 39(4).

Klein, H., Palmer, C., and Knutson, J. (1938). Studies on Dental Caries: I. Dental Status and Dental Needs of Elementary School Children. *Public Health Reports*, 53(19), 751-765.

Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Delhi: New Age International.

Krisdapong, S., Prasertsom, P., Rattanarangsima, K. and Sheiham, A. (2013). Sociodemographic differences in oral health-related quality of life related to dental caries in Thai school children. *Community Dental Health*, 30: 112–118.

Kruger, E., Dyson, K. and Tennant, M. (2005). Pre-school child oral health in rural Western Australia. *Australian Dental Journal*, 50:(4):258-262.

Krukowski, C. N., Conley, K. M., Sterling, M., Rainville, A. J. (2016). A Qualitative Study of Adolescent Views of Sugar-Sweetened Beverage Taxes, Michigan, 2014. *Preventing Chronic Disease*, 13:150543.

Lancaster, K. (2017). Confidentiality, anonymity and power relations in elite interviewing: conducting qualitative policy research in a politicised domain, *International Journal of Social Research Methodology*, 20:1, 93-103.

Lean, M. E. J. and Te Morenga, L. (2016). Sugar and Type 2 diabetes. *British Medical Bulletin*, 120(1):43–53.

Leon, D.A., Walt, G., Gibson, L. (2001). International perspectives on health inequalities and policy. *BMJ*, 322:591–4.

Li, H., Zou, Y. and Ding, G. (2012). Dietary Factors Associated with Dental Erosion: A Meta-Analysis. *PLoS ONE*, 7(8): e42626.

Li, Y., Zhang, Y., Yang, R., Zhang, Q., Zou, J. and Kang, D. (2011). Associations of social and behavioural factors with early childhood caries in Xiamen city in China. *International Journal of Paediatric Dentistry*, 21: 103–111.

Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gøtzsche, P.C., et al. (2009). The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration. *PLOS Medicine*, 6(7): e1000100.

Lim, S. S., et al. (2013). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The lancet*, 380(9859): 2224-2260.

Lincoln, Y. S. and Guba, E.G. (1985). *Naturalistic inquiry*. California: Sage Publications

Lincoln, Y. S., González y González, E. M. and Aroztegui Massera, C. (2016). 'Spanish is a loving tongue…': performing qualitative research across languages and cultures. *Qualitative Inquiry*, 22:531–540.

Litman, E. A., Gortmaker, S. L., Ebbeling, C. B., & Ludwig, D. S. (2018). Source of bias in sugar-sweetened beverage research: a systematic review. *Public health nutrition*, 21(12): 2345–2350.

Littell, J. H., Corcoran, J. and Pillai, V. (2008). *Systematic reviews and meta-analysis*. Oxford: Oxford University Press.

Liu, Q., Cook, N. R., Bergström, C. and Hsieh C. (2009). A two-stage hierarchical regression model for meta-analysis of epidemiologic nonlinear dose-response data. *Computational Statistics and Data Analysis*, 53:4157-4167.

Lopez-Frias, F. J., Castellanos-Cosano, L., Martin-Gonzalez, J., Llamas-Carreras, J. and Segura-Egea, J.J. (2012). Clinical measurement of tooth wear: Tooth wear indices. *Journal of Clinical and Experimental Dentistry*, 4(1): e48–e53.

Lussi, A., Jaeggi, T., Zero, D. (2004). The role of diet in the aetiology of dental erosion. *Caries Research*, 38:34–44.

Lustig, R. H. (2012). Fat chance: beating the odds against sugar, processed food, obesity, and disease: Penguin.

Lustig, R. H., Schmidt, L. A. and Brindis, C. D. (2012). Public health: The toxic truth about sugar. *Nature*, 482(7383), 27-29.

Lynch, R. J. M. (2013). The primary and mixed dentition, post-eruptive enamel maturation and dental caries: a review. *International Dental Journal*, 63 (Suppl. 2): 3–13.

Madden, D. (2015). The poverty effects of a “fat-tax” in Ireland. *Health Economics*, 24:104–21.

Maharani, D. A., Pratiwi, A. N., Setiawati, F., Zhang, S., Gao, S. S., Chu, C. H., Rahardjo, A. (2019). Tooth wear among five-year-old children in Jakarta, Indonesia. *BMC Oral Health*, 19(1):192.

Maharani, D., Zhang, S., Gao, S., Chu, C., Rahardjo, A. (2019). Dental Caries and the Erosive Tooth Wear Status of 12-Year-Old Children in Jakarta, Indonesia. *International Journal of Environmental Research and Public Health*, 16(16):2994.

Malik, V. S., Pan, A., Willett, W. C., Hu, F. B. (2013). Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *The American journal of clinical nutrition*, 98(4):1084-1102.

Malik, V. S., Popkin, B. M., Bray, G. A., Després, J-P., Hu, F. B. (2010). Sugar sweetened beverages, obesity, type 2 diabetes and cardiovascular disease risk. *Circulation*, 121(11):1356–64.

Manaf, Z.A., Lee, M.T., Ali, N.H., Samynathan, S., Jie, Y.P., Ismail, N.H., Bibiana hui Ying, Y., Wei Seng, Y. and Yahya, N.A. (2012). Relationship between food habits and tooth erosion occurrence in Malaysian university students. *Malaysian Journal of Medical Sciences*, 19:56–66.

Marmot, M. (2007). Commission on Social Determinants of Health. Achieving health equity: from root causes to fair outcomes. *Lancet*, 370(9593):1153-63.

Marriott, B. P., Hunt, K. J., Malek, A. M. and Newman, J. C. (2019). Trends in Intake of Energy and Total Sugar from Sugar-Sweetened Beverages in the United States among Children and Adults, NHANES 2003–2016. *Nutrients*, 11(9):2004.

