Western Graduate&PostdoctoralStudies

Western University
Scholarship@Western

Electronic Thesis and Dissertation Repository

8-16-2018 2:00 PM

Analysis of Added Sugar Intake of Canadian Children and Adolescents: Findings from the Canadian Community Health Survey on Nutrition

Ulaina Tariq, *The University of Western Ontario*

Supervisor: Wilk, Piotr, *The University of Western Ontario*

A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Epidemiology and Biostatistics

© Ulaina Tariq 2018

Follow this and additional works at: https://ir.lib.uwo.ca/etd

Part of the Nutritional Epidemiology Commons

Recommended Citation

Tariq, Ulaina, "Analysis of Added Sugar Intake of Canadian Children and Adolescents: Findings from the Canadian Community Health Survey on Nutrition" (2018). *Electronic Thesis and Dissertation Repository*. 5683.
https://ir.lib.uwo.ca/etd/5683

This Dissertation/Thesis is brought to you for free and open access by Scholarship@Western. It has been accepted for inclusion in Electronic Thesis and Dissertation Repository by an authorized administrator of Scholarship@Western. For more information, please contact wlswadmin@uwo.ca.

Abstract

Background: The added sugar intake of children and adolescents in Canada warrants more research due to its contribution to obesity, diabetes, and other chronic and mental health issues.

Objective: To assess the trends and correlates of added sugar intake in Canadians aged 6 to 17.

Methods: Data were provided by the Canadian Community Health Survey-Nutrition 2004 and 2015. Statistical analysis included multivariable regression and t-tests.

Results: In 2015, 35.66% of Canadians aged 6 to 17 met sugar intake guidelines. Compared to 2004, in 2015 intake of fruit and vegetables was higher, while sugar and caloric intake was lower. Sedentary activity, sex, age, race, household income, and region of residence were risk factors for high added sugar intake.

Conclusion: Dietary habits have improved from 2004 to 2015, but average sugar intake continues to surpass the recommended amount. Significant correlates were identified, but more research is needed to investigate variations in intake.

Keywords

Child Health, Adolescent Health, Nutrition, Obesity, Sugar, Canadian Community Health Survey

Acknowledgments

I would like to thank my thesis supervisor, Dr. Piotr Wilk for his mentorship during the completion of this project. Thank you for allowing me to grow, problem solve for myself, but also providing direction, guidance, and humour during stressful times. My thesis committee members, Dr. Saverio Stranges, and Dr. Colleen O'Connor must also be acknowledged for bringing their expertise to this project, and the invaluable feedback they provided that helped make this project even better.

Thanks must be expressed to Nathalie Goodwin and Pat Newcombe-Welch at the Research Data Centres at Western and Waterloo, respectively, for guiding me through the intricacies of using CCHS data. I would also like to acknowledge the Children's Health Research Institute Quality of Life Graduate Research Fellowship for their financial support; and the Department of Epidemiology and Biostatistics at Western University for the foundation they provided.

Thank you to my fellow cohort members, the Society for Higher Epidemiological Thinking, Archie, Sarah, and Filzah, for the emotional support and for making this journey so much more enjoyable. I must express gratitude to my parents and Fahad for perhaps not completely understanding what I was studying but being extremely supportive regardless. Thank you for listening to my rants about sugar, and for putting up with the health nut in me that emerged while I was writing this thesis. Lastly, I would like to dedicate this thesis to Nani; I wish I could have shared this achievement with you.

