
# Sugar-sweetened beverages and household sugar consumption patterns among adults living in Southgate Phoenix

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## DECLARATION

I, Sindisiwe P. Nene, hereby declare that the research work presented in this thesis is my original work and all the materials used are appropriately acknowledged and explicitly referenced. A reference list is attached to the thesis.

I also confirm that the thesis has not been submitted in any of its part or entirety for any degree in any other institution of higher learning locally or internationally.

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## DEDICATION

I dedicate this thesis to:

My supportive husband Kenneth Nene, our son Melokuhle and our expected bundle of joy,
My loving parents, Mr S. and Mrs N. Mbense,
My amazing siblings Sihle and Asande Mbense
and finally
My extended family and friends who motivated and supported me through this journey.

“I think we are the most powerful beings in the world, and that we should be given every opportunity. And that is what we should be teaching these young girls: to take up space. Nothing is as important as taking up space in society and cementing yourself.”
Zozibini Tunzi

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## ABSTRACT

**Background:** The Health Promotion Levy (HPL) was implemented in South Africa in 2018 as an intervention to decrease sugar consumption. While the link between excessive sugar consumption and dietary risk factors is well established, there is limited conclusive evidence that fiscal policy measures like the HPL can reduce sugar consumption and lead to favourable health outcomes.

**Aim:** To determine the current sugar-sweetened beverage (SSB) and household sugar consumption patterns among adults in the Southgate Phoenix area.

**Methods:** This study adopted both desktop and quantitative methods through a cross-sectional study. The desktop study included a scoping review using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The aim of the scoping review was to investigate the implementation of the sugar tax by various countries and assess the effectiveness thereof. Data from a syndicated Euromonitor generated report on sales of SSBs in South Africa were reviewed. Using a validated questionnaire, quantitative methods were also used to gather data on the current SSBs and household sugar consumption patterns among 399 consenting adults living in the Southgate Phoenix area. Sugar threshold detection test (TDT) of different sugar solutions and sweetness preference of market samples of cola SSBs were determined through sensory evaluation among 98 consenting adults living in the Southgate Phoenix area.

**Results:**

The scoping review included 37 studies on sugar tax in 17 countries. Most studies, 37.8% (n= 14), were conducted in various United States of America (US) states, followed by Mexico (16.2% n= 6) and South Africa (10.8% n= 4). Just over half of the studies (51.4% n= 19) reported a reduction in sales volume of SSBs. A decrease in SSB consumption was reported by 37.8% (n= 14) studies, whilst 2.7% (n= 1) study reported both reduced sales and consumption of SSBs. Reduced body mass index/weight was reported in 8.1% (n= 3) of studies. Key results for the household sugar and SSB consumption showed that a significant 55.1% (n= 220) of households purchased brown sugar, $p<0.001$, while 44.9% (n= 179) purchased white sugar. A significant 92.0% (n= 367) of households purchased sugar monthly $p<0.001$. Households (65.5% n= 102) predominantly purchased sugar in 2kg packs, $p<0.001$. There was a significant correlation between income and purchasing frequency and the size of sugar packaging purchased by participants; those with higher income purchased sugar less frequently (rho= .187, $p<0.001$) and in smaller packaging (rho= -.145, p= .006). A significant 96% (n= 382) of participants used sugar in tea and coffee, $p<0.001$, while 58% (n= 230) added it to cereal. A significant 68.1% of the participants reported using either 1 or 2 teaspoons of sugar in their tea/coffee, $\chi^2$ (4) = 153.619, $p<0.001$. However, 32.9% (n= 131), 16.5% (n= 51) and 2.5% (n= 10) consumed three teaspoons, four teaspoons and more than four teaspoons in their tea and coffee, respectively. The Mann-Whitney test analysis showed that males added significantly more sugar in their tea/coffee than females, Z= -2.779, p=.005. The amount of sugar added to tea/coffee was negatively correlated with

age, rho= -.186, p<0.001. Results also indicated that the consumption of tea or coffee with sugar was positively correlated with age (rho=.175, p<0.001), with older people consuming more servings of sugar-sweetened tea/coffee. Regarding the consumption of SSBs, a substantial 77% (n= 308) of participants indicated that they frequently consumed sugar-sweetened carbonated soft drinks. Flavoured water was the second most consumed category, with 32% (n= 129), followed by energy drinks at 24% (n= 96). The Pearson's chi-square analysis indicated that significantly more females consumed flavoured teas than males, $\chi^2$ (1) = 5.568, p=.018. Furthermore, the Pearson's chi-square analysis indicated that significantly more females consumed flavoured water than males, $\chi^2$ (1) = 12.983, p<.001. A significant 76% (n= 305) of participants reported consuming SSBs at home, p<0.001. The proportion of SSBs purchased positively correlated with age (rho=.150, p=.003), with older people being associated with buying larger sizes of SSBs. Results from the Pearson's chi-square test showed that a notable proportion of 18-25-year-olds were unaware of the sugar tax, while a notable proportion of 26-35-year-olds were aware of this tax, $\chi^2$ (4) = 13.924, p= .008. For the preference test, 40.8% (n= 40) participants preferred Coo-ee and noted that it was the sweetest SSB, followed by Coke at 27.6% (n= 27), $\chi^2$ (3) = 19.653, p<.001. Results for TDT found that a significant 57.1% (n= 56) of participants preferred the yellow-dot-30g/1ltr sugar sample (p<.001); the reason given by a significant percentage of 62.2% (n= 61) for their selection was sweetness preference (p<0.001). A significant 48.4% (n= 16) preferred the orange-dot-0.3g/ltr sample the least (p= .001). This indicates that the sample population has a preference for higher rather than lower levels of sweetness in their SSBs.

**Conclusion:**

South Africa was the first African country to implement the sugar tax, so it is important to document the barriers, challenges, and other findings from inception. In this study, we found that sugar tax studies were mostly conducted in first-world countries, and emerging literature is available on the South African context. While the SSB industry has been regulated, its resulting impact on the consumption of SSBs and household sugar consumption remains an underexplored research area. Households also lack information pertaining to optimal sugar intake and the long-term health implications of exceeding such limits. Joint efforts with multiple initiatives and interventions could yield better results in combating obesity and reducing the burden of non-communicable diseases (NCDs). These initiatives should include nutrition education and HPL awareness campaigns, as well as current fiscal policies.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| AIDS | Acquired Immune Deficiency Syndrome |
| ART | Antiretroviral Therapy |
| BMI | Body Mass Index |
| CVD | Cardiovascular Disease |
| CPS | Consumer Panel Services |
| CSD | Carbonated Soft Drinks |
| DALYs | Disability-Adjusted Life-Years |
| DUT | Durban University of Technology |
| HIV | Human Immunodeficiency Virus |
| HPL | Health Promotion Levy |
| IREC | Institutional Research Ethics Committee |
| KG | Kilogram |
| KJ | Kilojoules |
| LSM | Living Standards Measure |
| LCSs | Low-Calorie Sweeteners |
| LMICs | Low-to-Middle-Income Countries |
| NCDs | Non-Communicable Diseases |
| NNSs | Non-Nutritive Sweeteners |
| PRISMA | Preferred Reporting Items for Systematic Reviews and Meta-Analysis |
| POS | Point of Sale Information |
| SANHANES | South African National Health and Nutrition Examination Survey |
| SDG | Sustainable Development Goal |
| SFD | Sugar Free Drink |
| SPSS | Statistical Package for Social Science |
| SSB | Sugar-sweetened Beverage |
| TDT | Threshold Detection Test |
| TB | Tuberculosis |
| UK | United Kingdom |
| UPC | Universal Product Code |
| US | United States |
| USD | United States Dollars |
| WHO | World Health Organisation |
| YLL | Years of Life Lost |
| ZAR | South African Rand |

# CHAPTER ONE: INTRODUCTION

## 1.1 Introduction

This introductory chapter will provide an overview and summary of the study and explain the importance of the study and the problem statement, delineate the aim, objectives, assumptions, and study parameters, and, lastly, outline the structure of the dissertation.

## 1.2 Importance of the study

South Africa has seen a growing trend in overweight and obesity, as observed by the notable increase in body mass index (BMI) (South African Demographic Health Survey (SADHS) 2016: 298). The 2016 SADHS reported that 68% of females were either overweight or obese, while 31% of males were overweight or obese (SADHS 2016: 297). Overweight and obesity have been associated with an increased risk of acquiring lifestyle-related diseases such as stroke and type 2 diabetes, which are known as non-communicable diseases (NCDs) (Maritz 2020: 2). These diseases are directly linked to a diet high in sugar, saturated fat, and salt, low in fruits and vegetables, and a lack of physical activity (Maritz 2020: 3). Despite the World Health Organisation (WHO) recommendation that added sugars should not account for more than 10% of a person's daily energy intake, which is comparable to 12 teaspoons of sugar (WHO 2015: 3), there has been a global increase in sugar consumption with research evidence indicating a strong association between unhealthy diets, lifestyle diseases and a growing burden on the healthcare system (WHO 2015: 7).

Added sugar consumption has become a global focus area as excess consumption of sugar is linked to overweight and obesity as well as other NCDs such as type 2 diabetes, cardiovascular disease, and fatty liver (Moynihan and Miller 2020: 871). In 2012, NCDs accounted for 68% of global deaths, and by 2018, deaths related to NCDs had increased to 84% (Gowshall and Taylor-Robinson 2018: 255). It is important to note that most of these deaths occurred in low-and middle-income countries (LMICs) (WHO 2015: 6). The management of NCDs results in a financial strain on families, countries, the healthcare system, and has a negative impact on the workplace (Tugendhaft *et al*. 2015: 2296). In a study conducted by Finkelstein *et al.* (2021: 830), it was found that across the six Gulf countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates), the estimated cost of absenteeism from work, driven by NCDs was $80.6 billion annually making NCD related illness the highest driver of absenteeism in 2019 (Finkelstein *et al.* 2021: 830).

The sugar-sweetened beverage (SSB) industry in South Africa came under scrutiny due to the high sugar levels present in SSB formulations (Stacey *et al.* 2019: 1). In recent years, as a developing country, South Africa has experienced urbanisation and an increase in disposable income, as well as increased access to and affordability of energy-dense and high-fat meals (Tugendhaft *et al*. 2015: 2296). In reaction to the increase in dietary and lifestyle-related diseases, the Minister of Finance in South Africa proposed an introduction of a tax for SSBs (South African National Treasury, 2016: 2). The Health Promotion Levy (HPL) was implemented in 2018 as an intervention to decrease added

sugar consumption and this was set at 2.1 cents per gram of sugar content in beverages which exceeded 4g/100ml (South African National Treasury 2017: 1). The producers and the consumers would have to pay an additional amount for producing and consuming SSBs, respectively (Baijnath and Pillay 2020: 116). As a result, it was anticipated that the purchase of SSBs may decline or that SSBs would be reformulated to reduce sugar content to conform to the legislation (Baijnath and Pillay 2020: 116).

The SSB category includes the following: sports and energy drinks, carbonated soft drinks and juices (Stacey *et al.* 2019: 1). Sugar-sweetened beverages provide liquid kilojoules that contribute to increased energy intake with no nutrient density (Baijnath and Pillay 2020: 116). Traditionally, carbonated soft drinks contained 10-12g of sugar per 100ml; post-implementation of the HPL, beverage manufacturers had to reformulate their products to reduce sugar to 4g per 100ml to meet the guidelines provided by the government (Stacey *et al*. 2019: 3) and thus avoid the levy penalty. To date, 40 countries have implemented a sugar tax (Moynihan and Miller 2020: 872). The World Health Organisation (2016: 18) suggests that policymakers need to develop measures to reduce the consumption of added sugar by using a range of interventions and measures; these could include consumer education, regulation of marketing and production of products, and fiscal policies such as the HPL aimed at food and beverages with high sugar content. While the link between excessive sugar consumption and dietary risk factors is well established, there is no conclusive evidence that these fiscal policy measures can reduce sugar consumption and lead to favourable health outcomes (Maritz 2020: 2). However, Bonnet and Réquillart (2013: 78) suggest that taxes can serve as a self-control measure, especially for price-sensitive individuals or communities (Bonnet and Réquillart 2013: 78). Considering all the aforementioned factors, it is important to investigate consumption patterns of SSBs and overall household sugar consumption (Bonnet and Requillart 2011: 1021).

### 1.3 Problem statement

The rationale behind the adoption of the levy was to decrease the purchasing and consumption of SSBs, reduce obesity, and, in turn, improve population health (South African National Treasury 2016: 17). Even though the policy has kept the national manufacturing and import industry in line, the questions remain: has the policy influenced South African to reduce their overall sugar intake, has the HPL had any impact on promoting weight loss, and has household purchasing and consumption of SSBs and table sugar decreased post-policy implementation?

### 1.4 Aim of the study

To determine the current SSB and household table sugar consumption patterns among adults in the Southgate Phoenix area using self-reported surveys and sensory taste assessement.

### 1.5 Objectives

- To conduct a scoping review on the implementation of the sugar tax by various countries and assess the effectiveness thereof.

- To review SSB sales data from a syndicated report on the SSBs sold in South Africa between 2015 and 2020.
- To determine the consumption and purchasing patterns of SSB among adults living in the Southgate Phoenix area using a survey.
- To investigate the sugar consumption and purchasing patterns of table sugar among adults in households living in the Southgate Phoenix area using a household sugar consumption survey.
- To establish sugar threshold levels among a random sample of adults living in the Southgate, Phoenix area through a threshold detection test (TDT).
- To determine SSB sweetness preference through sensory evaluation among adults living in the Southgate, Phoenix area.

### 1.6 Assumptions

- It was assumed that the HPL implementation has influenced SSB consumption.
- It was assumed that the HPL has created mindful awareness regarding sugar consumption and thus has altered sugar purchase and consumption behaviour.
- It was assumed that the responses and data collected from the participants through the SSB consumption survey, household sugar consumption, the TDT test and paired preference sensory evaluation were of an unbiased and honest nature.

### 1.7 Study parameters

- The study targeted adults living in Southgate, Phoenix.
- People following a weight-reducing diet and those with diabetes were excluded from the study.
- The sample size comprised 400 participants for the SSB and the household sugar consumption survey and 100 participants each for the TDT test and paired preference sensory evaluation, respectively.

## 1.8 Outline of the study

| | |
|---|---|
| Stage 1 | •Compile research proposal and obtain departmental, faculty and ethical approval. |
| Stage 2 | •Conduct desktop study of other countries that have implemented sugar tax. |
| Stage 3 | •Retrieve sales data of SSBs from a syndicated report. |
| Stage 4 | •Pilot the consumption and purchasing patterns of SSB and table sugar survey. |
| Stage 5 | •Administer the the consumption and purchasing patterns of SSB and table sugar survey. |
| Stage 6 | •Administer sensory taste session: Paired preference. |
| Stage 7 | •Administer sensory taste session: Threshold detection test. |
| Stage 8 | •Results, data analysis conclusion and recommendations. |
| Stage 9 | •Final submission. |

**Figure 1.1:** Study outline

## 1.9 Definitions of terms

**Added sugar:** Sugars added to food and drink during processing or preparation are referred to as added sugars. This includes any free sugars added during processing or preparation, such as table sugar, honey, molasses, fruit or vegetable juices and juice concentrates, high-fructose corn syrup, malt syrup, agave syrup, and any other sugars (WHO 2022: 4).

**Body mass index (BMI)**: A measurement calculated by multiplying an individual's mass by the square of his or her height in metres and represented as $kg/m^2$ (WHO 2020: 2).

**Non-communicable diseases (NCDs):** Also known as chronic illness, NCDs are characterised by prolonged illness resulting from a combination of behavioural, genetic, environmental, and physiological factors which cannot be transmitted (WHO 2021:1).

**Obesity**: Excess body fat accumulation characterised by a body mass index (BMI) ≥ 30 $kg/m^2$ (WHO 2022: 2).

**Overweight:** Excess fat accumulation characterised by a body mass index (BMI) between 25 $kg/m^2$ - 29 $kg/m^2$ (WHO 2020: 2).

**Sugar-sweetened beverage (SSB):** Sweetened drinks that include soft drinks, sports drinks, energy drinks and fruit drinks, excluding sweetened teas, coffees, and sports drinks with protein (Marriott *et al.* 2019: 3). According to the WHO (2022: 2), sugar-free drinks (SFDs) are defined as "all types of beverages containing free sugars, and these include fruit/vegetable juices and drinks,

carbonated or non-carbonated soft drinks, liquid and powder concentrates, flavoured water, energy and sports drinks, ready-to-drink tea, ready-to-drink coffee, and flavoured milk drinks."

**Table sugar:** Sucrose sugars, such as granulated sugar, used in baking and cooking (Amoutzopoulos *et al.* 2020: 3)

### 1.10 Structure of the thesis

**Chapter 1: Introduction**

The research aims, objectives and context of the research are outlined.

**Chapter 2: Literature Review**

Findings and perspectives/recommendations from studies conducted by other researchers and their relevance to the current topic are detailed.

**Chapter 3: Methodology**

Research methods and tools used in the study are explained.

**Chapter 4: Results and Discussion**

Findings and results are presented and discussed.

**Chapter 5: Conclusion and Recommendations**

Conclusion and recommendations for further development and research are highlighted.

### 1.11 Conclusion

In conclusion, this study delves into the critical issue of sugar consumption patterns, particularly focusing on SSBs, in the context of South Africa's battle against rising obesity rates and NCDs. With the implementation of the HPL as a policy intervention to curb sugar intake, there arises a need to evaluate its effectiveness, not just in terms of its impact on SSB consumption but also its broader implications on overall sugar consumption and public health outcomes. Chapter One outlines the purpose and importance of the study. An overview of the research topic and outline of the stages of the study was also included in this chapter, as a guide to the development of the study. The next chapter will include a literature review expanding on the topics raised in this chapter.

### 1.12 Referencing

The referencing style used in this thesis is according to the guidelines used at Durban University of Technology (DUT) (DUT Harvard style 2015).

## CHAPTER TWO: LITERATURE REVIEW

### 2.1 Introduction

In this chapter, previous studies that addressed the research questions outlined in Chapter One will be reviewed. The literature review provides an overview of health challenges associated with sugar-sweetened beverages (SSBs), the motivation and structure of the SSB tax, and then hones in on the South African context with regard to the SSB tax before assessing the global impact of SSB tax implementation and the effectiveness of using fiscal measures to address a country's health issues. Finally, household table sugar consumption, including the types of sugar consumed and the South African sugar industry are discussed.

### 2.2 Global health challenges

The prevalence of obesity has become a global pandemic (Hu 2013: 607). In 2005, 400 million adults were found to be obese, and this was projected to increase to 700 million by 2015 (Hu 2013: 607). According to the WHO (2022), in 2022, 2,5 billion adults were overweight, and 890 million were obese (WHO: 2022). Further projections in a study conducted by Kelly *et al*. (2008: 1435) reported that by 2030, 1.12 billion adults will be found to be obese (Kelly *et al.* 2008: 1435). Obesity is characterised by having a body mass index (BMI) of 30kg/$m^2$ and above (Rössner 2012: 268). Obesity was once thought to be a problem exclusive to the United States (US) and other high-income Western countries. However, it has since evolved to be a significant factor in the global burden of disease (Malik, Willett and Hu 2013a: 13). Global trade liberalisation, economic growth, and rapid urbanisation continue to fuel significant changes in living conditions, food environments, dietary patterns and lifestyles (Kelly and Fuster 2010: 19). Food environments are characterised by increased consumption of animal fat and protein, refined carbohydrates, and added sugar, and these changes mark the nutritional transition in low-income and middle-income countries (LMICs) (Popkin 2014: 61). Urban diets are energy-dense, while urbanised individuals tend to lead sedentary lifestyles with low physical activity (Wiskerke 2015: 6). These factors are linked, leading to unbalanced energy expenditure and an increase in excess body fat (Malik, Willett and Hu 2013b: 13).