Marsh, P. D. and Martin, M. V. (2009). *Oral Microbiology*. Fifth edition. Churchill and Livingstone.

Mason, M. (2010). Sample Size and Saturation in PhD Studies Using Qualitative Interviews. *Forum: Qualitative Social Research*, 11(3).

Mays, N. and Pope, C. (2006). *Quality in qualitative health research*. In: Pope C. and Mays, N. (Eds). Qualitative research in health care. Oxford, UK, Blackwell Publishing.

Mazarello Paes, V., Hesketh, K., O'Malley, C., Moore, H., Summerbell, C., Griffin, S., van Sluijs, E. M., Ong, K. K., Lakshman, R. (2015). Determinants of sugar-sweetened beverage consumption in young children: a systematic review. *Obesity Reviews,* 16(11):903-13.

McKee, M., Stuckler, D. (2018). Revisiting the corporate and commercial determinants of health. *American Journal of Public Health*, 108(9):1167–70.

Mejàre, I., Axelsson, S., Dahlén, G., Espelid, I., Norlund, A., Tranæus, S., and Twetman, S. (2013). Caries risk assessment. A systematic review. *Acta Odontologica Scandinavica*, 72(2), 81–91.

Mello, T., Antunes, J., Waldman, E., Ramos, E., Relvas, M. and Barros, H. (2008). Prevalence and severity of dental caries in schoolchildren of Porto, Portugal. *Community Dental Health*, 25, 119-125.

Mergenthaler, P., et al. (2013). Sugar for the brain: the role of glucose in physiological and pathological brain function. *Trends in neurosciences*, 36(10), 587-597.

Methley, A. M., Campbell, S., Chew-Graham, C., McNally, R., and Cheraghi-Sohi, S. (2014). PICO, PICOS and SPIDER: a comparison study of specificity and sensitivity in three search tools for qualitative systematic reviews. *BMC Health Services Research,* 14, 579.

Milosevic, A., Bardsley, P. F. and Taylor, S. (2004). Epidemiological studies of tooth wear and dental erosion in 14-year old children in North West England. Part 2: The association of diet and habits. *British Dental Journal*, 97(8).

Ministerio de Salud Chile, MINSAL (2003). *Encuesta Nacional de Salud. Santiago: Ministerio de Salud OCHISAP.* Síntesis de la Salud en Chile. Santiago: Escuela de Salud Pública - Instituto de Salud Poblacional, Facultad de Medicina, Universidad de Chile.

Ministerio de Salud Chile, MINSAL (2007). *Informe Final. Estudio de carga de enfermedad y Carga Atribuible.* Ministerio de Salud Chile.

Ministerio de Salud Chile, MINSAL (2010). *Encuesta Nacional en Salud 2010/2011*. Ministerio de Salud.

Ministerio de Salud Chile, MINSAL (2010). *Estrategia Nacional de Salud Para el cumplimiento de los Objetivos Sanitarios de la Década 2011-2020*. Ministerio de Salud.

Ministerio de Salud Chile, MINSAL (2017). *Encuesta Nacional en Salud 2016/2017*. Ministerio de Salud.

Mitchell, M. (2020). *Data Management Using Stata: A Practical Handbook* (2nd Edition). Stata Press: Texas.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and MetaAnalyses: The PRISMA Statement. *PLoS Med*, 6(7): e1000097.

Mongan, D. (2015). *Standard drink measures throughout Europe; peoples' understanding of standard drinks and their use in drinking guidelines, alcohol surveys and labelling. Reducing Alcohol Related Harm (RARHA) and Health Programme of the European Union.* [Online] Available at: http://www.rarha.eu/Resources/Deliverables/Lists/Deliverables/Attachments/14/WP5%20Background%20paper%20Standard%20drink%20measures%20HRB.pdf. [Accessed 24 January 2019].

Moodie, R., Stuckler, D., Monteiro, C., Sheron, N., Neal, B., Thamarangsi, T., Lincoln, P., Casswell, S.; Lancet NCD Action Group (2013). Profits and pandemics: prevention of harmful effects of tobacco, alcohol, and ultra-processed food and drink industries. *The Lancet,* 381(9867), 670-679.

Moore, J. C., Stinson, L. L., and Welniak, E. J. (2000). Income Measurement Error in Surveys: A Review. *Journal of Official Statistics*, 16(4):331-361.

Moran-Ellis, J., Alexander, V. D., Cronin, A., et al. (2006). Triangulation and integration: processes, claims and implications. *Qualitative Research*, 6(1):45-59.

Morgan, D. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of Mixed Methods Research*, 1(1): 48-76.

Morse, J.M. (1991). Approaches to qualitative-quantitative methodological triangulation. *Nursing Research*, 40(2):120-3.

Mounsey, S., Veerman, L., Jan, S., Thow, A. M. (2020). The macroeconomic impacts of diet-related fiscal policy for NCD prevention: A systematic review. *Economics and Human Biology*, 37: 100854.

Moynihan, P. and Kelly, S. (2014). Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. *Journal of dental research*, 93(1), 8-18.

Mulic, A., Skudutyte-Rysstad, R., Tveit, A.B. and Skaare, A.B. (2012). Risk indicators for dental erosive wear among 18-yr-old subjects in Oslo, Norway. *European Journal of Oral Sciences*, 120: 531–538.

Mullee, A., Romaguera, D., Pearson-Studdard, J., Viallon, V., Stepien, M., Freisling, H., et al (2019). Association Between Soft Drink Consumption and Mortality in 10 European Countries. *JAMA Internal Medicine*, 179(11):1479-1490.