Table of Contents

List of Tables

List of Figures

List of Appendices

Abbreviations

AMPM:	Automated Multiple-Pass Method
aOR:	Adjusted Odds Ratio
β:	Beta Coefficient
BMI:	Body Mass Index
BNS:	Bureau of Nutritional Sciences
CAPI:	Computer Assisted Personal Interview
CATI:	Computer Assisted Telephone Interview
CCHS:	Canadian Community Health Survey
CI:	Confidence Interval
Das:	Census Dissemination Areas
df:	degrees of freedom
DRI:	Dietary Reference Intake
MVPA:	Moderate to Vigorous Physical Activity
NHANES:	National Health and Nutrition Examination Survey
OR:	Odds Ratio
PEI:	Prince Edward Island
PRISMA:	Preferred Reporting Items for Systematic Review and Meta-Analysis
SE:	Standard Error

SES:	Socio-economic Status
SSB:	Sugar Sweetened Beverages
TV:	Television
USDA:	United States Department of Agriculture
WHO:	World Health Organization

Chapter 1

1 Introduction

This chapter explores the prevalence and causes of childhood obesity in Canada. It also discusses the importance of studying determinants of added sugar consumption due to its association with childhood obesity, a critical public health issue. The purpose of this study and an overview of the remaining chapters of this thesis are also provided.

1.1 Childhood Obesity in Canada

Childhood obesity is a public health issue of vital importance in Canada, and worldwide. According to the 1978/1979 Canada Health Survey and the 2013 Canadian Health Measures Survey, over the past four decades, the rate of overweight in children and adolescents has more than doubled from 12% to 27% and the rate of obesity has increased more than fourfold from 3% to 13% (Rodd & Sharma, 2016). The trends in overweight and obesity rates in Canadian children and adolescents are in line with trends observed globally; from 1980 to 2013, overweight and obesity in children and adolescents in developed countries increased from 16.9% in boys and 16.2% in girls, to 23.8% in boys and 22.6% in girls in 2013 (Ng et al., 2014). While the prevalence of overweight and obesity in children and adolescents is lower in developing countries compared to developed countries, rates are increasing in developing countries as well; in 1980 8.1% of boys and 8.4% of girls in developing countries were either overweight or obese; these rates increased to 12.9% in boys and 13.4% in girls in 2013 (Ng et al., 2014).

Childhood obesity can contribute to the early development of chronic health conditions such as type II diabetes, atherosclerotic heart disease, and high blood pressure (Ball & McCargar, 2003; Morrison & Chanoine, 2007). It can also lead to low self-esteem, negative self-image, and internalizing behaviours such as sadness, loneliness, and depression (Pulgarón, 2013). Additionally, childhood obesity increases the risk of adulthood obesity (Singh et al., 2008), which contributes to many co-morbidities among adults such as type II diabetes, cardiovascular disease, hypertension, stroke, gallbladder disease, osteoarthritis, sleep apnea, and certain cancers that cumulatively can cost the Canadian healthcare system up to $7.1 billion per year (Anis et al., 2010).

Obesity, which is generally defined as an excess of body fat, is caused by an imbalance between energy intake and energy expenditure that results in a net positive intake of energy that is then stored by the body (Pulgarón, 2013). A widely accepted classification system for overweight and obesity is Body Mass Index (BMI), which takes into account an individual's height and weight such that an individual with a BMI over 25 kg/m^2 is considered to be overweight, and an individual with a BMI over 30 kg/m^2 is considered to have obesity (De Onis et al., 2007). For children and adolescents between ages 5 to 18, BMI classification also depends on age since growth rates are highly dependent on age during this period. The World Health Organization's Child Growth Standards provide BMI-for-age cutoffs such that a BMI-for-age above the 85th percentile is equivalent to an overweight classification, BMI-for-age above the 97th percentile is equivalent to an obese classification, and BMI-for-age above the 99.9th percentile is considered severely obese (Dietitians of Canada & Canadian Pediatric Society, 2014).

Poor diet, limited physical activity, and increased sedentary behaviours are the most direct and widely accepted contributors to obesity, but other risk factors have also been identified such as genetics, perinatal and prenatal factors, and social environment.