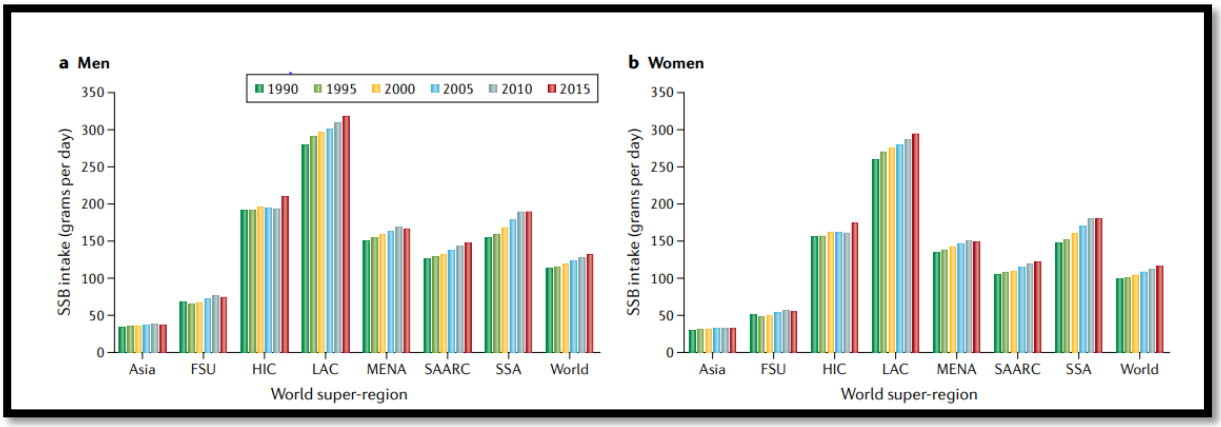
Research by Malik *et al*. (2013: 13) addressing global obesity trends, risk factors, and policy implications, stated that excessive body fat is a high-risk factor for morbidity and mortality and other non-communicable diseases (NCDs) such as type 2 diabetes and cancers (Malik, Willett and Hu 2013a: 13). The rising costs of obesity and its comorbidities, in terms of health care expenses and the quality of life globally, highlight how crucial it is to include prevention programmes (Malik, Willett and Hu 2013a: 19). According to Lehnert *et al*. (2013: 106), in a study based in Germany that examined the economic costs of overweight and obesity, the prevalence of obesity was associated with indirect expenses due to decreased labour productivity alongside rising healthcare costs. Moreover, an increase in the percentage of the overall yearly healthcare budget of affected countries is allocated to treating obesity and obesity-related health issues as more people are becoming overweight (Lehnert *et al.* 2013: 106). In LMICs, the average annual expenses allocated to a patient or household with diabetes, cancer, cardiovascular disease (CVD), and chronic obstructive pulmonary disease (COPD) were US$7386.71,

US$6055.99, US$3303.81, and US$1017.05, respectively (Kazibwe, Tran and Annerstedt 2021: 1). A global trend is emerging as developing countries have recorded increases in obesity prevalence, with obesity doubling from 6.4% in 1980 to 12% in 2008 (Stevens *et al.* 2012: 4). Overweight and obesity contributed to 34 million deaths, 4% of years of life lost (YLL), and 4% of disability-adjusted life-years (DALYs) in 2010 (Lim *et al.* 2012: 2224). Healthcare services are burdened with an estimated cost of US$ 990 billion annually due to the prevalence of high body mass index (BMI), representing over 13% of total global healthcare expenditure (World Obesity Organisation: 5). The annual economic impact of obesity is estimated to be US$ 2 trillion, taking into account healthcare costs, years lost to productivity, and investments made to offset the costs (WHO, 2022: 4).

From 1990-2017, there has been a significant rise in all-age total disability-adjusted life-years (DALYs) due to NCDs in sub-Saharan Africa. In 1990, there were 90.6 million people living with DALYs (95% uncertainty interval), and in 2017 there were 151.3 million (133.4–171.8) people living with DALYs (Gouda *et al.* 2019: 1383). Cardiovascular diseases (22·9 million [95% uncertainty interval 21.5–24.3] neoplasms (16·9 million [15.7–18.3]), mental disorders (13·6 million [9.9–17.7]), and diabetes (10·4 million [9.2–11.9]) were the leading causes of the NCD burden in 2017 (Gouda *et al.* 2019: 1383). These figures are comparable to the leading causes of NCD-related mortality in sub-Saharan Africa and worldwide (Gouda *et al.* 2019: 1383). The World Health Organisation (WHO) provided optional Global Nutrition Targets and recommendations for countries to adopt and to assist them in working towards eliminating obesity globally by 2025 (WHO, 2014: 1).

**2.3 Global perspective of sugar-sweetened beverages**

Various studies have proven that the human palate has a preference for high fat, high salt, high sugar and processed foods (Drewnowski and Schwartz 1990: 215). Extensive research has consistently linked the consumption of SSBs to weight gain and increased risk of developing type 2 diabetes and CVD (Malik *et al.* 2010: 1356). A normal 12 fl oz (355 ml) serving of SSB contained 35.0-37.5g of sugar and 140–150 calories (586 Kilojoules-628 Kilojoules), making SSBs a high source of added sugar in the diet (WHO, 2022: 2). According to a study of SSB consumption among adults in 187 countries, middle-income countries had higher consumption than that of high-income and low-income countries (Singh *et al.* 2015: 5). When analysing the global intake of SSBs in each country between 1990 and 2015, South and Central America, as well as regions of southern and northern Africa, showed significant increases (Malik and Hu 2022c: 207). Sugar-sweetened beverage consumption was highest in Latin America and the Caribbean, with a steady increase between 1990 to 2015, and lowest in Asia, with generally higher intakes observed in men than in women, in all global regions (Malik and Hu 2022c: 207).




FSU- Federation Syndicale Unitaire (French trade union), HIC- High-income countries, LAC- Latin American and the Caribbean, MENA- Middle East and North Africa, SAARC- South Asian Association for Regional Cooperation, SSA- Sub-Saharan Africa

**Figure 2.1:** Global trends in sugar-sweetened beverage intake by gender

Figure 2.1 highlights the SSB intake by grams per day by region and gender from 1990 to 2015. While the consumption between genders is the same across regions, the consumption of SSB is highest in Latin America and the Caribbean (LAC), followed by high-income countries (HIC) and sub-Saharan Africa (SSA). Reductions in SSB consumption have been urged by numerous health organisations (Malik and Hu 2022c: 207). A number of public measures in the form of fiscal policies have also been put in place to reduce SSB intake to enhance and maintain health as well as reduce rising medical costs (Malik and Hu 2022c: 214). According to a WHO 2022 report, eighty-five (n= 85) countries have implemented some form of SSB taxation. In 2022, the WHO released its first sugar tax manual (WHO 2022: 9). This tax manual serves as a practical handbook for policymakers and stakeholders engaged in the development of policies related to SSB taxation, aimed at fostering healthier dietary habits for populations. It offers concise summaries and illustrative case studies showcasing global evidence on SSB taxation, while also offering guidance on navigating the entire policy cycle involved in implementing SSB taxation. Furthermore, it exposes and refutes industry strategies aimed at deterring policymakers from enacting such taxes (WHO 2022: 9).

### 2.4 Sugar-sweetened beverages intake and its impact on health

The daily recommended intake of added sugars and free sugars is no more than 10% of total calories (added sugars plus sugars that are naturally present in honey, syrup, and fruit juices) (WHO 2022: 4), and SSBs equals to 6.5% of the daily intake (Malik and Hu 2022b: 206). Sugar-sweetened beverages increase kilojoule intake, accounting for the total energy (Wright *et al.* 2019: 2). However, the energy is regarded as empty kilojoules (micronutrient deplete) as they do not offer any nutritional benefit (Wright *et al.* 2019: 2). Sugar-sweetened beverages consumption is more likely to lead to over-eating and micronutrient deplete energy replacement during upcoming between meals (Prinz 2019: 1218).

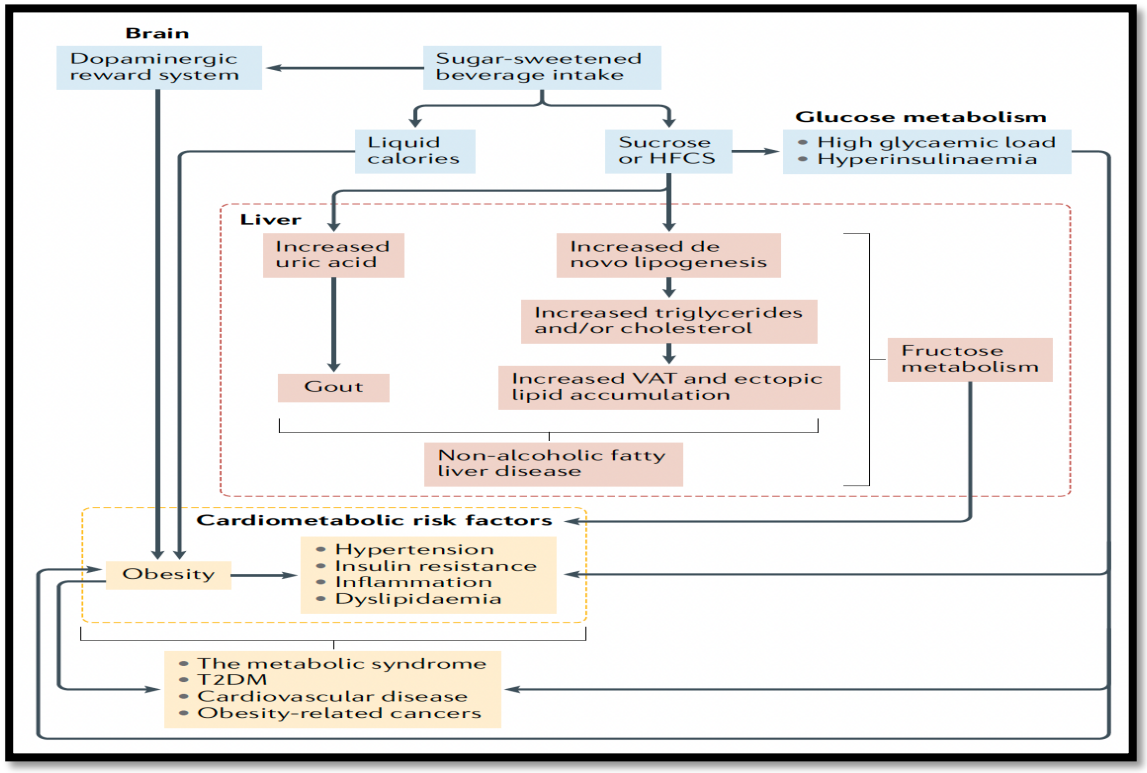



**Figure 2.2:** Biological mechanisms underlying the consumption of SSBs and the emergence of obesity, cardiometabolic risk, and associated chronic illnesses (Malik and Hu 2022c: 207)

Sugar consumption has been demonstrated to activate the dopaminergic reward system and release endogenous opioids in the nucleus accumbens, the brain's key location for rewarded behaviour, as reflected in Figure 2.2 (Malik and Hu 2022a: 212). Research suggests that there is a possibility that sugary meals and drinks are gratifying and may set off behaviours similar to addiction, which could be the cause of overindulgence (Malik and Hu 2022a: 212). Consuming SSBs also contributes to weight gain by negatively affecting metabolism and causing abrupt increases in blood glucose and insulin levels (Malik and Hu 2022a: 212). Sugar-sweetened beverages typically have moderate-to-high glycaemic index values, which, when paired with high consumption, result in a high dietary glycaemic load (Malik and Hu 2022a: 212). High-glycaemic diets increase the ratio of insulin to glucagon in the serum after meals, which then increases appetite and reduces energy expenditure, thus contributing to weight gain and insulin resistance (Malik and Hu 2022a: 212). Obesity involves an abnormal or excessive build-up of fat in adipose tissue, to the point where health may be compromised (Mohajan and Mohajan 2023: 27). Fat buildup is caused by consuming high-energy foods and having the energy not utilised or burned by the body (Hill, Wyatt and Peters 2012: 126); this is also termed an energy imbalance (Hill, Wyatt and Peters 2012: 126). In the year 2016, 1,6 billion adults were found to be overweight (or 1 in 8 of the world's population), and 650 million were obese worldwide (WHO, 2021). By gender, the WHO reported that in 2021, 11% of men and 15% of women in the adult population worldwide were obese; altogether, 13% of the world population were obese (WHO, 2021). Numerous disorders, including hypertension, cardiovascular conditions, Alzheimer's, asthma, metabolic

syndrome, hepatic steatosis, gallbladder disease and osteoarthritis, are linked to obesity (Mohajan and Mohajan 2023: 27).

Figure 2.2 also maps how a high SSB consumption leads to other underlying illnesses; fructose is the only sugar that has been linked to raised uric acid synthesis in the liver (Malik and Hu 2022c: 213). Simple sugars like fructose can be found in fruit and honey. It makes up 55% of the sugar in high-fructose corn syrup and 50% of table sugar which is sucrose, a disaccharide made up of one glucose and one fructose molecule (Nakagawa *et al.* 2005: 80). Gout is preceded by hyperuricaemia, and hyperuricaemia and gout have both been linked to hypertension, type 2 diabetes, and cardiovascular disease (Malik and Hu 2022c: 213). Obesity and type 2 diabetes have been demonstrated to develop prior to the beginning of hyperuricaemia (Malik and Hu 2022c: 213). Endothelial dysfunction and insulin resistance are the outcomes of fructose-induced hyperuricemia, which may represent a new mechanism of the metabolic syndrome (Nakagawa *et al.* 2005: 80).

### 2.4.1 Type 2 Diabetes

Type-2 diabetes is a chronic metabolic disorder that occurs as a result of pancreatic beta-cell failure and insulin resistance in the target organs (Olokoba, Obateru and Olokoba 2012: 269); type-2 diabetes is characterised by a relatively impaired insulin secretion (Chatterjee, Khunti and Davies 2017: 2239). A total number of 415 million people live with diabetes worldwide, with more than 46% (n= 193 million) of these individuals being undiagnosed (Chatterjee, Khunti and Davies 2017: 2239). It is important to note that this disorder is a lifestyle-related illness (Olokoba, Obateru and Olokoba 2012: 269). Type-2 diabetes has a causal pathway that involves unchangeable factors such as age and family history; it also has modifiable factors that influence, such as nutrition and lifestyle choices, also play a part in the disorder's onset (Neuenschwander *et al.* 2019: 1). The prevalence of adults who were obese and diagnosed with type-2 diabetes was 55% in 1999-2000, and this was attributed to a lack of physical activity, an increasingly sedentary lifestyle, smoking, and excessive alcohol use (Olokoba, Obateru and Olokoba 2012: 269).

In a systematic review and meta-analysis study conducted by Schwingshackl et al. (2016), it was concluded that reducing red and processed meat as well as SSB will result in a decreased risk of type-2 diabetes (Schwingshackl et al. 2017: 370). Furthermore, it was established that choosing an ideal diet, including the consumption of wholegrains, vegetables, fruits, and dairy products while avoiding red meat, processed meat, SSBs, and eggs, allowed for the reduction of the risk of type-2 diabetes (Schwingshackl *et al.* 2017: 370). The cumulative calculation of each food's capacity to reduce the risk of type-2 diabetes suggests that a reduction in T2D risk of approximately 80% may be possible (Schwingshackl *et al.* 2017: 370).

### 2.4.2 Cancer

More than 80 years ago, Otto Warburg, a prominent biologist, first documented how cancer cells actively ate glucose and made lactic acid in aerobic environments (Kim and Dang 2006: 8927). This observation

led to the hypothesis that decreased glucose intake due to reduced consumption of dietary sugars leads to a glucose "starvation" of tumour cells and also potentially decreases insulin-related cell development because of the reduction of blood glucose levels (Paoli *et al.* 2013: 793). The evidence supporting the link between dietary sugar and various cancers, while sometimes reported as weak; is however strongly linked to high body fat (Prinz 2019: 1220). A systematic review and meta-analysis conducted in the United Kingdom (UK) found that an increase in BMI of 5 kg/$m^2$ increases the risk of several types of cancer in both men and women, providing additional evidence to support the connection between body weight and the development of cancer (Renehan *et al.* 2008: 572). To reduce the risk of cancer, a healthy lifestyle with a healthy body weight is essential (Prinz 2019: 1220).

### 2.4.3 Tooth Decay

Dental hard tissues undergoes phasic demineralisation and remineralisation as a result of dental caries (Pitts *et al.* 2017: 7). Caries is a biofilm-influenced, sugar-driven, multifactorial and dynamic illness that affects children and adults (Bagramian, Garcia-Godoy and Volpe 2009: 4). Caries can harm the tooth crown and, in later life, also expose root surfaces. It can occur in both primary and permanent dentitions (Pitts *et al.* 2017: 27). In a study conducted in Cape Town, researchers found that 83% of participants had missing teeth and 14% of participants had tooth decay (Chikte *et al.* 2020: 178). A total of 93.7% of participants were found to have been affected by caries (Chikte *et al.* 2020: 178). A recent review concluded that increasing SSB consumption was associated with an increased risk of dental caries and erosion (Valenzuela *et al.* 2021: 22). However, it is important to note that it is not clear whether tooth decay can be directly associated with the consumption of SSBs without considering the impact of other factors, such as dental hygiene (Wilder *et al.* 2016: 77).

## 2.5 South African health challenges

Historically, South Africa is a country with various social inequalities due to apartheid (May 1998: 56). These inequalities resulted in the uneven distribution of wealth and resources among the citizens, leaving most Africans without access to clean and safe water, sufficient food, healthcare and other resources (May 1998: 56). During the apartheid era, many black South Africans were relocated to their respective “homelands” where they were forced to live in areas with poor infrastructure, were taught under the Bantu education system, and received inadequate public health care services (Aliber 2003: 474). After the 1994 elections, the country became a democratic country; the new government increased budget allocations for various social services in a bid to improve the status of the previously disadvantaged (May 1998: 57). Post 1994, through the public health system, the new administration of South Africa aimed to expand access to medical care to the entire population and shift the focus of doctors' care back to providing preventive healthcare (May 1998: 56).

### 2.5.1 Nutrition challenges

Based on the adult equivalent poverty level of R352 per month, 61% of Africans, 38% of Coloureds, 5% of Indians, and 1% of White people lived in poverty in 1995 (Aliber 2001: 11). Undernutrition in children is a byproduct of poverty due to income; a prolonged period of undernutrition resulted in the stunting of

approximately 27.4% of children in South Africa under the age of six in the year 2016 (Senekal *et al.* 2019: 1). Furthermore, in a study conducted by Senekal *et al*. in 2019, it was found that in a single household, both undernutrition and obesity can coexist (Senekal *et al.* 2019: 1). In a single South African household, children can be found to be both stunted and overweight or obese; this is classified as the double burden of malnutrition (Senekal *et al.* 2019: 2). These health challenges mostly affect low- to middle-income households and countries (Senekal *et al.* 2019: 2).

### 2.5.2 Disease challenges

The top three causes of premature deaths in the year 2000, apart from homicides, were *Human Immunodeficiency Virus* (HIV), and Acquired Immune Deficiency Syndrome (AIDS), and Tuberculosis (TB) (Bradshaw *et al.* 2003: 682). In 2001 to 2002, the national government spent R236 million on HIV/AIDS, which accounted for just 3.5% of the overall national health budget (Bradshaw *et al.* 2003: 686). South Africa has the highest number of people receiving antiretroviral therapy (ART) and living with HIV/AIDS (Blecher *et al.* 2016: 203) and 8.9 billion rands of the Comprehensive HIV and AIDS Conditional Grant were budgeted for the ART programme in the financial year of 2015/16 (Blecher *et al.* 2016: 203). Furthermore, the South African government's HIV allocations increased from R1.2 billion in 2004 to R17.5 billion in 2016 (Blecher *et al.* 2016: 203). The HIV and AIDS epidemic, high rates of tuberculosis, high rates of maternal and child mortality, high levels of violence and related injuries, and an increasing burden of NCDs such as cancer, diabetes, chronic respiratory conditions, and cardiovascular diseases, are all contributing factors to the multiple burdens of disease that South Africa is currently facing (Mayosi *et al.* 2012: 5).

South Africa currently has an unequal public-private funded healthcare system, with over 50% of the country's healthcare funding is allocated to public healthcare whilst over 79% of its doctors work in the private healthcare system (Ataguba 2010: 75). The private health care system providing services for roughly 20% of the population (Ataguba 2010: 76), leaving the balance of the South African population dependent on the public health care system (Coovadia *et al.* 2009: 827). The WHO urged countries to make plans to provide universal health coverage in 2005, and the African National Congress (ANC) led South African government responded in 2007 by committing to the creation of a national health insurance (NHI) programme, partly due to the shortcomings of the current healthcare system (Ataguba 2010: 75). However, implementing a NHI programme to meet universal healthcare needs is daunting and carries a burden in terms of real-world implementation, logistics as well as funding. To date, the NHI is not yet operational though plans have been set in motion for it to be fully implemented by 2026 (Ataguba 2010: 75).

## 2.6 Strategies to address modifiable risk factors for NCDs

A variety of strategies have been explored by the government to address NCD related diseases. The Department of Health (DoH) of South Africa in the year 2010 identified various strategies they could utilise to address NCDs, obesity and related illnesses due to unhealthy diets; these strategies included:

1. Implementing fiscal policies (tax) with the cost of R0.20c per person to implement.

2. Implementing food advertising regulations with the cost of R0.90c per person to implement.
3. Food labelling with the cost of R2.50 per person to implement.
4. Worksite interventions with the cost of R4.50 per person to implement.
5. Mass media campaigns with the cost of R7.50 per person to implement.
6. School-based interventions (e.g., Healthkick, Integrated school health policy) with the cost of R11.10 per person to implement.
7. Physical counselling with the cost of R11.80 per person to implement.

The HPL was found to be the most cost-effective solution to addressing obesity and unhealthy diets in South Africa (South African National Treasury, 2016: 6).