Murakami, C., Oliveira, L.B., Sheiham, A., Nahás Pires Corrêa, M.S., Haddad, A.E. and Bönecker, M. (2011). Risk Indicators for Erosive Tooth Wear in Brazilian Preschool Children. *Caries Research*, 45:121–129.

Mytton, O. T., Clarke, D. and Rayner, M. (2012). Taxing unhealthy food and drinks to improve health. *BMJ*, 344:e2931-e2931.

Nakamura, R., Mirelman, A. J., Cuadrado, C., Silva-Illanes, N., Dunstan, J., Suhrcke, M. (2018) Evaluating the 2014 sugar-sweetened beverage tax in Chile: An observational study in urban areas. *PLoS Med*, 15(7): e1002596.

Nakayama, Y. and Mori, M. (2015). Association between Nocturnal Breastfeeding and Snacking Habits and the Risk of Early Childhood Caries in 18- to 23-Month-Old Japanese Children. *Journal of Epidemiology*, 25(2):142-147.

Nakayama, Y. and Mori, M. (2015). Association of environmental tobacco smoke and snacking habits with the risk of early childhood caries among 3-year-old Japanese children. Journal of Public Health Dentistry, ISSN 0022-4006.

National Heart, Lung and Blood Institute, NHLBI (2014). *Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies.* USA: National Institutes of Health. [Online]. Available at: https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools [Accessed on 04 October 2018].

Navarro, V., Muntaner, C., Borrell, C., Benach, J., Quiroga, A., Rodriguez-Sanz, M., et al. (2006). Politics and health outcomes. *Lancet*, 368:1033–7.

Nestle, M., Bittman, M. and Baer, N. (2015). *Soda politics: taking on big soda (and winning)*. Oxford: Oxford University Press.

Ng, S. W., Rivera, J. A., Popkin, B. M., Colchero, M. A. (2019). Did high sugar-sweetened beverage purchasers respond differently to the excise tax on sugar-sweetened beverages in Mexico? *Public health nutrition*, 22(4): 750-6.

Niederdeppe, J., Gollust, S. E., Jarlenski, M. P., Nathanson, A. M., and Barry, C. L. (2013). News coverage of sugar-sweetened beverage taxes: pro- and anti-tax arguments in public discourse. *American journal of public health*, 103(6):e92–e98.

Nixon, L., Majia, P., Cheyne, A., Dorfman, L. (2015). Big Soda's long shadow: news coverage of local proposals to tax sugar-sweetened beverages in Richmond, El Monte and Telluride. *Critical Public Health*, 25:333–47.

O'Cathain, A. (2010). *Assessing the Quality of Mixed Methods Research: Toward a Comprehensive Framework.* In: SAGE Handbook of Mixed Methods in Social and Behavioral Research, 2nd ed. Thousand Oaks, CA: SAGE Publications, Inc. pp. 531-556. [Online] Available at: http://www.doi.org.libproxy.york.ac.uk/10.4135/9781506335193 [Accessed 12 May 2021]

O' Cathain, A., Murphy, E. and Nicholl, J. (2010). Three techniques for integrating data in mixed methods studies. *BMJ*, 341:7783.

O'Cathain, A., Murphy, E., Nicholl, J. (2007). Integration and publications as indicators of "yield" from mixed methods studies. *Journal of Mixed Methods Research*, 1(2):147-163.

O'Cathain, A., Murphy, E. and Nicholl, J. (2008). The quality of mixed methods studies in health services research. *Journal of Health Services Research & Policy*, 13(2).

Odendahl, T. and Shaw, A. (2001). *Interviewing Elites, in Handbook of Interview Research.* London: Sage Publications. [Online]. Available at: https://methods.sagepub.com/book/handbook-of-interview-research/d19.xml. [Accessed 8 Jun 2020].

OECD (1998). *Principles and Recommendations for Population and Housing Censuses, Revision 1.* New York: United Nations.

OECD (2013). *OECD Framework for Statistics on the Distribution of Household Income, Consumption and Wealth.* Paris: OECD Publishing.

OECD (2014). *Society at a Glance – OCDE Indicadores Sociales.* Organization for Economic Co-operation and Development. [Online]. Available at: http://www.oecd.org/els/societyataglance.htm [Accessed 29 June 2016]

OECD (2021). *Consumer price indices (CPIs) - Complete database*. [Online]. Available at: https://stats.oecd.org/index.aspx?queryid=82174# [Accessed 04/11/2019].

Onwuegbuzie, A. J., Johnson, R. B. (2006). The validity issue in mixed research. *Research Scholar*, 13: 48–63.

Orsini, N., Belloco, R. and Greenland, S. (2006). Generalized least squares for trend estimation of summarized dose-response data. *The Stata Journal*, 6(1):40-57.

Ortega-Avila, A. G., Papadaki, A., Jago, R. (2019). The role of the home environment in sugar sweetened beverage intake among northern Mexican adolescents: a qualitative study. *Journal of Public Health*, 27: 791-801.

Orwin, R. G. (1994). *Evaluating coding decisions*. In: Cooper, H. and Hedges, L.V. (Eds). The handbook of research synthesis (pp. 139-162). New York, NY, US: Russell Sage Foundation.

Page, R. C. (1998). The pathobiology of periodontal diseases may affect systemic diseases: inversion of a paradigm. *Annals of periodontology*, 3(1):108-120.

Pal, L. A. (2005). *Case Study Method and Policy Analysis*. In: Geva-May I. (eds) Thinking Like a Policy Analyst. Palgrave Macmillan, New York.

Pan, A. and Hu, F. B. (2011). Effects of carbohydrates on satiety: differences between liquid and solid food. *Current Opinion in Clinical Nutrition & Metabolic Care*, 14(4), 385-390.

Park, H. and Yu, S. (2019). Policy review: Implication of tax on sugar-sweetened beverages for reducing obesity and improving heart health. *Health Policy and Technology*, 8(1): 92-95.