1.2 Risk Factors of Obesity

1.2.1 Genetics

Some genetic conditions that can predispose children to become obese include Prader-Willi, Bardet-Biedl, Cohen, and Alstrom syndromes (Ebbelin, Pawlak, & Lugwig, 2002). These conditions are caused by genetic mutations and are thus very rare and account for only a handful number of cases of obesity worldwide; but genome wide association studies have identified up to 31 genes that are associated with BMI and may be the cause of a predisposition to obesity (Heid et al., 2011; Speliotes et al., 2011). However, the increase in the prevalence of obesity worldwide in the last 30 years cannot be attributed to genetics alone as the gene pool of a population tends to be stable and it can take generations for new genetic mutations to spread (Qi & Cho, 2008). Gene interactions, coupled with the emergence of a social environment that makes over-eating and under-exercising easy, help to exacerbate genetic preconditions to obesity (Qi & Cho, 2008).

1.2.2 Prenatal and Perinatal Factors

Numerous meta-analyses have found that pre- and perinatal factors such as maternal smoking during pregnancy, gestational weight gain, gestational diabetes, infant weight gain, duration of breastfeeding, and infant sleep patterns can have an effect on a child's risk of obesity at different life stages from infancy through to adolescence (Baird, 2005; Foley et al., 2012; Hillier et al., 2007; Ludwig & Currie, 2010; Oken, Levitan, & Gillman, 2008; Yan, Liu, Zhu, Huang, & Wang, 2016). Additionally, one study found that these factors can have a synergistic additive effect on the risk of childhood obesity, whereby children of mothers who smoked, gained excessive weight during pregnancy, were not breastfeeding for at least 12 months, and did not attain a minimum of 12 hours of sleep had a 0.29 probability of being overweight at 3 years of age, compared to a probability of 0.06 for infants that did not face or engage in these four risk factors (Oken et al., 2008).

1.2.3 Environment

Childhood obesity can also be influenced by familial, school, and environmental factors that result in poor diet quality, low physical activity, and sedentary behaviours. Parental food choices can be imprinted on their children due to food availability at home, with some studies indicating that the availability of fruits and vegetables at home strongly influences consumption of these foods (Jago, Baranowski, & Baranowski, 2007; Larson et al., 2015). The frequency of family meals has also been correlated to BMI in some studies, with frequent family meals acting as a protective factor against childhood obesity (Larson et al., 2013).

Children and adolescent's exposure to a harmful food environment has also been the subject of obesity-related research. The underlying rationale being that exposure to fast food outlets and convenience stores near homes and schools provides access to unhealthy energy-rich food options (Laska et al., 2010). A systematic review of the influence of the retail food environment on obesity-related outcomes found some evidence of a positive effect of retail food environment on body weight (Williams et al., 2014). A study on food access and children's BMI in Toronto, Ontario (aged 9 to 13, n=1035) also found that living in an area with a higher density of healthy food outlets and proximity to supermarkets decreased the odds of being overweight and obese (Larsen, Cook, Stone, & Faulkner, 2014).

The built environment and neighborhood characteristics can also influence the prevalence of obesity by either encouraging or discouraging physical activity among children and youth. The presence of public recreation facilities and neighbourhood walkability has been found to be inversely related to BMI scores in children (Casey et al., 2014; Gilliland et al., 2012). Other studies have also suggested a link between perceived neighbourhood unsafety and lower physical activity levels in children; although the direct link to children's BMI is less clear (An et al., 2017; Datar, Nicosia, & Shier, 2013; Singh, Siahpush, & Kogan, 2010).

1.2.4 Physical Activity and Sedentary Behaviours

Obesity occurs as a result of a net positive energy intake over time. Thus, engaging in regular physical activity may help prevent weight gain. For numerous health benefits including reducing the risk of weight gain, Health Canada and the World Health Organization recommend that children and adolescents (aged 5 to 17) attain a minimum of 60 minutes of moderate-to-vigorous physical activity (MVPA) per day. In order to obtain an objective and precise estimate of the amount of physical activity Canadian children are achieving, the Canadian Health Measures Survey used accelerometers to track the physical activity of a representative sample of children and adolescents 6 to 19 years old (Colley et al., 2011). The study found that only 7% of children accumulated 60 minutes of MVPA at least 6 days a week (Colley et al., 2011). Although long term data on trends in physical activity among children is not available, it is likely that societal and technological changes have led to less active commuting and outdoor play, and more participation in sedentary behaviours, such as watching television and computer use (Bassett et al., 2015).