### 2.7 Types of sugar tax implemented

Traditionally, taxes had one main objective, which was to generate revenue; however, modern tax models can have multiple objectives (Lombard and Koekemoer 2020: 64). As a result, the conceptual framework for a sugar tax system was developed using the following tax concepts, which were thought to be universal (Table 2.1). The following qualities are essential: a) equity, b) simplicity, c) efficiency, d) fairness, e) accountability and transparency, f) certainty, and g) low administrative costs (Lombard and Koekemoer 2020: 98). Consumption taxes, like those on sugar, are typically regressive and should not be thought of as an equal and fair method of raising money for the government (WHO 2017: 18). Therefore, even a sugar tax system must be justified by the benefits to consumers' health and from their feedback, for it to be consistent with the equity and fairness principle (Meade Report 1978: 12; WHO 2017: 18).

**Table 2.1:** Tax principles of a good sugar tax system (Lombard and Koekemoer 2020: 71)

**Tax principles of a good sugar tax system**

**Equity and fairness:**

a) The sugar tax's health benefit must outweigh the burden for lower-income households;
b) A sugar tax is regarded as fair if it does not only tax certain food or drinks products, but all products containing sugar; and
c) The sugar tax must provide an incentive to manufacturers to reformulate their products to contain less sugar.

**Simplicity and certainty**

a) The tax base must be kept as simple as possible;
b) Taxpayers must be informed of the working of the sugar tax; and
c) Existing infrastructure must be utilised to simplify the administration of the sugar tax.

**Efficiency and low administration costs**

a) The sugar tax system must be able to decrease sugar consumption by being passed through to consumers, as well as avoiding the substitution effect;
b) It should earmark the tax revenue for health-promotion initiatives; and
c) It should utilise existing tax infrastructure for administration.

**Transparency and accountability**

a) Governments must implement the sugar tax system in a transparent way by following a consultation process with all stakeholders; and
b) Governments must undertake to review the sugar tax system regularly in order to ensure its relevance.

### 2.7.1 Tax design

In a study published by Lombard and Koekemoer (2020: 72), three different tax design models were described as follows:

1. A flat tax on SSBs, value-based/ ad valorem.
2. A specific excise tax on each gram of content in the SSBs.
3. A specific excise tax on each gram of sugar-sweetened beverage content, featuring a tax-free threshold.

Taxation can occur in any of the following ways: the tax can either be levied directly to the manufacturers and importers of SSBs or directly to the consumers (Lombard and Koekemoer 2020: 72). With an SSB tax, there are three possible outcomes: under-shifting, wherein less than 100% of the tax is reflected, over-shifting, wherein more than 100% of the tax is reflected, or full pass-through, when 100% of the tax rise is reflected in the price increase (WHO 2022: 17).

## 2.8 South African perspective on sugar-sweetened beverages

South Africa was the first African country to introduce taxation on SSBs, known as the Health Promotion Levy (HPL), which came into effect in April 2018 (Hofman *et al.* 2021: 1). The levy was scheduled to be implemented at a 20% price increase; however, following consultation with various stakeholders, such as the sugar and beverage industry, the tax was finalised at a 10% price increase (Hofman *et al.* 2021: 2). According to the South African Reserve Bank (SARS), the sugar content of drinks is verified by testing reports generated from accredited laboratories; failure to submit a report means that the sugar content of the product is assumed to be 20 grams per 100ml (SARS 2021). According to prospective simulated mathematical model-based research conducted by using consumption data from the year 2012, a 20% increase in the price of SSBs would prevent 85,000 incidents of stroke cases, 550,000 stroke-related DALYs, and 72,000 adult deaths in South Africa (Manyema *et al.* 2016: 4). It would also

reduce the prevalence of obesity by 2.4%–3.8% points (Manyema *et al.* 2014: 212); this corresponds to projected savings in healthcare expenses of more than 5 billion South African Rand (ZAR) over 20 years (Manyema *et al.* 2016: 4). Both the sugar and beverage industries lobbied for voluntary action or self-regulation, claiming that the HPL would cause enormous job losses in their respective industries (Hofman *et al.* 2021: 4). The government and academics justified the tax by pointing out that it would lower healthcare costs and possibly generate revenue to pay for medical services (Hofman *et al.* 2021: 5). The HPL is 0.021 ZAR per gram of sugar over a threshold of 4g of sugar per 100 ml (SARS, 2018). "The tax is imposed on sugar-sweetened beverages (SSBs), which are defined as beverages that have added sugars (sucrose, high fructose corn syrup (HFCS), etc.); these include but are not restricted to, fruit drinks, sports drinks, energy and vitamin water drinks, sweetened iced tea, lemonade, and soft drinks" (National Treasury Policy Paper, 2016:16). Based on the amount of added sugar beverages contain, SSBs are therefore subject to a tax. According to WHO (2022: 2), all other beverage items with naturally occurring added sugars are currently exempt from taxes, though there are plans for this to be revised to include 100% fruit juices.


**Figure 2.3:** Countries that have implemented a sugary drink tax (Popkin and Ng 2021: 2)

Many international agreements have been negotiated over the last few decades to use fiscal policies to improve diets (WHO, 2022:11). The United Nations General Assembly amended its political statement on NCDs in 2018 and recommended the "implementation of appropriate fiscal measures to address NCD risk factors and promote healthy diets and lifestyles" (United Nations 2018: 4). Figure 2.3 outlines the different countries and regions that have implemented sugary drink taxes.

A 25% relative decrease in NCD mortality by 2025 was one of nine voluntary global targets included in the Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020, which the Sixty-sixth World Health Assembly adopted in May 2013 and has since been extended through 2030 (WHO 2022: 11). The WHO member countries unanimously agreed to pursue the following under Goal 3 of the Global Action Plan: "examining evidence-based economic tools, such as taxes and subsidies, that create incentives for behaviours associated with improved health outcomes, improve the affordability and encourage consumption of healthier food and drink products, and discourage the consumption of unhealthy options" (WHO 2022: 11). A guideline paper “using price policies to promote healthier diets” was released in 2014 by the WHO Regional Office for Europe (WHO 2022: 12). It examines policy changes throughout the WHO European Region and offers information on how fiscal policies might be used to encourage healthy diets (WHO 2022: 12). The guidebook is intended to specifically: provide key insights from finance officials with relevant experience in their country on the implementation of SSB excise taxes, along with important health and economic considerations, strategies, and lessons learned from other places for effective SSB tax policy development, design, implementation, and administration. It also explains key economic concepts related to SSB taxation, to public health personnel and SSB tax advocates, to aid in discussions and negotiations with ministry of finance officials (WHO 2022: 13).

### 2.9 Types of sugar sold for household consumption in South Africa

#### 2.9.1 Biological composition of sugar

Sugar is a carbohydrate (Cummings and Stephen 2007: 6); sugar is also referred to as sucrose (Sugar Association Inc. 2019). It is metabolised to provide energy as it contains glucose, which is a simple sugar found in fruits (Cummings and Stephen 2007: 7). The Sugar Association (2019) classifies sugar as a substance made up of two single molecules. The chemical structure is distinguished by one fructose molecule bound to one glucose molecule. Sugar is used as a sweetener in foods and drinks to enhance palatability; it can also function as a preserving agent (Cummings and Stephen 2007: 7). The WHO (2022: 4) further defined sugars and syrups that are added to foods during processing or preparation as added sugars (WHO 2022: 4).

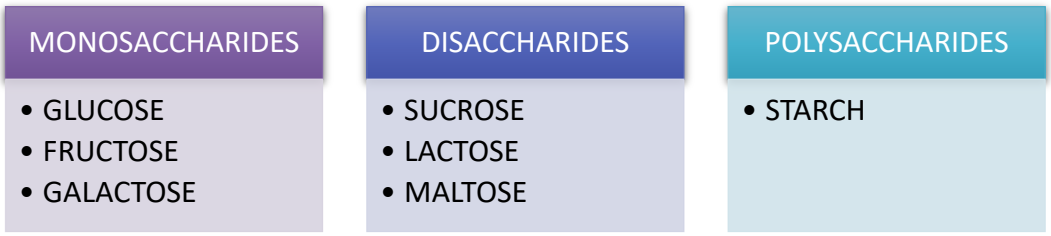



**Figure 2.4:** Carbohydrate classification (Sugar Association Inc. 2019)

### 2.9.2 The South African sugar industry

The South African sugar industry is one of the world leaders, currently ranked in the top 15 of the 120 sugar-producing nations contributing to the economy in terms of production and creation of employment, mostly in rural areas (South African Sugar Association (SASA) 2023). The sugar industry in South Africa creates approximately 65,000 direct employment jobs with a revenue of R20 billion (SASA 2023). The Cane Growers' sector constitutes 23,000 registered sugarcane producers, cultivating sugar in two major sugar-producing provinces: KwaZulu-Natal and Mpumalanga (SASA 2023). Sugar is supplied by six milling businesses, with 12 sugar mills operating in these regions, producing an estimated average of 2.2 million tonnes of sugar per season (SASA 2023). The announcement of the sugar tax posed a potential threat to the livelihood of employees in the sugar sector; this meant that the government had to relook the proposal and implement industrial strategies to assist with maintaining growth within the sector (Government Gazette 2021:430). The HPL, which was enforced on the 1st of April 2018, significantly decreased South Africa's demand for sugar as beverage manufacturers moved to reformulate their products with less sugar and switch product mix to beverages with no- and low-kilojoule alternative sweeteners (SASA 2020). A total of 250,000 tonnes of sales were lost in the first year following the implementation of the HPL, with an industry revenue loss of at least R1.2 billion (SASA 2020).

### 2.9.3 Types of sugars

A variety of sugars can be made after the juice from sugar beet or sugar cane plants has been extracted (Cheng *et al.* 2019: 728). Different types of sugar (Figure 2.5) can be produced by making a few alterations to the cleaning, crystallisation, and drying processes, during sugar making; as well as by adjusting the molasses input (Sugar Org. 2023). The use of sugar in a South African household includes:

- Adding it to tea and coffee
- Cooking, e.g., adding it into sauces, relishes, chutneys, and jam making.
- Confectionary
- Baking

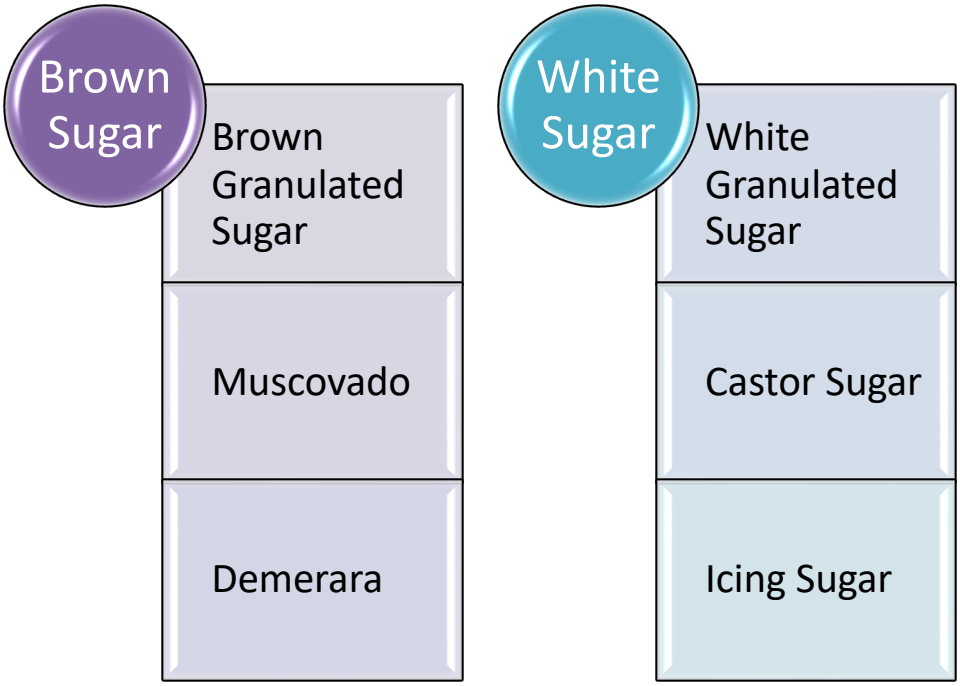



**Figure 2.5:** Classification of sugar sold in the South African market

Stores stock a wide range of packaging sizes between 500g-12.5kg as well as individual sachet servings.

### 2.10. Household added table sugar consumption patterns in South Africa

Vorster *et al.* have noted that the relationship between sugar consumption and NCD risk factors has been poorly documented in low- and middle-income nations. However, the consumption of added or free sugar in Southern Africa is not as prolific as it is in the United States, where table sugar is currently the main source of free sugars (Vorster *et al.* 2014: 1479). In their study to determine the added sugar intake of individuals living in urban and rural areas of Potchefstroom in South Africa, the percentage of participants who consumed more energy from added sugars than the recommended 10%, increased from 18% and 29% for men and women respectively, in 2005, to 40% and 46% in the year 2010 (Vorster *et al.* 2014: 1482). Women had higher BMIs and waist circumference than men, with women living in urban areas having the highest values (Vorster *et al.* 2014: 1482). In another conducted by Steyn and Temple (2012: 2), related to providing evidence to support a food-based dietary guideline on sugar consumption in South Africa (Steyn and Temple 2012). The researchers established that the population of South Africa was consuming sugar at a steady rate. Typically, children consumed 50 g daily whilst adolescents consumed up to 100 g daily, this equates to between 10% and 20% of the energy in food (Steyn and Temple 2012: 2).

### 2.11 Conclusion

South Africa was the first African country to implement a sugar tax; the insights gained and the framework used by the South African government can be adapted for use by other countries. Findings indicate that thoughtfully crafted SSB levies can be used to decrease the consumption of a targeted

product (WHO 2022: 95). In order to enhance nutrition, promote healthy diets, reduce obesity and diet-related NCDs, such levies must be put into place as part of a comprehensive, multisectoral plan (WHO 2022: 95). Nations debating the merits of adopting SSB taxes should be encouraged to use a comprehensive approach and to carefully analyse each stage of the policy-making process (WHO 2022: 95). Chapter 3 will focus on the methodology and measurement tools of the study.

# CHAPTER THREE: METHODOLOGY

## 3.1 Introduction

This chapter provides the foundation for the research design and methodology of this community study research project. The study design, study population, sample selection, measurement tools, and lastly, ethical considerations will be explained in detail.

## 3.2 Study design

This study adopted both desktop and quantitative methods through a cross-sectional study. The desktop study included a scoping review and the review of a syndicated report on sales of sugar-sweetened beverages (SSBs) in South Africa. Quantitative methods were used to gather data on the current SSB and household sugar consumption patterns among adults living in the Southgate Phoenix area. A threshold detection test (TDT) and sweetness preference sensory test was conducted among adults living in the Southgate Phoenix area.

## 3.3 Study area

Southgate is a community found in Phoenix, as illustrated in Figure 3.1. It is situated in the north of Durban in KwaZulu-Natal and has a population of more than one hundred and seventy thousand, (South African Statistics 2011). This community is representative of a typical South African urban middle-income community, made up of a predominately of Black and Indian population mix (South African Statistics 2011).

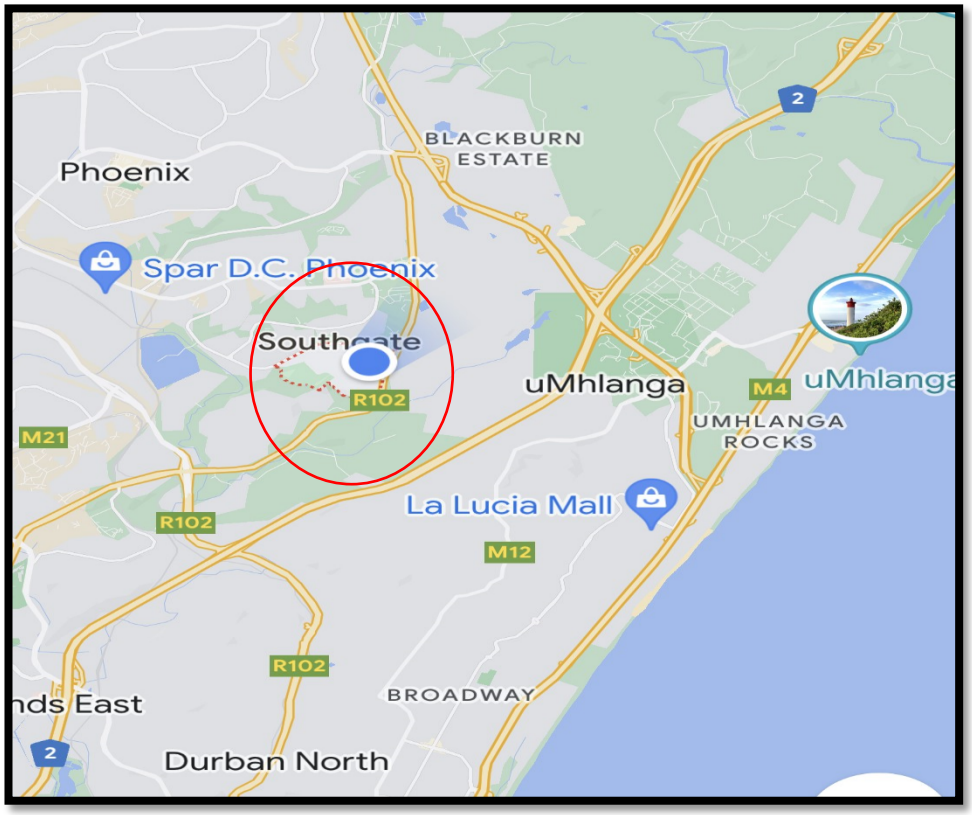



**Figure 3.1** Map highlighting the study location(Google maps, 2024)

### 3.4 Sample size

Using the Phoenix population of 176,000, the sample size for the cross-sectional survey was determined using the Taherdoost recommended sample size (South African Statistics 2011). According to Taherdoost (2017: 238), 383 is the recommended sample size to achieve a 95% confidence level with a 5% margin of error for a population of more than 100,000. Therefore, this study had a sample size of 399 participants for the cross-sectional surveys. To support the data collected from the survey, a preference sensory test was designed and administered to 98 participants. This test assisted in mapping the sugar solution preferred as well as the preferred brand of Cola on the market. A test sample size of 98 untrained participants was used for the threshold detection taste and carbonated paired preference test. According to Varela and Ares (2012: 902), results from sensory characterisation gathered from 50-100 participants are similar to those of a trained panel and a common guideline that produce reliable results.

### 3.5 Cross-sectional study

According to Kesmodel (2018: 388), a cross-sectional study design is relevant when assessing attitudes, behaviours, and knowledge among a population group. This is characterised by the collection of data within a defined time frame (Kesmodel 2018: 388). For this study, data was collected using the household consumption and SSB consumption survey which was administered as an online Microsoft Form. Levin (2006: 25) states that cross-sectional studies are advantageous as they are inexpensive and time-efficient to conduct. Cross-sectional studies also allow for data on multiple variables to be

collected simultaneously. Disadvantages include not being able to measure incidence and being affected by bias such as non-responsive bias and recall bias (Wang and Cheng 2020: S67).

### 3.6 Planning and administration

Participants were recruited using community social media groups that are in place in the form of community forums, community leaders were approached to share with the members an information poster (Appendix G and Appendix H) and door-to-door recruitment for both the survey and sensory. A link created for the study was shared directly with the community members who met the inclusion criteria. Participants were prompted to read and acknowledge an information letter and consent form. This confirmed that the participants acknowledged informed consent and that they agreed to participate in the survey. The survey allowed for each participant to answer it once to avoid multiple inputs from the same participant. Convience sampling method was used to collect data during this study for both the sensory and the surveys.