Patton, M.Q. (1990). *Qualitative evaluation and research methods*. Newbury Park: Sage.

Pereira M. A. (2013). Diet beverages and the risk of obesity, diabetes, and cardiovascular disease: a review of the evidence. *Nutrition reviews*, 71(7): 433–440.

Pereira, R. A., Souza, A. M., Duffey, K. J., Sichieri, R. and Popkin, B. M. (2015). Beverages Consumption in Brazil: Results from the first National Dietary Survey. *Public Health Nutrition*, 18 (7):1164–1172.

Peres, K. G., Vargas-Ferreira, F. (2021). *Dental Erosion*. In: Peres, M. A., Antunes, J. L. F., Watt, R. G. (eds) Oral Epidemiology. Textbooks in Contemporary Dentistry. Switzerland: Springer.

Peres, M. A., Liu, P., Demarco, F. F., Silva, A. E. R., Wehrmeister, F. C., Menezes, A. M., Peres, K. G. (2018). Income trajectories affect treatment of dental caries from childhood to young adulthood: a birth cohort study. *Brazilian Oral Research*, 32:e36.

Peres, M. A., Macpherson, L. M. D., Weyant, R. J., Daly, B., Venturelli, R., Mathur, M. R., Listl, S., Celeste, R. K., Guarnizo-Herreño, C. C., Kearns, C., Benzian, H., Allison, P., Watt, R. G. (2019). Oral diseases: a global public health challenge. *Lancet*, 394(10194):249-260.

Perinetti, G., Caputia, S. and Varvara, G. (2005). Risk/Prevention Indicators for the Prevalence of Dental Caries in Schoolchildren: Results from the Italian OHSAR Survey. *Caries Research*, 39:9–19.

Petersen, P. E. (2003). The World Oral Health Report 2003: continuous improvement of oral health in the 21st century - the approach of the WHO Global Oral Health Programme. *Community Dentistry and Oral Epidemiology*, 31:3-23.

Petersen, P. E., et al. (2005). The global burden of oral diseases and risks to oral health. *Bulletin of the World Health Organization*, 83(9), 661-669.

Petrisor, B. and Bhandari, M. (2007). The hierarchy of evidence: Levels and grades of recommendation. *Indian journal of orthopaedics*, 41(1):11-5.

Piangprach, T., Hengtrakool, C., Kukiattrakoon, B. and Kedjarune-Leggat, U. (2009). The effect of salivary factors on dental erosion in various age groups and tooth surfaces. *Journal of the American Dental Association*, 140(9):1137-43.

Piernas, C., Mendez, M. A., Ng, S. W., Gordon-Larsen, P., Popkin, B. M. (2014). Low-calorie- and calorie-sweetened beverages: diet quality, food intake, and purchase patterns of US household consumers. *The American journal of clinical nutrition*, 99(3), 567-577.

Piotrowski, S. J., and Van Ryzin, G. G. (2007). Citizen Attitudes Toward Transparency in Local Government. *The American Review of Public Administration*, 37(3):306-323

Pluye, P. and Hong, Q. N. (2014). Combining the power of stories and the power of numbers: mixed methods research and mixed studies reviews. *Annual Review of Public Health,* 35: 29–45.

Pope, C. and Mays, N. (2006). *Qualitative research in health care*. 3rd Edition. Oxford: Blackwell/ BMJ.

Popkin, B. M. and Hawkes, C. (2016). Sweetening of the global diet, particularly beverages: patterns, trends, and policy responses. *The Lancet Diabetes & Endocrinology,* 4(2): 174-186.

Poulton, R., Caspi, A., Milne, B. J., et al. (2002). Association between children's experience of socioeconomic disadvantage and adult health: a life-course study. *Lancet*, 360:1640-1645

Powell, L. M., Chriqui, J.F., Khan, T., Wada, R., Chaloupka, F. J. (2013). 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. *Obesity reviews*, 14(2): 110-128.

Powell, L. M., Wada, R., Persky, J. J., Chaloupka, F. J. (2014). Employment impact of sugar-sweetened beverage taxes. *American journal of public health*, 104(4): 672–677.

Pratiwi, A.N. and Maharani, D.A. (2017). Prevalence and Risk Factors of Tooth Erosion in Children. *Journal of Medical Sciences*, 17: 53-60.

PROSPERO (2018). *The effect of sugar-sweetened beverages on oral health: a systematic review* [Online]. Available at: http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42018088720 [Accessed 23/01/19].

Public Health England, PHE (2018). *Sugar reduction and wider reformulation programme: report on progress towards the first 5% reduction and next steps.* London: PHE. [Online] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/709008/Sugar_reduction_progress_report.pdf. [Accessed August 2019]

Punitha, V.C., Amudhan, A., Sivaprakasam, P. and Rathanaprabu, V. (2015). Role of dietary habits and diet in caries occurrence and severity among urban adolescent school children. *Journal of Pharmacy & Bioallied Sciences*, 7:S296-300.

Quinlan, K. (2017). Oral health figures are a 'national scandal'. *British Dental Journal*, 222: 503.

Rad, M., Shahravan, A. and Haghdoost, A. A. (2016). A systematic review of questionnaires used on oral health knowledge, attitude, and practice in 12-year-olds. *Journal of Oral Health and Oral Epidemiology*, 5(1): 1-12.

Rafferty, A., Walthery, P. Kind-Hele, S. (2015). *Analysing change over time: repeated cross-sectional and longitudinal survey data.* UK Data Service, University of Essex and University of Manchester.

Reisman, D. (2016). *Health Policy: Choice, equality and cost*. Cheltenham: Elgar.