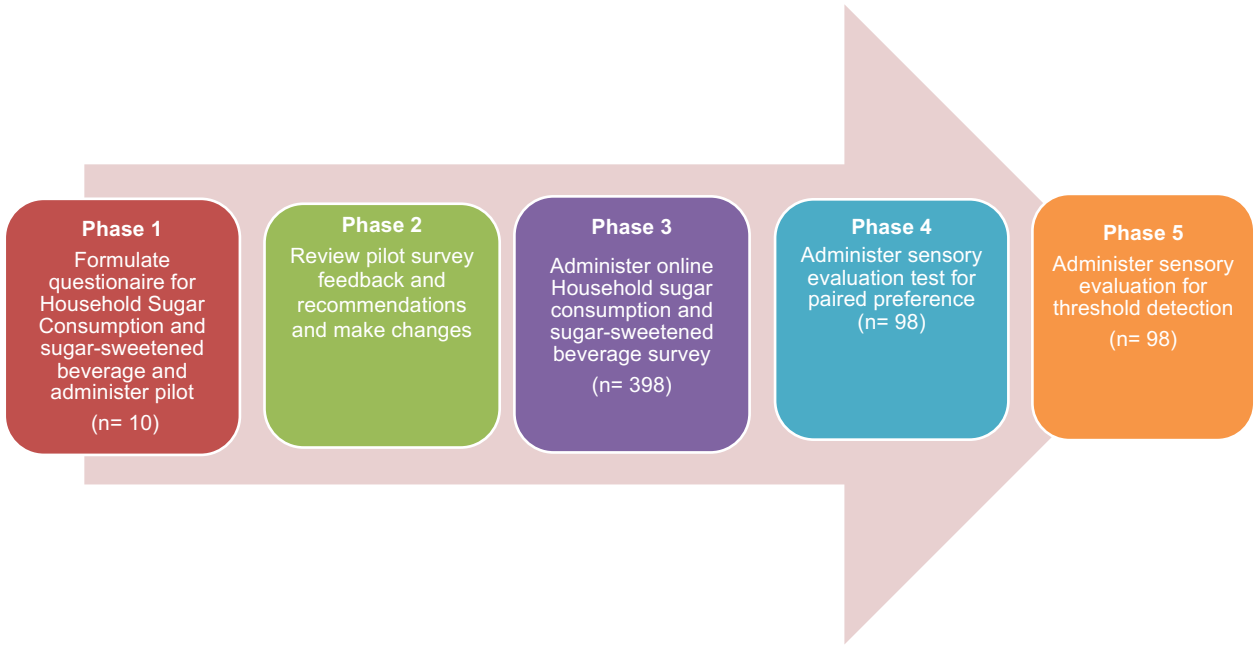



**Figure 3.2:** Flowchart illustrating the data collection process used in the study

**Inclusion criteria:**

Adult Southgate residents, male and female between the ages of 18 - 56 years and older.

**Exclusion criteria:**

Adults following a weight-reducing diet and diabetics. Persons visiting the area.

### 3.7 Measuring Instruments

#### 3.7.1 Scoping review:

The aim of the scoping review was to investigate the implementation of the sugar tax by various countries, and the effectiveness thereof. The 5-stage framework, as described by Arksey and O'Malley (2005: 22), was used for the scoping review. In stage 1, we identified the research question (Arksey and O'Malley 2005: 22). The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Extension for Scoping Reviews (PRISMA-ScR) guidelines were used. In stage 2, relevant studies were identified, and in stage 3, the study selection was included (Arksey and O'Malley 2005: 22). The keywords used to search included words such as **'sugar', 'health', 'soft drink', 'sugar-sweetened beverage', 'soda', 'tax' 'levy/levies', 'excise', 'taxes'** and **'implement', 'adopt'** which are **Articles** or **Review Articles**. The articles were sourced using the Endnote software from 4 major research engines, namely Scopus, PubMed, Science Direct and Web of Science. In stage 4, we charted the data Field (Arksey and O'Malley 2005: 22); the database was generated between the years 2012 and 2024, and once the articles were sourced, they were screened to remove any duplicates on Endnote. Screening of the articles by reading the abstract allowed for further filtering of the information, then articles were classified into 2 groups: the inclusion and exclusion groups. A total of 96 articles were selected for the further screening or extraction phase; the information on the articles was tabled on a spreadsheet. The 5$^{th}$ and final stage consisted of collating, summarising, and reporting the result (Arksey and O'Malley 2005: 22). The total number of articles included for reporting in the final scoping review was n= 39. Headings for the Excel spreadsheet included Country of Implementation, Tax Date Implementation, Type of Tax, Outcomes and Results, Conclusions, Risk of Bias, and Limitations. The results of the scoping review are discussed in Chapter Four.

#### 3.7.2 SSB sales data:

A review was conducted on the SSB sales data generated from a syndicated report of SSB sales in South Africa between the years 2015-2020. The data was generated using Euromonitor syndicated report. The sales data assisted in plotting the purchasing trends made nationally for the period 2015-2020. This electronic data tool is used by various industries to gain detailed market insights, research reports as well as data analysis regarding sales. Euromonitor gathers sales data from a variety of primary and secondary sources. These sources include store audits, company interviews, publicly accessible statistics, and corporate reports (Euromonitor International 2017).

### 3.7.3 Household sugar consumption and SSB consumption survey:

The questionnaire was designed using a sequence of structured questions to address the information needs of the study based on the problem statement and objectives (Taherdoost 2022: 8) and was a self-administered questionnaire. The questionnaire was made up of a total of 22 questions grouped into three sections; 19 of the questions required the participant to choose an answer from the options listed, and 3 of the questions required the participant to complete the question according to their own understanding and situation. Section 1 comprised demographic questions and household sugar consumption questions, section 2 involved SSB consumption and section 3 determined the participant's sugar tax knowledge. All questions were required questions. The form only allowed for one entry to prevent multiple entries from the same participant.

### 3.7.4 Sensory evaluation (threshold detection test (TDT) and sweetness preference test):

Sensory tests were set up to determine the threshold detection test and sweetness preference among group of 98 adults (Appendix A and B). Participants were required to travel to the venue, which is a 5-10 minute' drive from their dwellings; there was no compensation for participating in the study. Consent was obtained on the day by filling in consent forms prior to participating in the sensory taste session. Samples were marked with colour-coded stickers, and screens were set up to ensure that participants tasted independently. Plain water was offered, and participants were encouraged to drink to rinse their palate in between samples. Participants were not allowed to communicate during the sessions.

**Inclusion criteria:**

Adult Southgate residents, male and female between the ages of 18- 56 years and older.

**Exclusion criteria:**

Adults following a weight-reducing diet and diabetics. Persons visiting the area.

**Figure 3.3:** Taste panel booth

For the TDT, tasting solution samples were made up using sugar and water at different sweetness intensities at 0.1%-10%, and participants were asked to indicate if they detected sweetness. Samples were prepared by mixing sugar and water to make up the sugar solutions, the sugar samples were weighed by the researcher with assistance from the research assistants at the Durban University of Technology: Consumer Science masters laboratory using the scales on site. Water was measured and sugar was added and dissolved using volumetric jugs. The following dilutions were made up:

1. 1g sugar into 1000ml water (0.1% solution)
2. 10g sugar into 1000ml water (1% solution)
3. 100g sugar into 1000ml water (10% solution)

Containers containing the sugar solutions were also colour coded for easy identification by the research team and de-identification for the participants.

**Figure 3.4:** Taste panel samples: samples of sugar and water solution

For the sweetness preference sensory test, participants were asked to taste randomly placed Cola market samples for blind tasting to indicate the preferred sample of the market samples. This also gave an indication of whether the participants were sensitive to NNSs.

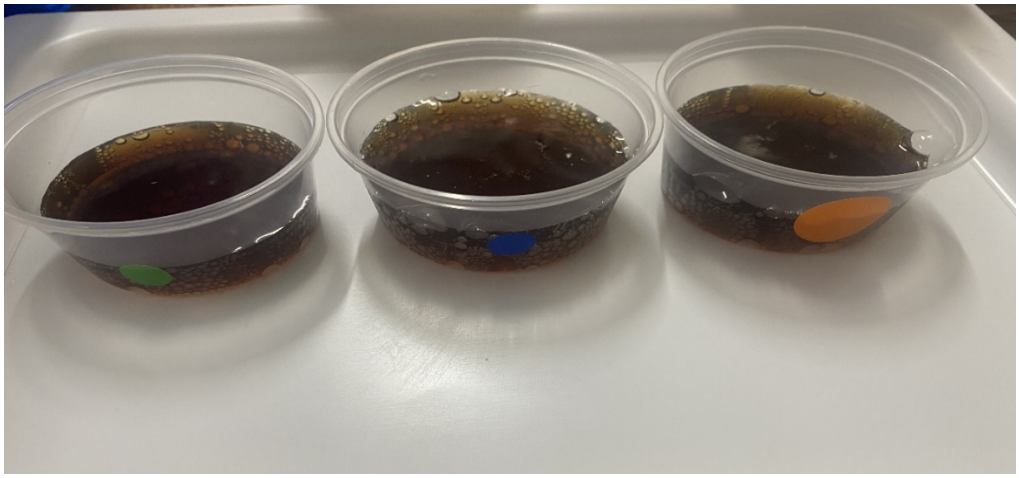


**Figure 3.5:** Taste panel samples: Cola market samples

### 3.8 Statistical analysis

Statistical analysis was conducted using the Statistical Package for Social Sciences (SPSS®) version 29IBM Corp, Armonk, NY, US). The Chi-square test of independence was used to determine whether a significant relationship exists between variables represented in cross-tabulations. When conditions are not met, Fisher's exact test was used. A binomial test was used to determine whether a significant

proportion of participants selected one of a possible two responses. Spearman's correlation measures how ordinal variables or rank orders are related. Descriptive statistics including means and standard deviations, where applicable. Frequencies are represented in tables or graphs. Statistical significance was accepted as $p<0.05$.

### 3.9 Validity and Reliability

According to Heale and Twycross, the term "validity" in research refers to the degree of precision attained during a study, which enables tools to assess the objectives they are designed to evaluate. Furthermore, Heale and Twycross (2015: 67) state that both consistency in measurement and reliability in research are crucial for the effectiveness of accurate research communication. Each phase of this study was validated through various methods to ensure that the data was accurate and reliable. The validation of tools, steps, implementation, and method used for validation will be discussed next.

#### 3.9.1 Pilot study tool validation

The method used to validate the pilot study tool included content and construct validity tests. The measure was the pilot study, and this tool was used to determine the suitability of the household sugar and SSB consumption survey. The reason for applying the content validity test was to ensure that the pilot study was a validation step to check that the survey was fully representative of what it aimed to measure before it was used in the study. The concept validity test is a tool that evaluates the precision and intent of what the research seeks to accomplish prior to application (Heale and Twycross 2015: 66). The pilot study was conducted to evaluate the validity of the questionnaire; and to ensure that the household sugar and SSB consumption was going to evaluate what it was intended to. Before the survey could be finalised for the main study, the pilot participants evaluated the survey's overall flow to ensure that it followed an acceptable order. The pilot group completed the form independently so they could also assessed the questions to ensure that these were not ambiguous or confusing for the participants and that they would speak to the study's objectives. The group were members of the Southgate community who were recruited specifically for the piloting questionnaire, these individuals were not included in the final study group.

#### 3.9.2 Household sugar and sugar-sweetened beverage consumption survey validity

The household sugar and SSB consumption survey was piloted on ten participants who were not included in the final study. Recommendations and comments were evaluated, and relevant amendments were made to the survey.

### 3.10 Reduction of bias

The phases of the research project that might have introduced bias were reviewed and the following actions were taken to reduce bias.

- Pilot study: Piloting of the Household Sugar and SSB consumption survey by the ten participants.

- An online survey form: the form was designed to accept only one response from a respective participant and was closed after 385 responses were received.
- Coding of samples: Market samples and sugar water dilution samples were colour coded.
- Household sugar and sugar-sweetened beverage consumption survey and database: All results captured on the MS Excel tool were validated. The statistician and supervisor both contributed to ensuring the reliability and quality of the data collected for this study.
- Data was cleaned and checked by the researcher and the statistician.
- The supervisor actively guided the research topic ensuring that a wide scope of journal articles, reviews and citations were applied in this research and that the research was true and well presented by conducting regular reviews.

### 3.11 Ethical consideration

Participants received a letter of information (Appendix C), and informed consent was attained (Appendix D) during recruitment. All data collected was de-identified, and sales data was collected from a syndicated report. All hard copy data was securely stored for five years (2023-2027) in the Department of Consumer Sciences: Food and Nutrition and thereafter will be disposed of; only the supervisor and the researcher had access to the data. Ethical approval was granted by the Institution Research Ethics Committee (IREC), as per Ethics Clearance Number: 152/21 (Appendix E).

### 3.12 Conclusion

This chapter provides an overview of the methods and tools used to facilitate optimum data collection and analysis. The findings of study will be presented and discussed in Chapter 4.

## CHAPTER FOUR: RESULTS AND DISCUSSION

### 4.1 Introduction

In this chapter, the results of the study are presented and discussed according to the objectives. Key patterns, trends and insights that have emerged from the findings of this study are discussed.

### 4.2 Objective 1

*Conduct a scoping review on countries that have implemented sugar tax and report on the effectiveness thereof.*

The objective of the scoping review was to examine diverse studies conducted in different countries regarding the sugar tax, its effectiveness, and its outcomes. The research followed the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) extension for Scoping Reviews (PRISMA-ScR) guidelines.

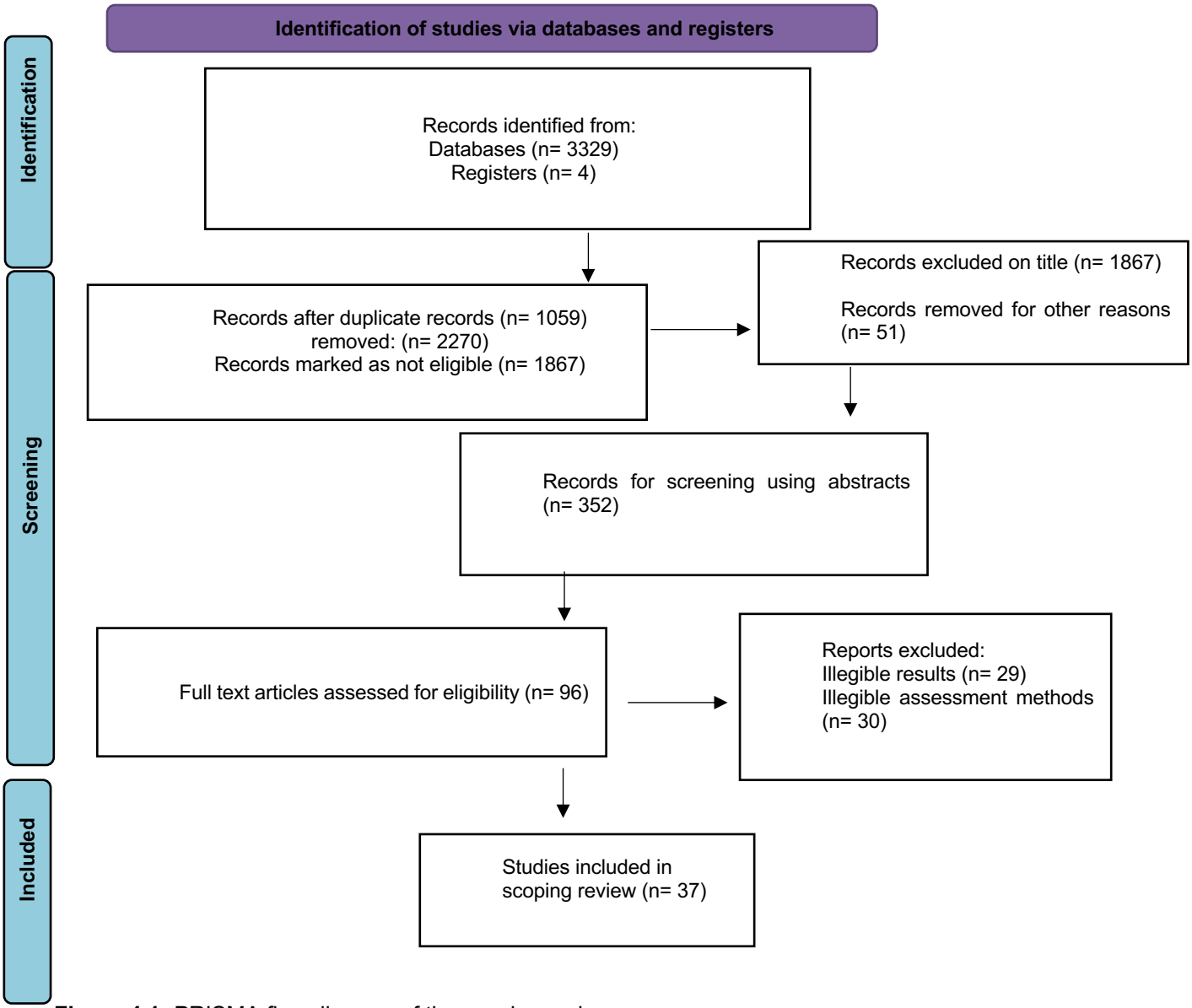



**Figure 4.1:** PRISMA flow diagram of the scoping review

The articles were sourced using the Endnote software from four major research engines namely: Scopus, PubMed, Science Direct and Web of Science. The keywords used for the search included: 'sugar', health', 'soft drink', 'sugar-sweetened beverage', 'soda', 'tax' 'levy/levies', 'excise', 'taxes' and 'implement', 'adopt'. A total of 3329 articles were generated, with 1059 duplicates removed and 1867 records deemed ineligible (Figure 4.1). Among the abstracts screened, 352 were included, and 96 were found to be eligible. Additionally, 29 articles were excluded due to illegible results, and 30 were excluded due to unclear assessment methods, resulting in 38 studies being included in the scoping review. Of the 38 studies included in this review, studies were conducted in 17 countries. The majority of studies, 37.8% (n= 14), were conducted in different states in the US, followed by Mexico (16.2% n= 6) and South Africa (10.8% n= 4).

**Table 4.1** Sugar tax implementation by country and year of implementation

| Country | Year of implementation |
|---|---|
| Barbados | 2015 |
| United States of America | Berkeley 2015<br>California 2015<br>Philadelphia 2014<br>Cook County, Illinois 2017<br>Seattle, Washington 2018 |
| Catalonia, Spain | 2014 |
| Chile, South America | 2014 |
| Europe | Finland 2011<br>Belgium 2015<br>France 2012<br>Portugal 2017 |
| France, Hungary | France 2012<br>Hungary 2011 |
| India | 2017 |
| Mauritius, Maldives | 2013 |
| Mexico | 2014 |
| Saudi Arabi | 2017 |
| South Africa | 2018 |
| Thailand | 2017 |
| United Kingdom (UK) | 2018 |

Table 4.1 summarises the implementation of sugar taxes in various countries, along with the corresponding years of implementation. Finland was the first country to implement the sugar-

sweetened beverage (SSB) tax in 2011, followed by France in 2012, and hereon, the remaining countries included in this review implemented the SSB tax within a five-year period.

**Table 4.2:** Characteristics of included studies (n= 37)

| Country | Study Design | Measuring Tools | | | Type of tax | Date of implementation of tax |
|---|---|---|---|---|---|---|
| | | POS | Surveys | Syndicated Reports | | |
| **Barbados** | Observational study | × | | | Valorem, Value-based tax | 2015 |
| **Berkeley** | Cross-sectional study | | × | | Volume-based tax | 2015 |
| **California, US** | Observational study | × | | | Volume-based tax | 2015 |
| **Philadelphia, US** | Observational study | × | | | Volume-based tax | 2017 |
| **Philadelphia, US** | Observational study | × | | | Volume-based tax | 2017 |
| **Philadelphia, US** | Difference-in-differences regression modelling | | × | | Volume-based tax | 2017 |
| **Philadelphia, US** | A longitudinal quasi-experiment | | × | | Volume-based tax | 2017 |
| **Philadelphia, US** | Observational study | × | | | Volume-based tax | 2017 |
| **Philadelphia, US** | Difference-in-differences analyses | | × | | Volume-based tax | 2017 |
| **Philadelphia, US** | Longitudinal study | | × | | Volume-based tax | 2017 |
| **Philadelphia, US** | Cross-sectional study | | × | | Volume-based tax | 2017 |
| **Seattle, US** | Quasi experimental study design | | × | | Volume-based tax | 2018 |

| Country | Study Design | Measuring Tools POS | Surveys | Syndicated Reports | Type of tax | Date of implementation of tax |
|---|---|---|---|---|---|---|
| **Seattle, US** | Difference-in-differences | × | | | Volume-based tax | 2018 |
| **Cook County, Illinois, US** | Interrupted time series analysis | × | | | Volume-based tax | 2017 |
| **Catalonia, Spain** | Time series cross sectional design | | × | | Sugar-content based tax | 2017 |
| **Catalonia, Spain** | Quasi-experimental design | | × | | Sugar-content based tax | 2017 |
| **Chile** | Observational /Longitudinal study | × | | | Sugar-content based tax | Modified 01 October 2014 |
| **Chile** | Observational study | × | | | Valorem, value-based tax | 2014 |
| **Europe** | Repeated cross-sectional surveys | | × | | Volume based tax | 2001–2002 2017–2018 |
| **France, Hungary** | Observational study | × | | | France (volume-based tax), Hungary (volume-based tax) | France 2012, Hungary 2011 |
| **India** | Observational study | | × | | Valorem, value-based taxes | 2017 |
| **Mauritius, Maldives** | Cross-sectional study | | | × | Sugar-content based tax | 2013 |
| **Mexico** | Observational study | × | | | Volume-based tax | 2014 |

| Country | Study Design | Measuring Tools | | | Type of tax | Date of implementation of tax |
|---|---|---|---|---|---|---|
| | | POS | Surveys | Syndicated Reports | | |
| **Mexico** | Observational study | × | | | Volume-based tax | 2014 |
| **Mexico** | Observational study | × | | | Volume-based tax | 2014 |
| **Mexico** | Longitudinal clinical study | × | | | Volume-based tax | 2014 |
| **Mexico** | Longitudinal study | | × | | Volume-based tax | 2014 |
| **Mexico** | Longitudinal study | | × | | Volume-based tax | 2014 |
| **Saudi Arabia** | Cross-sectional study | × | | | Valorem, Value-based tax | 2017 |
| **South Africa** | Desktop study | | | × | Volume-based tax | 2018 |
| **South Africa** | Cross-sectional study | | × | | Volume-based tax | 2018 |
| **South Africa** | Observational study | × | | | Sugar content-based tax | 2018 |
| **South Africa** | Longitudinal study | | × | | Sugar content-based tax | 2018 |
| **Thailand** | Prospective cohort study | | | × | Valorem, value-based tax | 2017 |
| **UK** | Cross-sectional study | | × | | Sugar-content based tax | 2018 |
| **UK** | Controlled interrupted | | | × | Valorem, Value-based tax | 2018 |

| Country | Study Design | POS | Measuring Tools Surveys | Syndicated Reports | Type of tax | Date of implementation of tax |
|---|---|---|---|---|---|---|
| | time series analysis | | | | | |
| **UK** | Observational study | | × | | Volume-based tax | 2018 |

POS: Point of Sale

Globally, sugar taxes have been in place for 11-12 years, having been implemented as early as 2011 in Finland. A steady growth in the number of countries implementing the sugar tax was noted after 2013 (Table 4.2). Of the studies conducted, 37.8% (n= 14) utilised an observational study design, followed by 18.9% (n= 7) with a cross-sectional study design, and 13.5% (n= 5) with a longitudinal study design. Forty-six percent of the studies (n= 17) collected data using consumer surveys, 43.2% (n= 16) collected data using point of sale (POS) records, and 10.8% (n= 4) used data generated from syndicated reports. Some countries and regions introduced different tax models, which could be categorised into three types of taxes: volume-based, value-based and sugar content-based. The majority of studies, 67 % (n= 25) used a volume-based tax, 18.9% (n= 7) implemented a sugar content-based tax, and 13.5% (n= 5) implemented a value-based tax.

**Table 1.3:** Results, risk of bias and limitations of studies

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Alvarado *et al*. (2019) | Barbados | Reduced sales of SSBs by 4.3% | Use of POS data via electronic means from a large chain of grocery stores. Customers might have moved to a different store after the tax, which could lead to an overestimation of the effect. | The conclusions are restricted to the shopping habits of the subset of customers that frequent this chain because the data may not be representative of all SSB sales. The estimate of the effect might be inflated because it's possible that customers moved to a different store after the levy. |
| Bandy *et al*. (2022) | UK | Reduced sales of SSBs by 30% | Possibility of not including soft drinks that are only available for purchase outside of the three supermarkets used in this study. | Firstly, results have not included soft drinks that are only available for purchase outside of the three included supermarkets. Secondly, taking the data from single time points means that the researchers may not have captured the soft drink products sales throughout the year. |
| Baskin and Coary (2018) | Philadelphia, US | Reduced sales of SSBs by 62.7% | Access to only one grocery chain. | Access to only one grocery chain, results would not reflect the patterns of the whole population. |
| Bercholz *et al*. (2022) | South Africa | Reduced consumption of SSBs by 32% | It was not possible to identify and track individual products due to data limitations, restricting the researchers' choice of unit of observation to sets of closely related products (same beverage category, brand, sub-brand, and tax category). | This study does not identify the causes of the observed reductions in the sugar content of beverage purchases, although it is reasonable to say that the HPL played some role. In particular, public debates and media campaigns about the HPL after it was announced may have contributed to these changes too, especially in light of some of the behavioural changes seen prior to implementation. Nevertheless, it is worth noting that most reformulations occurred after the tax came into effect. |
| Bleich *et al*. (2020) | Philadelphia, US | Reduced consumption of SSBs by 38.9% | These stores were frequented by low-income customers and were disproportionately concentrated in low-income areas. | Firstly, the study relied on a convenience sampling of stores and did not gather data on evening and weekend purchases, this limited the ability to generalise findings. Secondly, although sociodemographic characteristics of Philadelphia and Baltimore were similar over time, there was a possibility that unobserved factors might have changed, resulting in time-dependent residual confounding. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Caro *et al*. (2018) | Chile | Reduced consumption of SSBs by 3.4% | No control group. | There was no control group, so it was not possible to assess the causal impact of the tax. |
| Cawley *et al*. (2022) | Mauritius, Maldives | Reduced consumption of SSBs by 9-11% | Self-reported surveys can lead to under reporting. Sales of carbonated soft drinks(CSDs) were banned in primary and high schools since 2007. | There was limited statistical power to detect smaller effect sizes, particularly when estimating models by gender. For each country, there was only one time period prior to the tax and one after the tax, which prevents the assessment of the identifying assumption of parallel trends. Measures of SSB consumption and BMI were based on self-reports; as a result, they may contain some degree of reporting error. |
| Chatelan *et al*. (2022) | Europe | Reduced consumption of SSBs: Latvia (from 17.9 to 11.9%, Finland (4.2 to 2.5%, Belgium (35.1 to 27.8% and Portugal (17.4 to 14.9%, but not in Hungary (29.8 to 31.3%, or France (29.4 to 28.2%) | Study was underpowered to detect small changes when prevalence was high. | The absence of a fully parallel pre-tax soda consumption trend and self-reported dietary data may have limited interpretation of findings. |
| Colchero *et al*. (2017) | Mexico | Reduced sales of SSBs by 7.3% | If the amount of untaxed beverages included in the EMIM (Monthly Surveys of the Manufacturing Industry) was substantial and varied significantly in the post-tax period, the study of changes in SSB sales may yield skewed results. | The information's source omitted imports and included exports with no taxes. Analyses do not take into account variables other than the tax that affect the consumption and purchases of these beverages and that may vary from one period to the next. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Colchero *et al*. (2016) | Mexico | Reduced sales of SSBs by 6-12% | Short-term observation results (i.e. 1-year post tax), with no results on long-term observation. | One of the study's weaknesses is the lack of complete data on dairy beverages before to October 2012, which restricted the scope of the analysis to a shorter time frame and possibly overstated the rise in untaxed beverage purchases during the post-tax period. This is not ideal since more robust findings would have been possible with a longer pre-tax period. |
| Colchero *et al*. (2017) | Mexico | Reduced consumption of SSBs by an average of 7.6% | Used estimations for volumes sales, may have been over or under reported. | First, since the tax was implemented concurrently with other modifications, causality could not be proven. Second, the tax on SSBs was accompanied by an 8% ad valorem tax on non-essential, high-energy items. This move was linked to a decrease in the purchasing of foods subject to the tax. It is possible that the contemporaneous tax had an impact on beverage demand as well. |
| Edmondson *et al*. (2021) | Philadelphia, Pennsylvania | Reduced consumption of SSBs<br>0.81 servings of soda per week (95% CI, −1.48 to −0.14 servings; p = .02) | Relies on self-reported data. | Firstly, the results are based on self-reported data, which are subject to recall bias and measurement inaccuracy. Subsequently, the pre-tax trends in the consumption of 100% juice and milk were not consistent, which only allowed for preliminary analyses and limited the assessment whether or not these beverages would be substituted in reaction to the tax. Thirdly, the survey only measured the intake of soda, milk, and 100% juice; therefore, the relationship between the tax and the consumption of a variety of other sweetened beverages, like fruit drinks, sports drinks, and iced teas, could not be evaluated. |
| Essman *et al*. (2021) | South Africa | Reduced sales of SSBs by 14%.<br>Reduced consumptions of SSBs by 22-24% | The cross-sectional data prevented the follow-up on all individuals over time and only differences in population means were measured. Social desirability bias could have affected reporting and caused an underestimation of SSB intake. | This study is unable to make causal claims due to repeat cross-sectional data collection, additionally, the magnitude of reduction in taxed beverage intake may not be generalisable to higher income populations. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Falbe *et al*. (2016) | Berkeley | Reduced consumption of SSBs by 21% in Berkeley and increased 4% in comparison cities (p = .046) | Self-reported behaviours are vulnerable to social desirability bias; this was partially addressed by including three comparison cities, but SSB sales data could provide complementary objective evidence. Post tax sample sizes were larger than pre-tax sample sizes. | Although the results suggest that SSB taxes can significantly reduce SSB consumption, Berkeley is a single city of relatively high socioeconomic status, and results may not generalise to other cities. Measures of self-reported height, weight, or desire to lose or maintain weight, which may have been associated with the magnitude of change in SSB consumption in response to the tax, were not determined. |
| Gracner *et al*. (2022) | Mexico | Reduced BMI/weight by a 3% relative decrease in overweight or obesity prevalence within 2 years of a price change | Study results were reflective of middle income and urban areas only. | Price data were representative of urban areas, and health data were limited to patients who visited Instituto Mexicano del Seguro Social (IMSS) clinics annually. |
| Jalloun and Qurban (2022) | Saudi Arabia | Reduced BMI/weight by 32% (aOR = 0.688, 95% CI 0.048–0.989) | Self-reporting questionnaire might cause reporting bias. | Causal relationships between factors were not assessed. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Kurz and König (2021) | France, Hungary | Reduced sales of SSBs in Hungary by 12%, France by 5% | Incorrect categorisation of beverages could have caused sales bias. | The lack of estimation of sugar tax long-term effects on sales of SSBs in the study may restrict the ability to comprehend the intervention's long-term implications. Euromonitor's definition of soft drink categories might not have included all beverages with added sugar. For instance, although they fall within the juice category, (non-pure) juice drinks and nectars with added sugar are subject to taxation in Hungary and France. Because there are so few data points, there is a great deal of uncertainty in all estimates, and the analysis confidence intervals are typically wide. More detailed data cannot be used because Euromonitor data are only accessible once a year. Sugary beverages including soymilk substitutes, flavoured milk, ready-to-drink coffee and tea, and drinking yoghurts were not included in the study. |
| Law *et al*. (2021) | India | Reduced consumption of SSBs in Delhi − 1.31 million litres, West Bengal − 0.24 million litres and Kerala − 0.05 million litres | The use of self-reported diaries can result in reporting bias. | The study did not have a control group. The data set did not include purchases in rural India. Data excluded information from on-the-go or food service purchases (e.g., street vendors or restaurants). The study did not consider possible consumer substitution away from aerated drinks. |
| Lawman *et al*. (2020) | Philadelphia, US | Reduced sales of SSBs (−203.7 ounces, 95% CI: −399.6, −7.8) | It is possible that not all food and beverage receipts were submitted, which would result in under-representing beverage purchases. | The study only uses two-weeks of receipts per time point, which may not adequately capture typical purchasing behaviour. It is possible that not all food and beverage receipts were submitted, which would result in under-representing beverage purchases. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Lozano-Rojas and Carlin (2022) | Philadelphia, US | Reduced sales of SSBs by 19.1% however sales increased in neighbouring cities | Four different control groups were used to estimate the effects of a tax on SSBs in Philadelphia. The study only examined the effects of a tax on SSBs in one city (Philadelphia), which means that the results may not be generalisable to other cities. | Data from the Nielsen report was skewed toward bigger retailers, as it only captured 2% of convenience stores. The POS data obtained from Nielsen does not record sales made from vending machines and restaurants (unless stock was resupplied in Nielsen participating retailers). |
| Nakamura *et al*. (2018) | Chile | Reduced sales of SSBs by 21.6% for high-tax soft drinks | Only urban households in the following regions were included in the data: North, Valparaiso Region, Center South, Bio-Bio Region, and South. It is unknown if there was a decline in SSB purchases in rural regions following the adoption of the tax. | The focus was on purchasing data instead of consumption or health outcomes, and the lack of a randomised design limits the amount of causal inference that can be concluded. |
| Pedraza *et al*. (2019) | Mexico | Reduced sales of SSBs by 14-19% | Sampling bias: the study uses household-level data from Nielsen Consumer Panel Services (CPS) which only includes data from urban areas with more than 50,000 inhabitants and excludes rural and smaller urban areas. This can introduce bias, as beverage consumption patterns may differ significantly between urban and rural populations. Selection bias: the study relies on data from households that are part of the Nielsen CPS database. | For a particular product, the same nutritional profile was applied for the research timeline (pre and post-tax). Only goods with barcodes bought at retail food establishments were included in the Nielsen CPS. Therefore, concentrates, regular bar-coded containers of taxed beverages purchased from restaurants, and sugary drinks bought from street sellers were not captured, nor were home-prepared sugary drinks like aguas frescas. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Pell *et al*. (2021) | UK | Reduced consumption through the amount of sugar in SSBs by 10% (30g) per household | The data was collected from households that voluntarily participated in the study. Because participants had to keep track of their own food and drink purchases, self-reporting bias may have occurred. The £100 yearly gift cards that were provided to participants may have had an impact on the sample's representativeness. | The convenience sampling of stores and the exclusion of evening and weekend purchases, limited the generalisability of our findings. |
| Petimar *et al*. (2022) | Philadelphia, US | Reduced sales of SSBs by 50% | Information Resources Incorporated (IRI) statistics did not specify what percentage of Baltimore's sales volume was covered. While the analyses at the city level might be skewed by uneven coverage, the store-level analysis was likely to remain objective since it allowed for the calculation in changes in the average store regardless of the number of stores. | Sales from independent retailers and restaurants, which account for a sizeable amount of Philadelphia sales, were not included in the data. Since there is a toll to cross the border, stores in New Jersey probably accounted for a minor percentage of cross-border shopping, but they were not included in the sample. Consumption data was not included in the study. Due to simultaneous trend violations for energy drinks, sports drinks, and iced tea/lemonade, it was not possible to quantify changes at the city level for those beverage categories. |
| Phulkerd *et al*. (2020) | Thailand | Reduced consumption of SSBs by 2.5% | Self-reporting questionnaire could have resulted in reporting bias. | Results are based on self-reported data in which the accuracy of SSB intake from questionnaires, is variable and prone to participant recall bias. There was lack of information on changes in store-bought purchases and consumption habits, especially substitution behaviours. |
| Powell and Leider (2020) | Seattle, US | Reduced sales of SSBs by 22% ($p < 0.001$) | Sampling approach may have introduced bias, as it may not have represented all lines of beverage products or stores in these areas. Certain types of beverages and products were excluded from the analysis, including powdered drink | The scanner data for the full set of retailers covered by the Nielsen report were protected for confidentiality based on store name, type, and location and thus they were not able to stratify their analyses by store type or distance to the border. Further to this, the results from this study cannot be generalised to the overall impact on prices or consumption because the study does not cover prices or volume sold in |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| | | | mixes, frozen juices, fountain drink syrups, and energy shots | other venues such as restaurants, workplace cafeterias, vending machines, etc. |
| Powell and Leider (2020) | Cook County, Illinois | Reduced sales of SSBs by 25.7% | The selection of St. Louis as a comparison site may have introduced bias if there were unobserved differences between the two sites that affect the study outcomes. | The four months that the sugar tax was in effect may not have been sufficient to establish behavioural adjustments in response to recently disclosed health risks linked to SSB use. Restaurant purchases are not covered by the Nielsen report's statistics. |
| Powell and Leider (2020) | Seattle, US | Reduced sales of SSBs by 22% | The study relied on Nielsen scanner data which did not include store-brand products or covered purchases made in venues other than food stores. This excluded a portion of the population's consumption habits from the analysis. | Since the Nielsen scanner data was proprietary, store-brand products were excluded from the study's estimations of total calories sold. The reported variations in total calories sold and dollars were at the level of the Universal Product Code (UPC), not the individual level. Consequently, it was not possible to test for substitution effects among those who bought fewer taxed beverages. Since the study lacked individual-level data, it was unable to determine if replacements varied according to wealth or race/ethnicity. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Puig-Codina *et al*. (2021) | Catalonia, Spain | Reduced sales of SSBs by 4.8% -12.1% | The exclusion of non-household consumption from studies conducted in hotels, restaurants, and bars may have led to bias as it failed to consider possible differences in consumption patterns between different settings. Potential implications of brand and product form substitution among taxed entities were not considered in this study. | The results may not apply to other areas because the study solely examined how the SSB tax affected cola purchasing in Catalonia. Customers may transition from taxed to untaxed beverages, it can be troublesome to use untaxed beverages as a control in the analysis and potentially skew the results. Furthermore, even though it is legally required for retail prices to reflect 100% of the tax, the study was unable to identify the percentage of the tax that was paid by customers in the form of higher prices. Furthermore, the study did not take into consideration reformulations and labelling strategies that have been used in other European countries with the goal of lowering the amount of sugar in products and the associated tax. |
| Rogers *et al*. (2023) | UK | Reduced BMI/weight by 1.6% | It was less common for obese girls to take part in the National Child Measurement Programme (NCMP). This could lead to an undervaluation of the contribution of the Soft Drinks Industry Levy (SDIL) on the incidence of obesity among females. | Instead of quantifying socioeconomic disadvantage at the family level, the study employed an area-level indication of the school each child attended as a proxy measure. When comparing the date of SDIL deployment to counterfactuals, the study discovered that there were less notable changes in the prevalence of obesity. Estimating how long it takes to see changes in childhood obesity prevalence after the SDIL announcement was difficult since studies do not routinely track weight-related outcomes from baseline, i.e., early in the intervention. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Royo-Bordonada *et al*. (2022) | Catalonia, Spain | Reduced sales of SSBs by 16.7% | Sample households recorded their daily purchases. This could have led to self-recording bias, where participants may have altered their behaviour or only reported certain purchases, leading to inaccurate data. The requirement for households to participate in the panel for at least nine months may have introduced bias if households with shorter or longer participation durations had different consumption patterns. | The analysis could only be done on beverages whose data was separated by sugar content (that is, sugar vs. sugar-free). Consumption in locations/POS not meant for home purchases, like bars and beverage vending machines, was excluded from the study. Potential effect modifiers, such as the socioeconomic status and makeup of the households included, were not included in the data. Due to a lack of data on these variables, the potential consequences of switching to less expensive brands, larger-sized containers, or beverages with less sugar could not be determined. |
| Sanchez-Romero *et al*. (2020) | Mexico | Reduced consumption of SSBs by 10.8% | Reporting bias may result from self-reporting questionnaires, and the study lacked a control group. Although the study recognised that reporting and behaviour may be influenced by media attention to the tax, it was uncertain if this bias would persist after the tax wave. | Because there was no control group in the study, determining the tax's causal influence was difficult. The sample was made up of health professionals and their families, who are perhaps more aware of the potential health risks associated with SSBs than the typical Mexican. Social and economic variables that were not taken into consideration during the research and could have had an impact on the outcomes. The study's investigation of variations in water consumption was hindered by variations in the survey questions among the three waves. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Silver *et al*. (2017) | California, US | Reduced sales of SSBs by 9.6% | The study's findings did not consider factors that could have influenced the observed changes in prices and sales (for e.g. whether distributors, retailers, and consumers altered their behaviours in anticipation of the SSB tax). The 26-store survey sample was less representative of small and independent stores than larger grocery stores, limiting the generalisability of the findings. The use of telephone survey can cause self-reporting bias. | The study was observational and could not establish causal links between the implementation of the SSB tax and changes in measured outcomes nor did it assess health outcomes. The study could not clarify whether distributors, retailers, and consumers altered their behaviours in anticipation of the SSB tax or to what extent these changes were associated with price and sales variations. The 26-store survey sample was less representative of small and independent stores than larger grocery stores, limiting the generalisability of the findings. The study did not have a comparison community. |
| Stacey *et al*. (2021) | South Africa | Reduced sales of SSBs by 26.83ml/capita per day | Extremely poor homes, defined as Living Standards Measure (LSM) 1-3, which accounted for roughly 5–10% of South African households, were not included in the study. The process of recruiting households through online, text, and phone recruitment may have resulted in sampling bias as these techniques may be unavailable to some households. | The lowest LSM subgroup of South Africans (LSM 1-3), which made up between 5 and 10% of the total population, was not included in the statistics. Since the HPL is a national programme and lacks actual control, it is impossible to determine its causal relationship. |
| Wrottesley *et al*. (2021) | South Africa | Reduced consumption of SSBs by 54ml/per day | The use of the Quantitative Food Frequency Questionnaire (QFFQ) can cause recall bias and may not accurately capture individual nutrient consumption. | This study had high dropout rates which reduced the stratified analyses by age and gender groups.<br>There was no control group. The study was limited to a relatively short follow-up period (2 years). The use of South African Food Composition Tables, which have not been updated to reflect changes in sugar density due to the SSB tax, introduces potential inaccuracies in estimating added sugar intake. Only black participants who attended the Chris Hani Baragwanath Academic Hospital in Soweto were included in the study. This limits the studies generalisability to other populations or regions. |

| Author | Country | Results | Risk of Bias | Limitation |
|---|---|---|---|---|
| Zhong *et al*. (2020) | Philadelphia, US | Reduced sales of SSBs by 5.7% | Participants were paid $20 at follow-up. This could have led to subject bias. The use of telephone surveys could have introduced self- reporting bias. The study had a low response rate (33% retention) for the follow-up survey. | The sample size was relatively small, and due to the large variance in consumption data, this study was only able to detect large changes relative to the baseline consumption. The results are not likely generalisable to subpopulations, such as high consumers of soda and lower income residents. |
| Zhong *et al*. (2018) | Philadelphia, US | Reduced consumption of SSBs 40% lower | The survey had a very low response rate (3%). This low response rate could have introduced non-response bias, where those who did not respond may have different characteristics or behaviours from those who did respond. | Due to the short follow-up period, the impact of the tax throughout the year were not evaluated. The study was conducted in winter however the impact of the tax may differ across seasons. The survey's low response rate limited the generalisability of the findings. |

The majority of studies reported a reduction in sales volume (51.4% n=19) of SSBs; the reduction in SSB consumption was reported by 37.8% (n= 14) studies, whilst 2.7% (n= 1) studies reported both reduced sales and consumption of SSBs. Reduced BMI/weight was reported in 8.1% (n= 3) of studies. Study limitations include non-representative samples, as data was often collected in specific areas or stores, and convenience sampling was occasionally employed. The data collection also occurred at specific time points, introducing the risk of not accurately reflecting year-long consumption patterns. Methodological biases, such as convenience sampling, were evident in some studies. Additionally, self-reported data was used in certain instances. Some studies failed to determine the causal impact of taxes on health outcomes, and long-term effects were not explored.