Restrepo, B. and Cantor, J. (2020). The effects of soda taxes on adolescent sugar intake and blood sugar. *Health Economics*, 29:1422–1434.

Righolt, A. J., Jevdjevic, M., Marcenes, W., Listl, S. (2018). Global-, Regional-, and Country-Level Economic Impacts of Dental Diseases in 2015. *Journal of Dental Research*, 97(5):501-507.

Ritchie, J. and Spencer, L. (1994) *Qualitative data analysis for applied policy research*. In: Bryman, A. and Burgess, R. (eds.) Analysing qualitative data. London: Routledge, pp.173-194.

Ritchie, J., Lewis, J., McNaughton Nicholls, C. and Ormston, R. (2014). *Qualitative research practice: a guide for social science students and researchers*. (2nd ed). London: Sage.

Roache, S. A., Gostin, L. O. (2017) The Untapped Power of Soda Taxes: Incentivizing Consumers, Generating Revenue, and Altering Corporate Behavior. International *Journal of Health Policy and Management*, 6(9): 489–493.

Roberto, C. A., Lawman, H. G., LeVasseur, M. T., et al. (2019). Association of a beverage tax on sugar-sweetened and artificially sweetened beverages with changes in beverage prices and sales at chain retailers in a large urban setting. *JAMA*, 321(18): 1799-810.

Roberto, C. A., Swinburn, B., Hawkes, C., Huang, T. T., Costa, S. A., Ashe, M., Zwicker, L., Cawley, J. H., Brownell, K. D. (2015). Patchy progress on obesity prevention: emerging examples, entrenched barriers, and new thinking. *The Lancet*, 385(9985): 2400-2409.

Rosinger, A., Herrick, K., Gahche, J., Park, S. (2017). Sugar-sweetened Beverage Consumption Among U.S. Youth, 2011-2014. *NCHS Data Brief* (271):1-8.

Rytomaa, I., Jarvinen, V., Kanerva, R. and Heinonen, O.P. (1998). Bulimia and tooth erosion. *Acta Odontologica Scandinavica*, 56(1):36-40.

Salas, M. M. S., Dantas, R. V. F., Sarmento, H. R., Vargas-Ferreira, F., Torriani, D. and Demarco, F. F. (2014). Tooth erosion and dental caries in schoolchildren: is there a relationship between them? *Brazilian Journal of Oral Sciences*, 13(1): 12-16.

Salas, M. M., Nascimento, G. G., Vargas-Ferreira, F., Tarquinio, S. B., Huysmans, M. C., Demarco, F. F. (2015). Diet influenced tooth erosion prevalence in children and adolescents: results of a meta-analysis and meta-regression. *Journal of Dentistry*, 43(8):865–75.

Sánchez-Pimienta, T. G., Batis, C., Lutter, C. K., Rivera, J. A. (2016). Sugar-Sweetened Beverages Are the Main Sources of Added Sugar Intake in the Mexican Population. *The Journal of Nutrition*, 146 (Suppl): 1888S–1896S.

Sassi, F., Belloni, A., Mirelman, A. J., Suhrcke, M., Thomas, A., Salti, N., Vellakkal, S., Visaruthvong, C., Popkin, B. M., Nugent, R. (2018). Equity impacts of price policies to promote healthy behaviours. *The Lancet*, 391(10134): 2059-2070.

Scarborough, P., Adhikari, V., Harrington, R. A., Elhussein, A., Briggs, A., Rayner, M., Adams, J., Cummins, S., Penney, T., White, M. (2020). Impact of the announcement and implementation of the UK Soft Drinks Industry Levy on sugar content, price, product size and number of available soft drinks in the UK, 2015-19: A controlled interrupted time series analysis. *PLoS Med*, 17(2):e1003025.

Scheie, A. A. and Petersen, F. C. (2004). The biofilm concept: consequences for future prophylaxis of oral diseases? *Critical Reviews in Oral Biology & Medicine*, 15(1): 4-12.

Schmeer, K. (1999). *Guidelines for Conducting a Stakeholder Analysis. Bethesda. Partnerships for Health Reform.* [Online] Available at: https://www.who.int/workforcealliance/knowledge/toolkit/33.pdf. [Accessed January 2019].

Schneider, S., Mata, J. and Kadel, P. (2020). Relations between sweetened beverage consumption and individual, interpersonal, and environmental factors: a 6-year longitudinal study in German children and adolescents. *International Journal of Public Health*, 65: 559–570.

Schwendicke, F., Dörfer, C. E., Schlattmann, P., Foster Page, L., Thomson, W. M., Paris, S. (2015). Socioeconomic inequality and caries: a systematic review and meta-analysis. *Journal of Dental Research*, 94(1):10-8.

Schwendicke, F., Thomson, W. M., Broadbent, J. M., Stolpe, M. (2016). Effects of taxing sugar-sweetened beverages on caries and treatment costs. *Journal of Dental Research,* 95(12):1327–32.

Seale, C., Gobo, G., Gubrium, J. F., and Silverman, D. (2004). *Qualitative research practice*. London: Sage Publications

Sedgwick, P. (2015). Meta-analyses: what is heterogeneity? *BMJ*, 350:h1435

Seirawan, H., Faust, S., and Mulligan, R. (2012). The impact of oral health on the academic performance of disadvantaged children. *American journal of public health*, 102(9): 1729–1734.

Senesombath, S., Nakornchai, S., Banditsing, P. and Lexomboon, D. (2010). Early childhood caries and related factors in Vientiane, Lao PDR. The Southeast Asian *Journal of Tropical Medicine and Public Health*, 41(3):717-25.

Sengupta, A. (2018). Dental Erosion: Etiology, Diagnosis and Management. *Acta Scientific Dental Sciences*, 2(11): 43-48.