### 4.3 Objective 2

*Review sugar-sweetened beverage sales data from a syndicated report of sugar-sweetened beverages sold in South Africa between 2015 and 2020.*

**Table 4.4:** Data extracted from Euromonitor International Report of SSBs sold in South Africa

| Category | Data Type | UNIT | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|
| **Carbonates** | Total Volume | Million litres | 4,422.9 | 4,714.9 | 4,937.2 | 5,153.1 | 5,337.8 | 5,479.0 |
| | Off trade value Retail Selling Price (RSP) | ZAR million | 33,930.6 | 36,883.8 | 40,317.8 | 44,204.3 | 47,071.2 | 49,176.5 |
| **Energy Drinks** | Total Volume | Million litres | 141.9 | 157.2 | 170.2 | 182.6 | 196.9 | 206.7 |
| | Off trade value RSP | ZAR million | 6,454.1 | 6,61.3 | 6,808.0 | 7,012.7 | 7,238.0 | 7,482.3 |
| **Sports Drinks** | Total Volume | Million litres | 68.4 | 72.7 | 77.0 | 80.0 | 82.0 | 83.2 |
| | Off trade value RSP | ZAR million | 1,402.2 | 1,556.1 | 1,784,6 | 1,912.6 | 2,031.9 | 2,132.7 |

RSP= Retail Selling Price

Table 4.4 is a presentation of data that was extracted directly from an original syndicated report from the Euromonitor site (Euromonitor International 2021). The results presented are for South Africa between the period of 2015-2020. The data extraction were for carbonates, energy drinks and sports drinks categories as these represent the key products impacted by the sugar tax in South Africa. The trend noted across all of the SSB ranges is a downward curve between years in which the sales continue to grow after HPL implementation but at a slower rate as compared to the previous years.

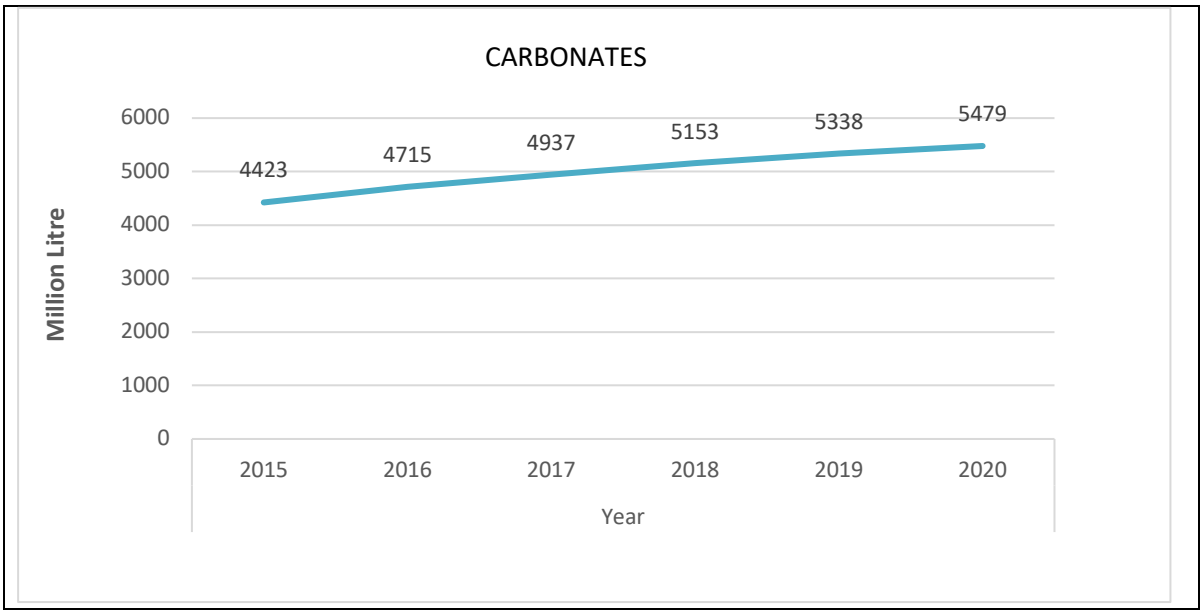



**Figure 4.2:** Sales of carbonates by volume in million litres (Euromonitor International 2021)

Figure 4.2 indicates the year-on-year growth in sales; this growth was in the range of 200-300 million litres between 2015-2017. Sales continued to grow in 2018. However, this was at a slower rate than what was recorded for the period 2015-2017; 2018 was the introductory year of the HPL by the South African Government (Wrottesley *et al*. 2021: 268). Between the year 2018-2020, the growth in the sales range was 140-250 million litres; this was, on average, 50-60 million litres less than the previous three years.

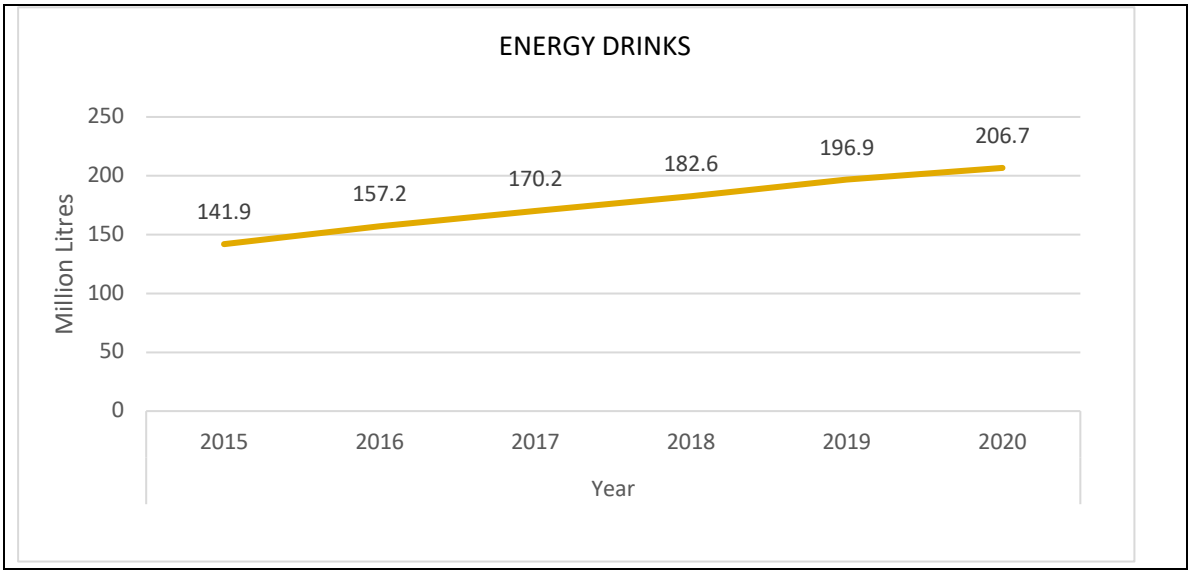



**Figure 4.3:** Sales of energy drinks by volume in million litres (Euromonitor International 2021)

The graph above indicates the year-on-year growth in sales, which was projected at 13-15 million litres between 2015-2017. Sales continued to grow, but at a slower rate from the year 2018, which between the year 2018-2020, the growth in sales ranged between 9-13 million litres; this was, on average 2-4

million litre difference as compared to the previous three years. Sales of sports drinks followed the same trend of 4-5 million litres between 2015-2017, a slowdown after 2018 to 1-3 million litres between 2018-2022.

### 4.4 Objective 3

*Investigate sugar consumption and purchasing patterns of table sugar in households among adults living in the Southgate Phoenix area using a household sugar consumption survey*

#### 4.4.1 Household sugar and sugar-sweetened beverages consumption survey

##### 4.4.1.1 Demographics

**Table 4.5:** Demographic information of participants for household sugar and SSBs consumption survey

| Category | Description | % (n) |
|---|---|---|
| **Gender** | Male | 32.3 (192) |
| | Female | 66.2 (264) |
| | Prefer not to say | 1.5 (6) |
| **Age** | 18-25 | 17.0 (68) |
| | 26-35 | 36.1 (144) |
| | 36-45 | 27.1 (108) |
| | 46-55 | 14.3 (57) |
| | 56+ | 5.5 (22) |
| **Employment status** | Employed | 71.4 (285) |
| | Unemployed | 13.0 (52) |
| | Self-employed | 8.8 (35) |
| | Student | 6.8 (27) |

The data was collected using a questionnaire administered to n= 399 participants. For gender, the majority of participants (66.2% n= 264) were female, followed by male participants (32.3% n= 192). With 36.1% (n= 144) participants, the 26-35 year age group had a substantial number of participants, followed by 36-45 years with 27.1% (n= 108), 18-25 years with 17% (n= 68), 46-55 years with 14.3% (n= 57). The age group with the least number of participants was 56+, with 5.5% (n= 22). With regards to employment status, 71.4% (n= 285) of the participants were employed, 13% (n= 52) were unemployed, 8.8% (n= 35) were self-employed, and 6.8% (n= 27) were students.

##### 4.4.1.2. Household Sugar Purchases

**Table 4.6:** Frequency of purchasing table sugar for households

| Item | Responses as frequency (%) | | | $X^2$ | Df | p-value |
|---|---|---|---|---|---|---|
| | Weekly | Monthly | Yearly | | | |
| **How often do you purchase sugar for the household?** | 14 (3.5) | 367 (92.0) | 18 (4.5) | 617.609 | 2 | <.001* |

A significant 92.0% (n= 367) of households purchased sugar on a monthly basis; households that purchased sugar weekly and yearly were 3.5% (n= 14) and 4.5% (n= 18), respectively.

**Table 4.7:** Type of table sugar purchased by households

| Item | Responses as frequency (%) n | | $X^2$ | df | p-value |
|---|---|---|---|---|---|
| | White | Brown | | | |
| **Which sugar type do you purchase regularly?** | 44.9 (179) | 55.1 (220) | 4.213 | 1 | p=.017 |

A significant 55.1% (n= 220) of households purchased brown sugar, p<0.001 whilst 44.9% (n=179) purchased white sugar, respectively.

**Table 4.8:** Package size of sugar purchased by households

| Packaging sizes | Participants (n) | Percent (%) |
|---|---|---|
| **500g** | 3 | 0.8 |
| **1kg** | 30 | 7.5 |
| **2kg** | 102 | 25.6 |
| **3kg** | 57 | 14.3 |
| **5kg** | 105 | 26.3 |
| **10kg** | 102 | 25.6 |

A significant number of households, (65.5% n= 102) purchased sugar in 2kg packs, p<0.001, 65.5% (n= 105) purchased sugar in 5kg packs and 65.5% (n= 102) purchased sugar in 10kg packs. With regards to income and purchasing frequency, there was a significant correlation between income and purchasing frequency and the size of sugar packaging purchased by participants. Those with higher income purchased sugar less frequently (rho= .187, p<0.001) and in smaller packaging (rho= -.145, p= .006).

#### 4.4.1.3. Household sugar consumption

**Table 4.9:** Uses of sugar in households

| Item | Frequency (%) | | N | p-value |
|---|---|---|---|---|
| | Yes | No | | |
| **Baking** | 144 (36) | 255 (64) | 399 | <.001* |
| **Teas and coffee** | 382 (96) | 17 (4) | 399 | <.001* |
| **Add to cereal** | 230 (58) | 169 (42) | 399 | .003* |
| **Cooking** | 26 (7) | 373 (93) | 399 | <.001* |

Table 4.9 indicates that a significant 96% (n= 382) of participants used sugar in tea and coffee, p<0.001; while a significant 58% (n= 230) added it to cereal. A significant number of participants indicated that they did not use sugar in baking and cooking, p<0.001.

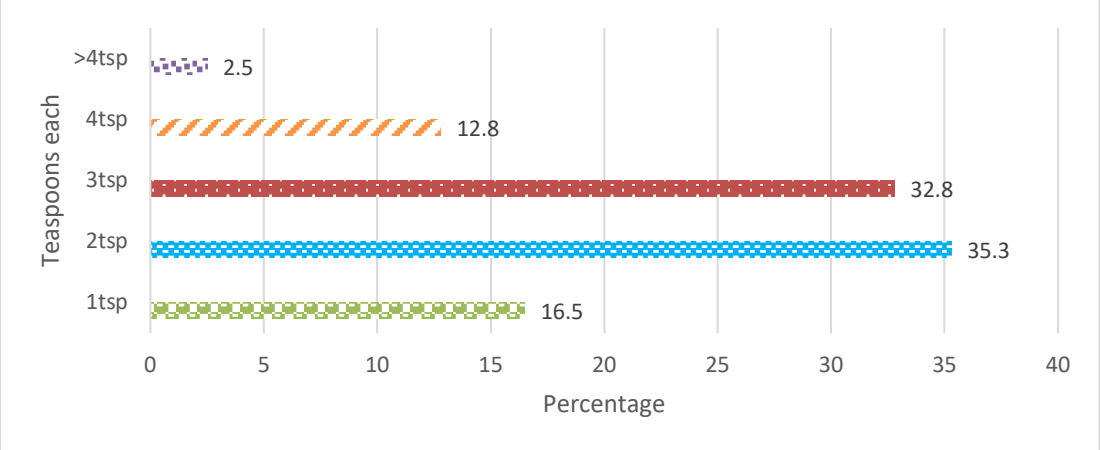



**Figure 4.4:** Teaspoons of sugar used in teas and coffee

A significant 68.1% of the participants reported having used either 1 or 2 teaspoons of sugar in their tea/coffee, $\chi^2$ (4) = 153.619, p<0.001. However, 32.9% (n= 131), 16.5% (n= 51) and 2.5% (n= 10) of participants consumed 3 teaspoons, 4 teaspoons and more than 4 teaspoons in their tea and coffee, respectively. Further analysis conducted using the Mann-Whitney test showed that males added significantly more sugar in their tea/coffee than females, Z= -2.779, p= .005. The amount of sugar added to tea/coffee was negatively correlated with age, rho= -.186, p<.001. Results also indicated that the consumption of tea or coffee with sugar was positively correlated with age (rho=.175, p<.001), with older people consuming more servings of sugar-sweetened tea/coffee.

### 4.5 Objective 4

*Determine SSB consumption and purchasing patterns of SSBs among adults living in the Southgate Phoenix area using a survey*

#### 4.5.1 SSB Consumed by participants

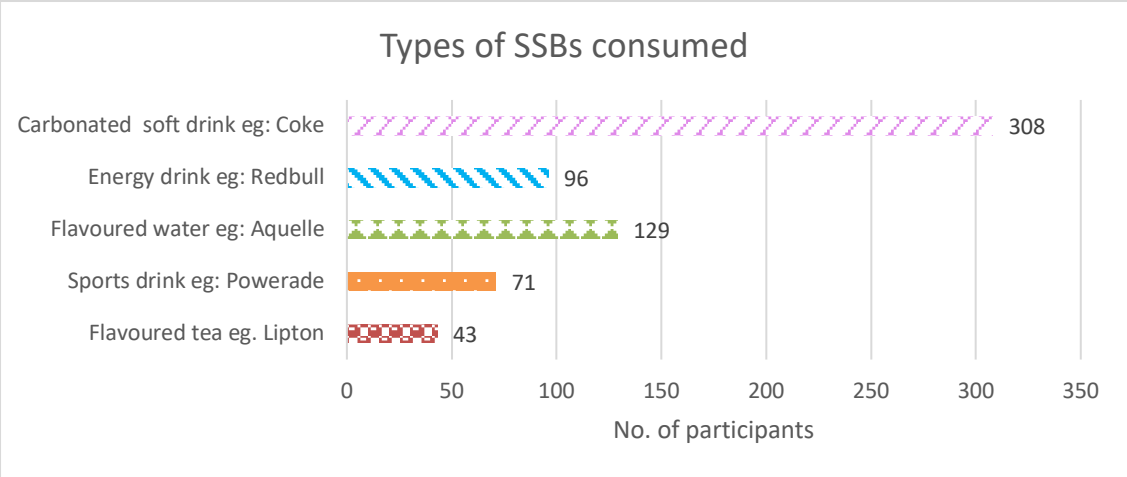



Figure 4.5: Type of SSB consumed For this question, participants could select more than one response. A substantial 77% (n= 308) of participants indicated that they frequently consumed carbonated soft drinks. Flavoured water was the second most consumed category, with 32% (n= 129) followed by energy drinks at 24% (n= 96). Consumption of sports drinks was 18% (n= 71), with flavoured tea the least consumed at 11% (n= 43). Results from the Pearson's chi-square analysis indicated that significantly more females consumed flavoured teas than males, $\chi^2$ (1) = 5.568, p=.018. Furthermore, the Pearson's chi-square analysis indicated that significantly more females consumed sweetened flavoured waters than males, $\chi^2$ (1) = 12.983, p<0.001. Results from the Pearson's chi-square test indicated that a significant proportion of those with a monthly income of R1000-R5000 did not consume sweetened flavoured waters, while a significant proportion of those who earn >R20000, consumed sweetened flavoured waters, $\chi^2$ (5) = 12.479, p=.029. A significant 76% (n= 305) of participants reported consuming SSBs at home, p<0.001. The proportion of SSBs purchased was positively correlated with age (rho=.150, p=.003), with older people being associated with buying larger bottle sizes of SSBs.

**Table 4.10:** Motivators for purchasing SSB

| Motivation for purchasing decision of SSBs | Category | N=399 | Percentage (%) | Asymp. Sig. (2-tailed) |
|---|---|---|---|---|
| **Brand loyalty** | Yes | 181 | 45 | .071[a] |
| | No | 218 | 55 | |
| **Price** | No | 251 | 63 | .000[a] |
| | Yes | 148 | 37 | |
| **Taste** | No | 135 | 34 | .000[a] |
| | Yes | 264 | 66 | |
| **Packaging size** | No | 365 | 91 | .000[a] |
| | Yes | 34 | 9 | |
| **Flavour** | No | 208 | 52 | .423[a] |
| | Yes | 191 | 48 | |

Table 4.10 illustrates the motivating reason as to why the participants would purchase a SSB at any time. Participants were prompted to reply with a yes or no answer. Forty-five percent (n= 181) of participants indicated that their purchase decision was influenced by brand loyalty, whilst 55% (n= 218) indicated no to that question. Sixty-six percent (n= 264) of participants indicated that taste was a motivating reason for their purchasing decision. A substantial number of participants indicated that their purchasing decision was influenced by flavour (48% n= 191) and price (37% n= 148).

### 4.5.2 Awareness of the health promotion levy implementation (HPL)

**Table 4.11:** Awareness of the HPL

| | Category | n=399 | Percentage% | Test Prop. | Asymp. Sig. (2-tailed) |
|---|---|---|---|---|---|
| **Are you aware of the Health Promotion Levy (HPL)/ Sugar tax implemented by the government in 2018?** | No | 238 | 60 | .50 | .000[a] |
| | Yes | 161 | 40 | | |

Results from the Pearson's chi-square test showed that a significant proportion of 18-25-year-olds were not aware of the sugar tax, while a significant proportion of 26-35-year-olds were aware of this tax, $\chi^2$ (4) = 13.924, p= .008. In addition, a significant proportion of those with a monthly income of either <R1000 or R6000-R10000 were not aware of the tax, while a significant proportion of those who earn >R20000 was aware of it, $\chi^2$ (5) = 12.755, p= .026.

### 4.6 Objective 5

*To determine SSB sweetness preference through sensory evaluation among adults living in the Southgate, Phoenix area.*

A total of 98 responses were collected for the sensory aspect of the study. Female participants accounted for 63.3% (n= 62) and males for 36.7% (n= 36). Southgate is a suburb made up of predominately Black and Indian residents (Statistics SA 2011); a significant 77.6% (n= 76) of the participants were Black, with Indians accounting for 17.3% (n= 17).

#### 4.6.1. Sensory evaluation

##### 4.6.1.1 Sweetness preference sample tasting

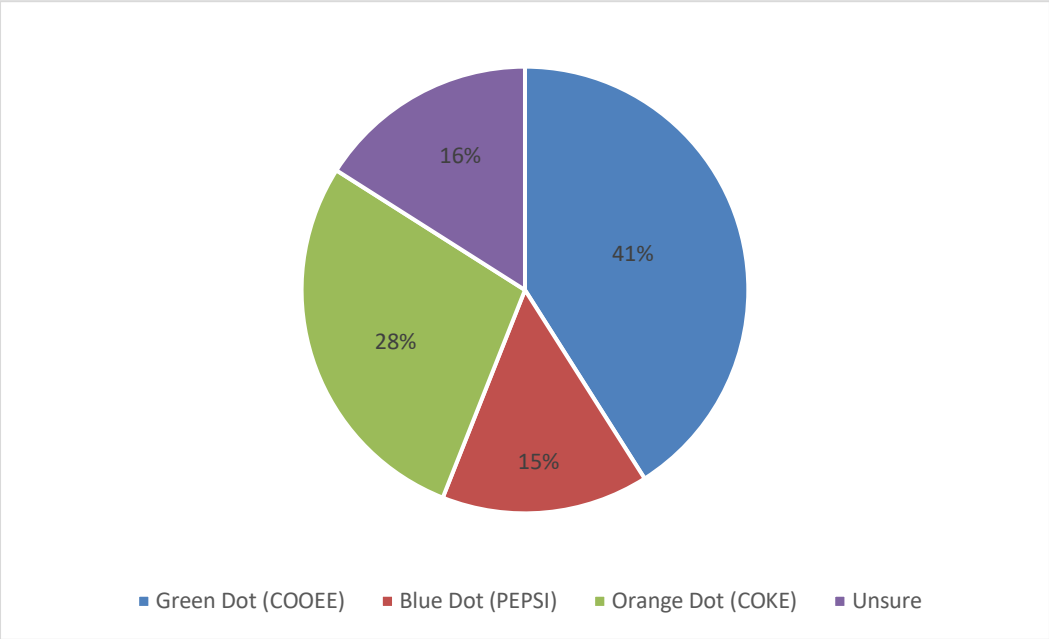



**Figure 4.6:** Market sample: preferred sample

Figure 4.6 illustrates the results for sweetness detection. A total of 41% (n= 40) participants felt that Coo-ee was the sweetest SSB followed by Coke at 28% (n= 27), $\chi^2$ (3) = 19.653, p<.001.

**Table 4.12:** Market samples of SSBs comparison of sugar content and non-nutritive sweetener used

| Cola | Brand | Sugar content per 100ml | Non-nutritive sweeteners used |
|---|---|---|---|
| | Coke-Original | 10.6g | None declared |
| | Pepsi-Original | 7g | Sucralose (E995) and Acesulfame potassium (E950) |
| | ZIP | 6g | None declared |
| | Coo-ee | 4g | Sodium cyclamate (E952), Acesulfame potassium (E950) and Saccharin (E954) |
| | Pick n Pay | 4g | Sodium cyclamate (E952) and sucralose (E955) |

The above table is a representation of data that is displayed on packaging labels of respective brands of market cola samples available in the market and used in the sweetness preference sampling test. In response to the sugar tax, companies have reformulated and decreased sugar content, increasing the use of NNSs as observed in the range of products in the table above. Common NNSs used in the products were sucralose, Acesulfame K, sucralose and sodium cyclamate.

The samples are those that are reformulated as reduced sugar samples available for sale to the South African market. The last column states the declared non-nutritive or artificial sugars used in the reformulations.

### 4.7 Objective 6

*Establish sugar threshold levels among a random sample of adults living in the Southgate Phoenix area using sensory evaluation*

#### 4.7.1 Threshold detection test: sugar solution tasting

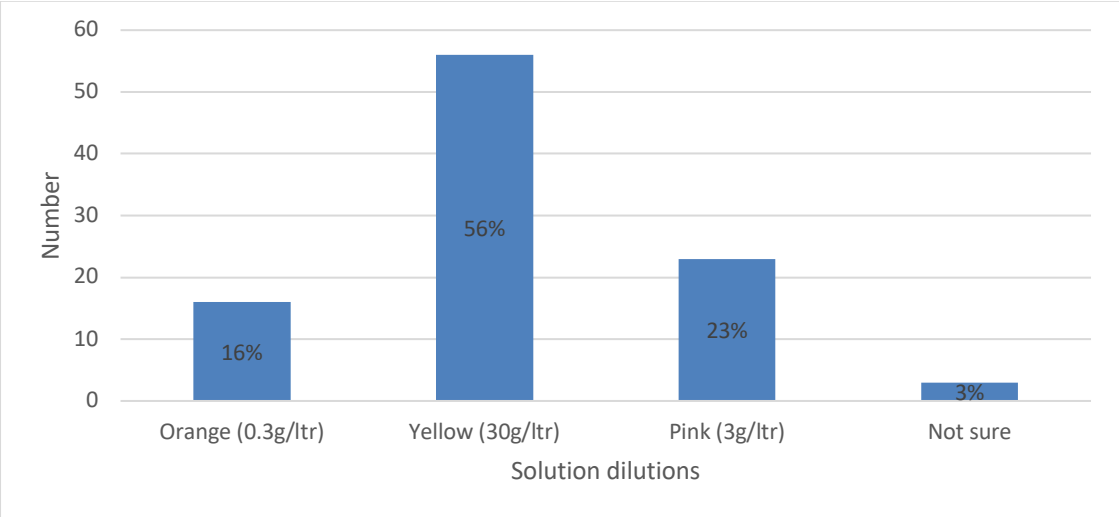



**Figure 4.7**: Threshold detection test: sugar solution samples

A significant 57.1% (n= 56) of participants preferred the yellow-dot-30g/1ltr sugar sample (p<.001); the reason given by a significant percentage of 62.2% (n= 61) for their selection was sweetness preference (p<0.001). A significant 48.4% (n= 16) preferred the orange-dot-0.3g/ltr sample the least (p= .001). There was a significant relationship between gender and the sugar solution sample most preferred, $\chi^2$ (2) = 8.115, p=.017. A significant proportion of females preferred the pink dot-3g/1ltr sample most.

### 4.8 Discussion

#### 4.8.1 Overview of the findings of the scoping review

A number of countries have made commitments over the last few decades to use economic policies to improve diet and promote overall healthy lifestyles (WHO 2022: 11). Statistics from the WHO Global database on the Implementation of Nutrition Action (GINA), as of May 2022, reported that more than 85 countries at national or subnational levels had implemented SSB-related taxes (WHO 2022: 9). Although these levies are unlikely to have a significant long-term influence on obesity rates in the population, their significance in promoting healthier diets by reducing consumption and lowering diet-related illness should not be underestimated (Backholer, Blake and Vandevijvere 2017: 3223).

The introduction of the SSB tax at the policy level is viewed as a strategic tactic since economic theory indicates that when SSB costs rise, there will be a decrease in SSB demand and consumption (Cawley *et al*. 2019: 3). However, the effectiveness of the SSB tax depends on a number of factors, such as the design of the tax (type of tax), the implementation, public awareness and response and the industry's response. In the scoping review of our study, the majority of countries, 64.9% (n= 24), implemented a volume-based tax, whilst 18.9% (n= 7) implemented a sugar content-based tax, and 16.2% (n= 6) implemented a value-based tax. Sugar content criteria for different tax amounts per unit of volume should be implemented at relevant distances below the major cluster ranges in order to discourage the use of high-sugar beverages and encourage industry reformulation (Lee *et al.* 2020: 129). While the adoption of a volume-based flat tax is straightforward, it does not encourage consumers to switch to beverages with lower sugar content per serving or the beverage sector to reformulate its products (Powell, Andreyeva and Isgor 2020: 126). Value-based taxes, which can amount to 10% of the price charged by the producer, taxing drinks according to their value may result in a higher price gradient among other products, SSB taxes may stimulate brand down switching where the consumer strategy of switching to less expensive brands is adopted (Alvarado *et al.* 2019: 3). Studies included in the scoping review have reported on three major changes, i.e., reduction in sales, reduction in consumption of SSB and reduction in weight or body mass index (BMI). Studies that reported sales volume decline were 51.4% (n= 19) of SSBs, the reduction in SSB consumption were reported by 37.8% (n= 14) studies, whilst 2.7% (n= 1) study reported both reduced sales and reduced consumption of SSBs. Reduced BMI/weight was reported in 8.1% (n= 3) of studies. Study limitations included the following: non-representative samples since convenience sampling were occasionally used and data was frequently gathered in particular locations or stores. Additionally, because the data was collected at specified times, there is a chance that it may not correctly reflect trends of use throughout the year. Certain studies clearly displayed methodological biases, such as convenience sampling. In several cases, self-reported data was also used. Long-term consequences were not

investigated, and several research were unable to establish the causal relationship between taxes and health outcomes.

### 4.8.2 Sales of SSBs: Euromonitor data

A private market research firm called Euromonitor releases yearly data on items, markets, and products sold in South Africa including but not limited to SSBs (van Schalkwyk *et al.* 2020: 2). Although price and packaging data from Euromonitor are meant for commercial use, public health research also uses this data (van Schalkwyk *et al.* 2020: 5). Examining sales data from the syndicated report provided insights into the dynamics of the SSB market, including trends in consumer preferences and shifts in product categories Sales of SSBs in all categories declined after the implementation of the HPL (Wrottesley *et al.* 2021: 2908). Sales of carbonates increased significantly between 2015 and 2017, rising by 200–300 million litres on an annual basis. Sales of carbonated soft drinks worldwide rose to 196 billion litres annually in 2013, accounting for 12% of all drinks sold worldwide (Renfrew 2016: 17), whilst over 5.6 billion litres of energy drinks were sold worldwide in 2013, with a market worth estimated at US$40 billion, this marked a double-digit increase in both volume and value field (Renfrew 2016: 19). The HPL, which was implemented by the South African government in 2018, coincided with a slowdown in the growth rate of carbonate sales in 2018. Sales of carbonates continued to increase by 140–250 million litres between 2018 and 2020, which is an average decline of 50–60 million litres when compared to the growth seen in the preceding three years. With variations in the growth rates of SSB sales, this data points to a possible impact of the sugar tax, especially in 2018, and offers insights into the market dynamics impacted by the regulatory intervention. Other studies conducted in countries such as Mexico showed similar sales purchase data post-implementation of the SSB levies (Dams 2017: 85). Customers have been encouraged by SSB levies to buy more bottled water and other healthier, non-taxable beverages (Teng *et al.* 2019: 407).

The tax percentage has proven to yield different results, studies have suggested that a 10% tax on SSBs will cause a daily mean decrease in energy intake of 2.1 kcal/person, meaning a reduction in 5 kcal/week, 770 kcal/year (Briggs *et al*. 2013: 4). In a study conducted in Ireland, a 10% SSB tax is predicted to cut the number of obese adults by 10,000 and the number of overweight or obese people by 14,000 (Briggs *et al*. 2013: 8). A 20% tax was expected to result in a daily energy intake reduction of roughly 36kJ (Manyema *et al*. 2014: 5). The estimated decrease in obesity was 2.4% for women and 3.8% for males (Manyema *et al*. 2014: 5). In SA, the sugar tax is applicable if the SSB contains more than 4g/100ml sugar (Stacey *et al.* 2019: 2); thus, to avoid being taxed, manufacturers have opted to reformulate their products, failing which, they would need to pass the tax to the consumer (Gonçalves and Dos Santos 2020: 2). Should the latter option remain in place, it carries a cost implication for the consumer, who will pay more for these products.

### 4.8.3. Household sugar and sugar-sweetened beverage consumption

The survey had a majority of female participants; this echoes other studies that have reported that women are more likely to participate in research studies than men (Stockard, Van De Kragt and Dodge 1988: 158). Similar to a study conducted by Moore and Tarnai (2002: 133), which reported that younger people were more likely to participate in surveys than older people, this study also attracted younger participants (Moore and Tarnai

2002: 133). In this study, a large number of participants were purchasing sugar monthly, with a majority purchasing brown granulated sugar, followed closely by white granulated sugar. Brown granulated sugar is made by centrifuging cane sugar, which separates the molasses throughout the manufacturing process. Brown granulated sugar has light-yellow colouration from the presence of small amounts of molasses; otherwise, the crystal particles are comparable to those of white granulated sugar (Chen *et al.* 2021: 1). In their study, Chen *et al*. (2021:2) found that brown granulated sugar was preferred for its intense sweetness and attractive colour (Chen *et al.* 2021: 2). A possible reason for the change over from white to brown sugar in this community is potentially due the beliefs regarding sugar, such as the notions that brown sugar is more natural and healthier than white sugar (Patterson, Sadler and Cooper 2012: 123).

Participants with higher income were found to purchase sugar less frequently. In another study conducted by Vermeulenin, it was reported that affluent consumers attributed only 32% of their total expenditure to granulated sugar, whilst marginalised consumers attributed 87% (Vermeulen 2020: 46). In a study conducted in the US Golan *et al.* (2008: 27) found that low-income households tend to consume less nutritious and energy-dense foods (Golan *et al.* 2008: 27); data from our study reflected the same outcome. An Australian study found that people with low income are less likely to buy foods that are high in fibre and low in salt, sugar, and fat (Turrell and Kavanagh 2006: 381).

The use of sugar in teas and coffee was reported as significant in this study. Tea is the most consumed beverage in the world (Ronquest-Ross, Vink and Sigge 2015: 5). It is important to note that SA was previously colonised by the British Empire, which came with the teatime snacks concept (Stafford 2000: 7). Tea from India and coffee from East Africa were the mainstays of the colonial trade, and these beverages were the focus of the tea break or coffee break (Stafford 2000: 7). Younger participants in this study were found to use more sugar. In a study conducted in 2012 on chemosensory traits in human twins, researchers found that younger participants liked the taste of sucrose (sugar), more than the older participants (Knaapila *et al.* 2012: 874). This is supported by a study conducted in the US between 2011-2016. However, older participants in this study were found to consume more servings of tea; in a study by Vieux *et al*. (2019: 5), results showed that tea consumption was higher among the older adults group as when people aged, they drank more coffee and tea, including herbal teas (Vieux *et al.* 2019: 5).

The most consumed SSB drink was carbonated soft drinks. In a study conducted in Nigeria, it was reported that fruit juice, soft drinks, cocoa-sweetened beverages, and malt drinks were the most popular SSBs consumed (Adeoye 2023: 4). This correlates with another study that investigated the SSB consumption behaviours of university students in Australia, where it was reported on SSB consumption of females; it was highlighted that females had a preference for fruit-based drinks (O'Leary *et al.* 2012: 121). Females tend to make more health-conscious decisions as compared to their male counterparts as they place a higher onus on the purchase of healthier food and drink options (Dhuria *et al.* 2021: 6). Renfrew (2016: 334) found that flavoured water was perceived as a healthier alternative to the high-energy SSBs (Renfrew 2016: 334). Another study conducted in Australia in 2007 reported that higher-income households purchased a higher volume of SSBs; this consumption increased by 49%-53% between the period 2004-2006 (Levy and Tapsell 2007: 275). Furthermore, Levy and Tapsell (2007: 268), reported that the majority of consumers of SSBs were younger

persons from higher-income households. Young men were also the main purchasers of sports and energy drinks (Levy and Tapsell 2007: 268). Sugar-sweetened beverage consumption was associated with meal times (McNaughton *et al.* 2020: 3); in a study conducted in Australia, it was reported that screen-based activities were the most often reported activity while consuming SSBs, and the home was the most common place for consumption, followed by work or university (McNaughton *et al.* 2020: 3).

#### 4.8.4. Preference for sugar through sensory test

According to the back of the pack nutritional information label, Coo-ee samples are lower in grams of sugar per 100ml, i.e., 4g/100ml, as compared to Coke, which is 10.6g/100ml without any sweetener used as none were declared on the back label. However, in this study, for the paired preference test, Coo-ee was noted as being sweeter, mainly because of the contents of NNSs. Coo-ee, in their formulation, has declared the use of the following combination of artificial sweeteners: Sodium cyclamate (E952), Acesulfame-potassium (E950), and Saccharin (E954). Acesulfame-potassium, aspartame, saccharin, and sucralose are examples of low-calorie sweeteners (LCSs) used by beverage manufacturers in reformulations to offer a sweet flavour and are good substitutes for calorie-containing sugar (Sylvetsky, Blau and Rother 2016: 446).

Another type of analytical sensory test that serves the purpose of identifying thresholds is the threshold detection test (TDT), the sensitivity of the highest and lowest concentration at which a sensory reaction may be identified as a threshold (Drake 2007: 4927). Other types of thresholds include the previously mentioned absolute threshold, the lowest concentration at which a compound can be recognised, the concentration at which differences in stimuli can be detected, and the terminal threshold, which is the concentration above which an increase in sensory stimulus is not perceived (Drake 2007: 4927). The threshold detection taste session revealed that the majority of participants preferred the yellow dot (30g/1ltr), which was the sample with the higher sugar added also mentioning that it was the sweetest. It is now evident that South Africans have a sweet palate, and if they could choose, they are most inclined to prefer sweeter-tasting drinks (Reed and McDaniel 2006: 1). When it comes to flavour attributes, sweetness is the most favoured by all (Reed and McDaniel 2006: 1). Human history has been shaped by the insatiable desire for sweet foods and beverages, especially refined sugar, and the recent and dramatic increase in sugar intake may have been unexpected (Reed and McDaniel 2006: 1).

#### 4.8.5. Industry response

The use of NNSs in the production of food and beverage products has gained popularity in the food and beverage industry because NNSs facilitate the quest for lower sugar, calorie, and cost of goods while maintaining the intended product quality and taste (Naicker, Naicker and Singh 2023: 28). Industry has reformulated SSBs to avoid the penalty and remain within the stipulated guidelines, however the question of whether NNS are good or bad for human health is contentious and has been discussed extensively in recent years (Fowler *et al.* 2008: 1894). Research has found that exposure to NNS can lead to increased appetite, hunger and high food consumption (Fowler *et al.* 2008: 1898). Fowler *et al*. (2008:1899) found a well-established, positive, dose-response correlation between long-term weight increase and beverage consumption. However, this correlation does not prove causation on its own (Fowler *et al.* 2008: 1899).

Manufacturers are required to narrate when products are formulated with sweeteners according to Codex regulation 4.2.3.3 Codex Regulation, which governs the use of sweeteners (Naicker, Naicker and Singh 2023: 26). However, the amount of sweetener the product contains is not required to be declared by the producer, making it challenging to estimate the average amount of NNSs being consumed by any person on a daily basis (Naicker, Naicker and Singh 2023: 26). There are a lot of contradictory claims made regarding the benefits and drawbacks of NNS usage and human health (Naicker, Naicker and Singh 2023: 34). There are advantages and disadvantages to sweeteners, and many discussions over the safety of NNSs; according to meta-analyses of prospective cohort studies, there is a 32% increased risk of cardiovascular disease (CVDs), including stroke (19% increase) and its precursor hypertension with a 13% increase (WHO 2023: 10).

#### 4.8.6. Health promotion levy (HPL) awareness

In this study, we found that a large number of participants aged 26 to 35 years were aware of the sugar tax, and a notable portion of those aged 18 to 25 were unaware of it. Furthermore, a considerable segment of the population earning less than R1000 or between R6000 and R10000 per month did not know about the tax, although a substantial segment of the population earning more than R20,000 was aware of it. In another study conducted in Pietermaritzburg, South Africa, researchers found that of those surveyed, 58.1% (n= 229) had knowledge of the HPL, compared to 38.8% (n= 153) who had no knowledge and 3.0% (n= 12) who did not respond (Baijnath and Pillay 2020: 120). Even after implementation, the HPL was not well known, which suggests that non-government organisation (NGO) representation and advocacy was insufficient (Kruger, Goldstein and Hofman 2023: 55). The degree of industry vested interests in the HPL issue makes genuine public engagement even more crucial in order to counteract process distortion (Kruger, Goldstein and Hofman 2023: 55). The general public's lack of understanding affects a number of fairness criteria, including the impact and purpose of the public involvement procedure, the inclusivity of the procedures, and the equality and consistency of individuals (Kruger, Goldstein and Hofman 2023: 55). Variations in opinions regarding the HPL indicate the need for greater HPL awareness (Baijnath and Pillay 2020: 122). The purpose of awareness efforts should be to educate South Africans about the HPL, its calculation, which drinks are subject to taxes, and how the money collected from them is spent (Baijnath and Pillay 2020: 123). Studies that have been published on South Africans' awareness of the HPL and their reactions to it are limited (Baijnath and Pillay 2020: 123).