Shadish, W. R., Cook, T. D., Campbell, D. T. (2002). *Experimental and Quasi-Experimental Designs for Generalised Causal Inference*. New York: Houghton Mifflin.

Shahbaz, U., Quadir, F. and Hosein, T. (2016). Determination of Prevalence of Dental Erosion in 12 - 14 Years School Children and Its Relationship with Dietary Habits. *Journal of the College of Physicians and Surgeons Pakistan*, 26 (7): 553-556.

Shamah-Levy, T., García-Chávez, C. G., Rodríguez-Ramírez, S. (2016). Association between Plain Water and Sugar-Sweetened Beverages and Total Energy Intake among Mexican School-Age Children. *Nutrients*, 8(12): 710.

Shearer, D. M., Thomson, W. M., Caspi, A., Moffitt, T. E., Broadbent, J. M., Poulton, R. (2012). Family history and oral health: findings from the Dunedin Study. *Community dentistry and oral epidemiology,* 40(2): 105–115.

Sheiham, A. and James, W. P. (2015). Diet and dental caries: the pivotal role of free sugars reemphasized. *Journal of Dental Research*, 94(10):1341–7.

Sheiham, A. and James, W. P. T. (2014). A new understanding of the relationship between sugars, dental caries and fluoride use: implications for limits on sugars consumption. Public health nutrition, 17(10), 2176-2184.

Singh, A., Antunes, J. L. F., Peres, M. A. (2021). *Socio-Economic Inequalities in Oral Health*. In: Peres, M. A., Antunes, J. L. F., Watt, R. G. (eds) Oral Epidemiology. Textbooks in Contemporary Dentistry. Switzerland: Springer.

Singh, G. M., Micha, R., Khatibzadeh, S., Lim, S., Ezzati, M., Mozaffarian, D.; Global Burden of Diseases Nutrition and Chronic Diseases Expert Group (NutriCoDE). (2015a). Estimated Global, Regional, and National Disease Burdens Related to Sugar-Sweetened Beverage Consumption in 2010. *Circulation*, 132(8):639-66.

Singh, G. M., Micha, R., Khatibzadeh, S., Shi, P., Lim, S., Andrews, K. G., Engell, R. E., Ezzati, M., Mozaffarian, D., & Global Burden of Diseases Nutrition and Chronic Diseases Expert Group (NutriCoDE) (2015b). Global, Regional, and National Consumption of Sugar-Sweetened Beverages, Fruit Juices, and Milk: A Systematic Assessment of Beverage Intake in 187 Countries. *PloS one,* 10(8): e0124845.

Skinner, J., Byun, R., Blinkhorn, A. and Johnson, G. (2015). Sugary drink consumption and dental caries in New South Wales teenagers. *Australian Dental Journal*, 60: 169–175.

SNA, United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, and the World Bank (2009). *System of national accounts 2008. New York: United Nations*. [Online] Available at: https://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=348954. [Accessed 26 December 2020]

Soto, L., Tapia, R., Jara, G., Rodríguez, G. and Urbina, T. (2007). *Diagnóstico Nacional de Salud Bucal del Adolescente de 12 años y Evaluación del Grado de Cumplimiento de los Objetivos Sanitarios de Salud Bucal 2000-2010.* Santiago: Ediciones Universidad Mayor.

Sowa, P. M., Keller, E., Stormon, N., Lalloo, R., Ford, P. J. (2019) The impact of a sugar-sweetened beverages tax on oral health and costs of dental care in Australia. *European Journal of Public Health*, 29(1):173–7.

Spencer, L., Ritchie, J., Ormston, R., O'Connor, W. and Barnard, M. (2014). *Analysis: Principles and processes*. In: Ritchie, J., Lewis, J., McNaughton Nicholls, C. and Ormston, R. (2014). Qualitative research practice: a guide for social science students and researchers. 2nd ed. London: Sage, pp. 269-293.

Stacey, N., Mudara, C., Ng, S. W., van Walbeek, C., Hofman, K., Edoka, I. (2019) Sugar-based beverage taxes and beverage prices: Evidence from South Africa's Health Promotion Levy. *Social Science and Medicine*, 238:112465.

Stephan, R. M., Miller, B. F. (1943). A quantitative method for evaluating physical and chemical agents which modify production of acids in bacterial plaques on human teeth. *Journal of Dental Research*, 22(1):45–51.

Stephens, N. (2007). Collecting data from elites and ultra elites: telephone and face-to-face interviews with macroeconomists. *Qualitative Research*, 7(2): 203-216

Su, H., Yang, R., Deng, Q., Qian, W., Yu, J. (2018). Deciduous dental caries status and associated risk factors among preschool children in Xuhui District of Shanghai, China. *BMC Oral Health*, 18(1):111.

Tahmassebi, J. F., BaniHani, A. (2020). Impact of soft drinks to health and economy: a critical review. *European Archives of Paediatric Dentistry*, 21(1):109-117.

Tahmassebi, J. F., Duggal, M. S., Malik-Kotru, G. and Curzon, M. E. J. (2006). Soft drinks and dental health: A review of the current literature. *Journal of Dentistry*, 34: 2–11.

Takeuchi, M. (1961). Epidemiological study on dental caries in Japanese children before, during and after World War II. *International Journal of Dentistry*, 11: 443.

Tamir, O., Cohen-Yogev, T., Furman-Assaf, S., Endevelt, R. (2018). Taxation of sugar sweetened beverages and unhealthy foods: a qualitative study of key opinion leaders' views. *Israel Journal of Health Policy Research*, 7(1):43.

Tashakkorri, A., and Teddlie, C. (2003). *Handbook of mixed methods research in social and behavioural research.* Thousand Oaks, CA: Sage.

Te Morenga, L., Mallard, S. and Mann, J. (2012). Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials and cohort studies. *BMJ*, 346:e7492.