### 4.9. Conclusion

Chapter 4 presented the results of the study, which were analysed and discussed according to the objectives of the study. Many countries, including South Africa, have implemented the SSB tax as a public health intervention strategy to reduce the prevalence of overweight and obesity. Although the SSB tax is relatively new, reports indicate benefits such as decreased sales, reduced consumption, and, to a certain extent, lower BMI. However, further long-term studies are necessary to comprehensively assess the efficacy of this public health intervention. The introduction of the SSB tax prompted the SSB manufacturing industry to adapt to new regulations in various countries, leading to the exploration of alternative solutions. Consequently, there has been an increase in the reformulation of SSBs with NNSs. This trend has raised concerns in light of emerging evidence questioning the safety and benefits of NNSs, as indicated by public health organisations. Despite the primary goal of the SSB tax being the reduction of overweight and obesity, household sugar consumption remains high in South Africa. It is evident that South Africans have a sweet palate and a persistent preference

for sweet foods and beverages. The proliferation of processed foods in the South African market attests to savvy manufacturer awareness and exploitation of this supply-demand trend; thus, regulating and monitoring is imperative. In Chapter 5, the conclusion and recommendations of this study will be presented.

## CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

### 5.1 Introduction

This chapter draws conclusions from the main findings of the study and makes recommendations. The strengths, limitations and recommendations are also discussed to assist and provide guidance for future studies within this field. The purpose of the study was to determine the current sugar-sweetened beverage (SSB) and household sugar consumption patterns among adults in the Southgate Phoenix area.

### 5.2 Summary of the findings

This study aimed to research six objectives:

***Objective 1:*** *To conduct a scoping review on the implementation of the sugar tax by various countries and the effectiveness thereof.*

The review comprised of 38 studies conducted in 17 countries. Most of the studies were conducted in several states in the United States of America (US), followed by Mexico and South Africa. A variety of study designs were employed, observational studies being the most common, followed by cross-sectional and longitudinal studies. Data collection methods included mainly consumer surveys and point-of-sale records and, to a lesser extent, syndicated reports. Most countries implemented a volume-based tax, while fewer countries implemented a sugar content-based and value-based tax. Post-intervention implementation, fifty percent of the studies reviewed reported a reduction in the sales volume of SSBs. In contrast, 39.5% of studies reported a decrease in SSB consumption, three studies reported a reduction in body mass index (BMI), and only one study reported both reduced sales and reduced consumption of SSB. In summary, the scoping review on the implementation and effectiveness of sugar taxes was important for understanding the impact and variation in the effectiveness of reducing consumption of SSB and improving health outcomes across different countries. Assessing the impact of SSB taxes requires robust data on pre-post consumption patterns, health outcomes, and economic indicators, which, given the recent introduction of the SSB tax across different countries, means that more time is required to measure the effectiveness of the tax. Additionally, long-term data trends are required to assess the impact of SSB taxes, as short-term data may not capture sustained changes in consumer behaviour or health outcomes.

***Objective 2****: To review sugar-sweetened beverage sales data from a syndicated report of sugar-sweetened beverages sold in South Africa between 2015 and 2020.*

Objective two of the study aimed to assess SSB sales data from a syndicated report in South Africa between 2015 and 2020, with a focus on carbonates, energy and sports drinks, the key products impacted by the sugar tax. The year-on-year growth in sales for carbonates showed a substantial increase of 200-300 million litres between 2015 and 2017. Although sales of carbonates continued to grow in 2018, the rate of growth slowed, coinciding with the South African Government's introduction of the Health Promotion Levy (HPL). The growth in sales of carbonates between 2018 and 2020 ranged from 140-250 million litres, indicating a decrease of 50-60 million litres on average compared to the growth observed in the previous three years. This data suggests a potential impact of the sugar tax, particularly in 2018, with changes in the growth rates of SSB sales, providing insights into the market dynamics influenced by the regulatory intervention. The year-on-year growth figures and trends in sales for carbonates, energy, and sports drinks provided valuable information about how

consumer preferences and industry dynamics evolved between 2015 and 2020. The SSB tax was embedded within this period of. Examining sales data from the syndicated report provided insights into the dynamics of the SSB market pre and post implementation of the HPL, including trends in consumer preferences and shifts in product categories.

***Objective 3****: To determine the sugar-sweetened beverage consumption and purchasing patterns among adults living in the Southgate Phoenix area using a survey.*

A substantial proportion of participants reported that they regularly purchased and consumed carbonated soft drinks. Other popular categories were flavoured water, followed by energy drinks and sports drinks; the least popular category was flavoured tea. The findings showed that women were much more likely than men to consume flavoured teas and water. The findings additionally demonstrated that a noteworthy segment of the population with a higher income consumed flavoured water and that the consumption of SSBs was primarily at home, followed by 53.9% of participants who consumed these at work or school and 49.6% consuming these at restaurants and takeaways. Age and income were influential factors in determining awareness of the sugar tax, with older individuals and those with higher incomes being more informed about the tax.

***Objective 4:*** *To investigate the sugar consumption and purchasing patterns of table sugar in households among adults living in the Southgate Phoenix area using a household sugar consumption survey.*

The findings of this study showed that participants mainly purchased sugar on a monthly basis with a growing preference for brown sugar over white sugar in both purchase and consumption patterns. It was also observed that participants with higher income tended to purchase sugar less frequently and in smaller packaging. A substantial percentage of participants in this study added sugar to teas and coffee. While a noteworthy proportion of participants added between two teaspoons to three teaspoons of sugar to their coffee or tea, some participants consumed as much as three to four teaspoons of sugar per cup. Males added much more sugar to their tea/coffee than females, and older adults drank more servings of tea or coffee with added sugar.

***Objective 5****: To establish sugar threshold levels among a random sample of adults living in the Southgate Phoenix area through a threshold detection test (TDT).*

In this study, the TDT showed that participant preferences were inclined towards sweeter samples with a substantial 57.1% of participants selecting the yellow-dot-30g/1ltr sugar sample. There was a significant correlation between gender and the most preferred sugar solution sample. Most of the female participants showed a substantial preference for the 3g/1ltr sample which was the second sweetest dilution. The threshold sensitivity of different concentrations of sugar was lower among men than women. The TDT of sugar solutions, showed through participants' threshold sensitivity and intensity perception, that participants preferred foods with a higher sugar content. This highlights the normed exposure to processed foods with a high sugar content within the food system.

***Objective 6**: To determine SSB sweetness preference through sensory evaluation among adults living in the Southgate, Phoenix area.*

Participants in this study preferred the Coo-ee market sample as it was ranked the sweetest SSB, followed by the Coke market sample. The Coo-ee sample formulation had sugar at 4g/100ml of sugar with the addition of non-nutritive sweetener (NNS) whilst Coke had 10g/100ml of sugar without having declared a sweetener on the label.

### 5.3 Strengths of the study

This study had several strengths:

- The study's focus on both SSB and household sugar consumption allows for a comprehensive understanding of sugar intake sources, enabling targeted strategies for intervention.
- Establishing the current SSB and household sugar consumption patterns provides a baseline against which future studies can measure change, aiding in the evaluation and monitoring of the effectiveness of public health campaigns or interventions.
- Each phase of this study was validated through methods, as detailed in Chapter 3, to ensure that the data was accurate and reliable. For example, the household sugar and SSB consumption survey was piloted before administration to the main study participants.
- The sample size was calculated using the recommended variance to obtain reliable results.
- This study used sales data obtained from an international market leader and consumer insight tool, Euromonitor.
- The statistician and supervisors contributed to ensuring the reliability and quality of the data collected for this study.
- The supervisors actively guided the research topic, ensuring that a wide scope of journal articles, reviews and citations were applied in this research and that the research was true and well presented by conducting regular reviews.

### 5.4 Limitations of the study

Despite the strengths of this study, it is important to acknowledge the following limitations of the study:

- The study's conclusions may not accurately reflect the overall South African population; rather, it is indicative of middle-class living standards measure (LSM) households. Participation was only limited to adults.
- The study was conducted over a specific period, and consumption patterns can vary seasonally or due to external factors. A short study duration may not have captured long-term trends accurately.
- There may have been some bias toward self-selection because participation in this study was voluntary.
- Survey data was self-reported and not supported by till receipts.
- There are no results available for pre-tax household sugar, and SSB consumption to compare the study results.

### 5.5 Recommendations

The following recommendations are made from the findings of this study:

- Targeted public awareness campaigns should be developed and implemented to educate adults in the Southgate Phoenix area about the health risks associated with excessive SSB and household sugar consumption.
- Revenue generated from the HPL should be directed towards sugar tax awareness campaigns, nutrition education programmes and promoting healthy eating. These can be done by targeting mainstream media channels and using social media.
- More longitudinal research studies need to be conducted into the sugar tax and its effectiveness nationally throughout the different provinces and communities, including rural areas, townships and other lower LSM communities in South Africa.
- A monitoring and evaluation system should be established to track SSB, and sugar consumption patterns change over time.
- The development of a tool aimed at helping South Africans to monitor their daily sugar intake, serving sizes and portions of food items and drinks would be useful if users could input their data and the tool would calculate total sugar consumption and provide customised tips on how to reduce sugar intake.
- More research needs to be conducted into the increased use and long-term impact of consuming NNSs and their effect on public health.

### 5.6 Conclusion

Worldwide, there is increasing interest in using tax and fiscal policy to lower the adverse effects of consuming SSBs. As a result, broad guidelines have been devised to impose taxes on SSBs, with higher tax rates imposed on items with higher than recommended sugar content. However, more research is needed to inform best practices on SSB levies. South Africa was the first African country to implement a sugar tax, so it is important to document the barriers, challenges, and other findings from inception. In this study, we found that sugar tax studies were mostly conducted in first-world and Western countries, and limited literature was available in the South African context. While the SSB industry has been regulated, household sugar consumption remains an unexplored research area. Households lack information pertaining to optimal sugar intake and the long-term health implications of exceeding such limits. Joint efforts with multiple initiatives could yield better results in combating obesity and reducing the financial strain of treating non-communicable diseases (NCDs). These initiatives should include nutrition education and HPL awareness campaigns together with the current fiscal policies.

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**Appendix A:** Threshold Detection Test (TDT)- Intensity

Please taste each sample in the order presented to you and rank according to the scales provided. Please drink water after tasting each sample

Section 1

1.Please indicate age (Single choice.)
18-25

26-35

36-55

56 & older

2.Gender (Single choice.)
Male

Female

Prefer not to say.

3.Please indicate race (Single choice.)
White

African/black

Coloured

Indian

Prefer not to say

4.Indicate if you can taste the sweetness for Pink-dot solution (Single choice.)
Yes

No

5.Indicate if you can taste the sweetness for Yellow-dot solution Single choice.
Yes

No

6.Indicate if you can taste the sweetness for Orange-dot solution (Single choice.)
Yes

No

7.Which sample is the sweetest? (Single choice.)
Pink-dot solution

Yellow-dot solution

Orange-dot solution

Not sure

8.Which sample is the LEAST sweet? (Single choice.)
Pink-dot solution

Yellow-dot solution

Orange-dot solution

Not sure

**Appendix B**

## Sensory - Preference

Please taste the following market samples in the order that they have been presented to you.Please rinse your mouth with water in-between tasting each sample.

* This form will record your name, please fill your name.

**1. Which sample do you like the MOST?**

- ◯ Green Dot
- ◯ Blue Dot
- ◯ Orange Dot

**2. Why do you prefer the sample chosen in Question 1?**

- ◯ Flavour
- ◯ Colour
- ◯ Sweetest
- ◯ Other

3. **Which sample do you like the LEAST?**

- ◯ Green Dot
- ◯ Blue Dot
- ◯ Orange Dot

4. **Why is the sample in Question 3 your LEAST preferred?**

- ◯ Flavour
- ◯ Colour
- ◯ Sweetness
- ◯ Other

5. **Did you notice any bitter aftertaste in any of the samples?**

- ◯ Yes
- ◯ No
- ◯ Not sure

6. **Please indicate sample colour below that had a bitter taste?**

**Appendix C**


## LETTER OF INFORMATION

**Title of the Research Study:** Sugar-sweetened beverages and household sugar consumption patterns among adults living in Southgate Phoenix.

**Principal Investigator/s/researcher/Lecturer:** Sindisiwe P. Nene (B. Tech: Food & Nutrition)

**Co-Investigator/s/supervisor/s:** A. Naicker (PhD), E. Singh (Med)

**Brief Introduction and Purpose of the Study:**

Good day. I am a Masters in Applied science student in the Department of Food and Nutrition at the Durban University of Technology (DUT). I am researching the sugar-sweetened beverage (SSB) and household sugar consumption patterns among South Africans.

**Outline of the Procedures:**

The aim of the study is to determine if the introduction of the Health Promotion Levy (HPL) has changed the overall purchasing and consumption behaviours for SSBs and household sugar of adults living in South Africa. You will be requested to complete two questionnaires; one is a Household sugar consumption and the other a sugar-sweetened beverage consumption questionnaire.

**Risks or Discomforts to the Participant:**

There will be no risks to you for your participation in this survey.

**Explain to the participant the reasons he/she may be withdraw from the study:**

Should you wish to withdraw from the survey, there will be no adverse consequences.

**Benefits:**

This survey will benefit by providing insight into consumer behaviour post the HPL implementation, this will help identify other areas of improvement.

**Remuneration:**

You will not receive any remuneration for completing the survey.

**Costs of the Study:**

There will be no cost incurred to you if you participate in this study.

**Confidentiality:** The survey has no identifying values that can link the information to you such as your name, email address or IP address. All data will be stored in a password protected electronic format and used only for research purposes. Only the researcher and the supervisor will have access to the data, all information will be de-identified.

**Research-related Injury:**

There is no expected research related injury from your participation in this survey.

**Storage of all electronic and hard copies including tape recordings**:

Data will be stored securely in the Durban University of Technology: Department of Consumer Sciences: Food and Nutrition server. This information will only be available to the research team for a retention period of 5 years. Thereafter it will be shredded to protect the participant's information.

**Persons to contact in the Event of Any Problems or Queries:** (Sindisiwe Nene) Please contact the researcher (031 373762) or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Dr L Linganiso on 031 373 2577 or researchdirector@dut.ac.za

**Appendix D**


**CONSENT FORM**

**Full Title of the Study:** Sugar-sweetened beverage and household sugar consumption patterns among South Africans

**Names of Researcher/s: Sindisiwe P. Nene**

**Statement of Agreement to Participate in the Research Study:**

I hereby confirm that I have been informed by the researcher, Sindisiwe Nene, about the nature, conduct, benefits, and risks of this study.

I have also received, read, and understood the above written information (Participant Letter of Information) regarding the study.

I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.

In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.

I may, at any stage, without prejudice, withdraw my consent and participation in the study.

I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

I understand that significant new findings developed during this research which may relate to my participation will be made available to me.

| | | | |
|---|---|---|---|
| **Full Name of Participant** | **Date** | **Time** | **Signature / Right Thumbprint** |

I, Sindisiwe Nene herewith confirm that the above participant has been fully informed about the nature of the study, conduct and risks of the above study.

| | | | |
|---|---|---|---|
| **Full Name of Researcher** | **Date** | **Signature** | **Date** |

| | | |
|---|---|---|
| **Full Name of Witness (If applicable)** | **Date** | **Signature** |

## Appendix E: IREC APPROVAL


**Institutional Research Ethics Committee** Research and Postgraduate Support Directorate 2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

"28 March 2022

Mrs S P Nene
28 Rosegate GardensSouthgate
Phoenix4068

Dear Mrs Nene

**Sugar-sweetened beverages and household sugar consumption patterns among adults living in Southgate Phoenix.**
**Ethics Clearance Number: 152/21**

The Institutional Research Ethics Committee acknowledges receipt of your final data collection toolfor review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure thatparticipants used for the pilot study are not part of the main study.
Please note that FULL APPROVAL is granted to your research proposal. You may proceed withdata collection.
Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).
Please note that any deviations from the approved proposal require the approval of the IREC asoutlined in the IREC SOP's."

Yours Sincerely,

Prof J K Adam
Chairperson: IREC

**Appendix F**

Household sugar consumption and Sugar-sweetened beverage consumption
Dear Participant,

You have been selected to participate in this questionnaire to determine Household sugar consumption and Sugar sweetened beverage consumption. Your participation in this survey process is voluntary. Should you wish to participate in the study by answering the questionnaire, note that your answers will not be shared with anyone but will be used anonymously for only scholarly purposes by the research team. The survey will take you approximately 20 minutes.

Please visit the link for information letter and Ethics approval:

https://www.dropbox.com/sh/df3wfvtkl153g0q/AAAqwosGCvLoVUMF5LzCToQJa?dl=0

Section 1

Household Sugar Consumption survey
Please may you answer to following questions regarding to your household sugar consumption.

1.GenderRequired to answer. Single choice.
Male

Female

Prefer not to say

2.Consent. Please select your choice (Single choice.)
Yes
No
**Correct answers:** Yes

3.Age (Single choice.)
18-25
26-35
36-45
46-55
56-older

4.Please indicate your average household monthly income/ spending allowance? (Single choice.)
Less than R1000
R1000- R5000
R6000-R10 000
R10 000-R15 000
R18 000- R20 000

More than R20 000
Prefer not to say

5.Please indicate your employment status? (Single choice.)

Student

Employed

Self employed.

Unemployed

6. Please indicate the number of people in your household? Eg:4 (Multi Line Text.)

7.How often do you purchase sugar for the household? (Single choice.)

Weekly

Monthly

Yearly

8.Please indicate which sugar type do you purchase regularly? (Single choice.)

White

Brown

9.Please specify package size of sugar purchased? (Single choice.)

1kg

2kg

3kg

5kg

10kg

500g

10.Where do you use sugar the most? Please tick all that are applicable. (Multiple choice.)

Baking

Teas & coffee

Add to cereal

Cooking

11.How much of sugar do you put into your tea or coffee? (Single choice.)

5ml/ 1 teaspoon

10ml/ 2 teaspoon

15ml/3 teaspoons

20ml/ 4 teaspoons

More than 20ml/ 4 teaspoons

12.How many servings of tea or coffee with sugar do you drink daily? (Single choice.)

1 cup

2 cups

3 cups

4 cups

5 cups

Section 2

Sugar-sweetened Beverage consumption

Sweetened drinks that include soft drinks, sports drinks, energy drinks and fruit drinks excluding sweetened teas, coffees, and sports drinks with protein (Marriott *et al. 2019*:3).

Please answer the following questions in relation to your sugar sweetened beverage consumption.

13.Which of the following Sugar-Sweetened Beverages (SSBs) do you purchase regularly, please tick all that are applicable. (Multiple choice.)

Carbonated Soft drink eg. Coke

Energy drink eg. Redbull

Flavoured waters eg. Aquelle

Sports drinks eg. Powerade

Flavoured tea eg. Lipton

Other

14.On average, how many times a month do you consume Sugar-sweetened beverages? (Single choice.)

0-2 times

3-4 times

5-6 times

More than 6 times

15.Where do you usually consume Sugar-sweetened beverages? Please tick all that are applicable (Multiple choice.)

At home

At work/ school

At restaurants or take-away outlets

Other

16.Please specify if you choose Other for Question 15Required to answer. Multi Line Text.

17.On a single purchase, please indicate the size of Sugar-sweetened beverages that you usually purchase? (Single choice.)

200ml

500ml

1-1.5ltrs

2ltr

2.25ml

18.When purchasing Sugar-sweetened beverages which of the following influencing your purchase decision. Please tick all that are applicable (Multiple choice.)

Brand loyalty
Price

Taste

Packaging size

Flavour

19.Please indicate your favourite brand of SSB of choice. (Multi Line Text.)

20.Are you aware of the Health Promotion Levy (HPL)/ Sugar tax implemented by the government in 2018? (Single choice.)
Yes

No

21.How has your Sugar-sweetened beverage consumption changed over the last 4 years (2017-2021)? (Single choice.)

Yes
No

Thank you for answering this questionnaire.

22.How has your Sugar-sweetened beverages Consumption been through the COVID-19 lockdown? (Single choice.)

Yes
No

**Appendix G: Call for participation flyer**


Please scan the QR Code to participate in a research study.

The study is based on Household Sugar and Sugar drinks consumption, the survey takes 10 minutes of your time.

DUT
DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

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## Appendix H: Sensory participation invite

DUT
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**You are invited to participate in a Sensory Taste Session for a Masters Research project.**

**Please note that you will be tasting liquid based samples as well as soft drink market samples . This session should take 15-20mins of your time**

**Please attend 1 of the two sessions, participants must be 18years and older**

| | |
|---|---|
| **Date: 10 March 2023** | **Date: 11 March 2023** |
| **Venue: Stonebridge Library** | **Venue: Stonebridge Library** |
| **Time: 13h00-15h00** | **Time: 09h00- 2h00** |

**Research Topic: Sugar-sweetened beverages and household sugar consumption Patterns among adults living in Southgate Phoenix**

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