Temple, B. and Young, A. (2004). Quantitative Research and Translation Dilemmas. *Qualitative Research*, 4(2): 161-178.

Teng, A. M., Jones, A. C., Mizdrak, A., Signal, L., Genç, M., Wilson, N. (2019). Impact of sugar-sweetened beverage taxes on purchases and dietary intake: Systematic review and meta-analysis. *Obesity Reviews*, 20(9):1187-1204.

Teruel, G., Rubalcaba, L. and Santana, A. (2005). *Escalas de equivalencia para México*. Mexico City: SEDESOL Documento de investigación 23.

The European Competitiveness and Sustainable Industrial Policy Consortium, ECSIP (2014). *Food taxes and their impact on competitiveness in the agri-food sector. Annexes to the main report.* [Online] Available at: https://ec.europa.eu/growth/content/food-taxes-and-their-impact-competitiveness-agri-food-sector-study-0_en [Accessed 10 May 2021].

The World Bank, TWB (2016). *Chile's overview*. [Online]. Available at: http://www.worldbank.org/en/country/chile [Accessed 23 June 2017].

The World Bank, TWB (2020). *Taxes on Sugar-Sweetened Beverages: International Evidence and Experiences. The World Bank Group*. [Online]. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/33969/Support-for-Sugary-Drinks-Taxes-Taxes-on-Sugar-Sweetened-Beverages-Summary-of-International-Evidence-and-Experiences.pdf?sequence=6. [Accessed 10 May 2021].

Theodore, F., Bonvecchio, A., Blanco, I., Irizarry, L., Nava, A., Carriedo, A. (2011). Culturally constructed meanings for consumption of sweetened beverages among schoolchildren in Mexico City. *Revista Panamericana de Salud Publica*, 30: 327–334.

Thow, A. M. and Hawkes, C. (2014). Global sugar guidelines: an opportunity to strengthen nutrition policy. *Public health nutrition*, 17(10): 2151-2155.

Thow, A. M., Quested, C., Juventin, L., Kun, R., Khan, A. N., Swinburn, B. (2011). Taxing soft drinks in the Pacific: implementation lessons for improving health. *Health Promotion International,* 26(1):55-64.

Timpson, H., Lavin, R., Hughes, L. (2013). *Exploring the Acceptability of a Tax on Sugar-Sweetened Beverages Insight Work September*. Applied Health and Wellbeing Partnership Centre for Public Health Liverpool John Moores University.

Thomson, K., Hillier-Brown, F., Todd, A., McNamara, C., Huijts, T., & Bambra, C. (2018). The effects of public health policies on health inequalities in high-income countries: an umbrella review. *BMC public health*, 18(1): 869.

Tong, A., Sainsbury, P. and Craig, J. (2007). Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*, 19(6): 349–357.

Torgerson, C. (2003). *Systematic Reviews*. London: Continuum.

Tselengidis, A., Östergren, P.O. (2019). Lobbying against sugar taxation in the European Union: Analysing the lobbying arguments and tactics of stakeholders in the food and drink industries. *Scandinavian Journal of Public Health*, 47(5):565-575.

Tudoroniu, C., Popa, M., Iacob, S. M., Pop, A. L., Năsui, B. A. (2020). Correlation of Caries Prevalence, Oral Health Behavior and Sweets Nutritional Habits among 10 to 19-Year-Old Cluj-Napoca Romanian Adolescents. International Journal of *Environmental Research and Public Health*, 22:17(18):6923.

United Nations, UN (2005). *Household Sample Surveys in Developing and Transition Countries.* Department of Economic and Social Affairs, Studies in Methods, Series F No. 96. New York: United Nations publication.

United Nations, UN (2018). *Classification of Individual Consumption According to Purpose (COICOP) 2018.* Department of Economic and Social Affairs Statistics Division United Nations. New York: Statistical Papers Series M No. 99.

Urwannachotima, N., Hanvoravongchai, P., Ansah, J. P., Prasertsom, P., Koh, V. R.Y. (2020). Impact of sugar-sweetened beverage tax on dental caries: a simulation analysis. *BMC Oral Health*, 20(1):76.

Vainio, A. (2013). Beyond research ethics: Anonymity as 'ontology', 'analysis' and 'independence'. *Qualitative Research*, 13: 685–698.

Valenzuela, M. J., Waterhouse, B., Aggarwal, V. R., Bloor, K., Doran, T. (2021). Effect of sugar-sweetened beverages on oral health: a systematic review and meta-analysis. *European Journal of Public Health*, 1;31(1):122-129.

Van Ansem, W. J., Van Lenthe, F. J., Schrijvers, C. T., Rodenburg, G., Van de Mheen, D. (2014). Socio-economic inequalities in children's snack consumption and sugar-sweetened beverage consumption: the contribution of home environmental factors. *British Journal of Nutrition*, 112:467–476.

Van Nes, F., Abma, T., Jonsson, H., Deeg, D. (2010). Language differences in qualitative research: is meaning lost in translation? *European Journal of Aging*, 7(4):313-316.

Vartanian, L. R., Schwartz, M. B. and Brownell, K. D. (2007). Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *American journal of public health*, 97(4): 667-675.

Vasquez, F., Paraje, G. and Estay, M. (2013). Income-related inequality in health and health care utilization in Chile, 2000–2009. *Pan American Journal of Public Health*, 33(2):98-106.

Volkow, N. D., Wang, G. J., Tomasi, D., Baler, R.D. (2013). Obesity and addiction: neurobiological overlaps. *Obesity Reviews*, 14(1):2-18.

Walsh, T., Worthington, H. V., Glenny, A. M., Marinho, V. C.C., Jeroncic, A. (2019). Fluoride toothpastes of different concentrations for preventing dental caries. *Cochrane Database of Systematic Reviews*, 3(3):CD007868.

Walter, S. D. (2000). Choice of effect measure for epidemiological data. *Journal of Clinical Epidemiology*, 53(9):931-9.

Wang, P., Lin, H. C., Chen, J. H. and Liang, H. Y. (2010). The prevalence of dental erosion and associated risk factors in 12-13-year-old school children in Southern China. *BMC Public Health*, 10:478.

Waterhouse, P., Auad, S., Nunn, J., Steen, I. and Moynihan, P. (2008). Diet and dental erosion in young people in south-east Brazil. *International Journal of Paediatric Dentistry*, 18: 353–360.

Watt, R. G. (2012). Social determinants of oral health inequalities: implications for action. *Community Dentistry and Oral Epidemiology*, 40(2): 44–48.

Watt, R. G. and Sheiham, A. (2012). Integrating the common risk factor approach into a social determinants framework. *Community Dentistry and Oral Epidemiology*, 40(4):289-296.

Watt, R. G., Daly, B., Allison, P., Macpherson, L. M. D., Venturelli, R., Listl, S., Weyant, R. J., Mathur, M. R., Guarnizo-Herreño, C. C., Celeste, R. K., Peres, M. A., Kearns, C., Benzian, H. (2019). Ending the neglect of global oral health: time for radical action. *Lancet*, 394(10194):261-272.

Watt, R. G., Rouxel, P. L. (2012). Dental caries, sugars and food policy. *Archives of Disease in Childhood*, 97(9):769–72.

Weed, D. L., Althuis, M. D. and Mink, P. J. (2011). Quality of reviews on sugar-sweetened beverages and health outcomes: a systematic review. *American Journal of Clinical Nutrition*, 94(5): 1340–1347.

Weitzman, E. A. (2000). *Software and qualitative research.* In: Denzin, N. K. and Lincoln, Y. S., (Eds). Handbook of qualitative research, 2nd ed. London: Sage, pp. 803–820.

Whitehead, M. and Dahlgren, G. (2006). *Concepts and principles for tackling social inequities in health: levelling up part 1.* WHO Regional Office for Europe: Copenhagen. [Online] Available at: https://www.euro.who.int/__data/assets/pdf_file/0010/74737/E89383.pdf. [Accessed 10 May 2021].

Wilder, J.R., Kaste, L.M., Handler, A., Chapple-McGruder, T., and Rankin, K.M. (2016). The association between sugar-sweetened beverages and dental caries among third-grade students in Georgia. *Journal of Public Health Dentistry*, 76(1):76-84.

Williamson, A. E. and Burns, N. (2014). The safety of researchers and participants in primary care qualitative research. *The British journal of general practice: the journal of the Royal College of General Practitioners*, 64(621): 198–200.

Wordley, V., Lee, H., Lomazzi, M., Bedi, R. (2017). The sugar tax – An opportunity to advance oral health. *British Dental Journal*, 223:11–2.

World Cancer Research Fund International, WCRFI (2018). *Building momentum: lessons on implementing a robust sugar sweetened beverage tax*. London: World Cancer Research Fund International.

World Health Organisation, WHO (2013). *Oral health surveys: basic methods - 5th edition.* Geneva: World Health Organization.

World Health Organization, WHO (2008). *Closing the gap in a generation: health equity through action on the social determinants of health. Final report of the Commission on Social Determinants of Health*. Geneva: World Health Organisation.

World Health Organization, WHO (2013). *Global action plan for the prevention and control of noncommunicable diseases 2013-2020*. Geneva: World Health Organisation.

World Health Organization, WHO (2015). *Guideline: sugars intake for adults and children.* Geneva: World Health Organization.

World Health Organization, WHO (2016). *Fiscal policies for diet and prevention of noncommunicable diseases: technical meeting report, 5-6 May 2015*. Geneva: World Health Organization.

Worsley, A. (2002). Nutrition knowledge and food consumption: can nutrition knowledge change food behaviour? Asia Pacific *Journal of Clinical Nutrition*, 11(Suppl 3):S579-85.

Wright, A., Smith, K. E., Hellowell, M. (2017). Policy lessons from health taxes: a systematic review of empirical studies. *BMC Public Health*, 17(1):583.

Wulaerhan, J., Abudureyimu, A., Bao, X. L. and Zhao, J. (2014). Risk determinants associated with early childhood caries in Uygur children: a preschool-based cross-sectional study. *BMC Oral Health*, 14:136.

Xi, B., Huang, Y., Reilly, K. H., Li, S., Zheng, R., Barrio-Lopez, M. T., Martinez-Gonzalez, M.A. and Zhou, D. (2015). Sugar-sweetened beverages and risk of hypertension and CVD: a dose-response meta-analysis. *British Journal of Nutrition*, 113(5):709-17.

Yin, J., Zhu, Y., Malik, V., Li, X., Peng, X., Zhang, F. F., Shan, Z., Liu, L. (2021). Intake of Sugar-Sweetened and Low-Calorie Sweetened Beverages and Risk of Cardiovascular Disease: A Meta-Analysis and Systematic Review. *Advances in Nutrition*, 12(1):89-101.

Yin, R. K. (2009). *Case Study Research: Design and Methods*. 4th ed. California: Sage.

Yin, R. K. (2018). Case *Study Research and Applications: Design and Methods*. 6th ed. London: Sage Publications.

Zhang, W. and Creswell, J. (2013). The use of "mixing" procedure of mixed methods in health services research. *Medical Care*, 51(8):e51-7.

Zhang, S., Chau, A., Lo, E. and Chu, C. (2014). Dental caries and erosion status of 12-year-old Hong Kong children. *BMC Public Health*, 14:7.