In addition to a decrease in the physical activity levels of children, there has also been an increase in sedentary behaviours such as watching television, playing video games, and computer/smartphone use. Longitudinal studies of children that watch television have found a strong link between how much TV children watch, and their likelihood of gaining excess weight (Jackson & Cunningham, 2017; Rey-López, Vicente-Rodríguez, Biosca, & Moreno, 2008). While a meta-analysis of interventions to reduce sedentary behaviours found that reduction in sedentary behaviours lead to a significant decrease in the BMI of children and adolescents (van Grieken et al., 2012), it should be noted that while a negative association between sedentary behaviour and physical activity exists, it is very small, suggesting that one activity does not necessarily displace the other (Pearson et al., 2014). Other reasons sedentary behaviours may contribute to childhood obesity are unhealthy snacking during television viewing, advertisement of unhealthy food and beverages to children, and interference with sleep (Moreira et al., 2010; Rey-López et al., 2008; The Academy of American Pediatrics, 2011).

1.3 Dietary Intake

In addition to physical activity, the most direct and important determinant to the risk of obesity is diet since weight gain results from chronic over-consumption of calories that are not expended by the body (Malik, Willett, & Hu, 2013). While weight gain can result from the over-consumption of any food or drink items, simple carbohydrates such as sugar have a low thermic effect and high glycemic index, as such, they are metabolized quickly by the body leading to a spike in blood glucose and insulin levels (Abete et al., 2010). This spike in blood glucose increases short term hunger and can lead to over eating (Abete et al., 2010).

Yet, another theory about the relationship between added sugar and weight gain is more intricate and asserts that the relationship may not be as straight forward as individuals being at fault for simply over-consuming calories. From an endocrine perspective, the consumption of refined sugar may not affect appetite the same way consumption of other food does. Certain research suggests that the fructose in refined sugar may not suppress the hormone ghrelin, which functions to stimulate appetite; nor raise levels of the hormone leptin, which inhibits hunger after a person has eaten, thus leading to an overconsumption of calories (Lustig, 2016).

Children and adolescents also tend to have a greater preference for sweetness in general, and a preference for higher concentrations of sugar, compared to adults (Drewnowski, Mennella, Johnson, & Bellisle, 2012; Mennella, Finkbeiner, Lipchock, Hwang, & Reed, 2014), suggesting that high sugar consumption leads to children and adolescents becoming more susceptible to overweight and obesity.

From a sociological perspective, there are also many influences embedded in Western societies and culture that make consuming sugar a more entrancing option than consuming healthier, more nutrient dense foods.

Factors that have been found to influence the intake of high sugar food items in children and adolescents include the ease of accessibility at home, school, sports arenas, and the homes of friends (Battram, et al., 2016). As well as an appeal to consume these items that is cultivated by the advertising and marketing of high sugar items specifically towards children (Battram et al., 2016). Studies of food marketing towards children and adolescents has found that 91% of food advertisements during Saturday morning children's TV programming was for foods that are high in added sugar, fat, or sodium, and low in nutrients (Batada, Seitz, Wootan, & Story, 2008).

Additionally, high sugar items tend to be available in the convenient form of snacks, drinks, and fast food items, which are energy dense (kcal/100grams) but nutrient poor, and have a lower energy cost ($/100kcal) compared to more nutrient dense foods (Drewnowski, 2003). Fast food and food away from home in general, is also typically served in larger portion sizes compared to foods available at home (Altman et al., 2015).

All the factors mentioned above indicate how consuming food and drink items with added sugar is a palatable, appealing, cheap, and convenient option for children and adolescents that makes it easy for them to consume more than their recommended number of daily calories.

1.4 Sugar and Obesity

Added sugar consumption among Canadian children warrants further investigation given that higher added sugar consumption has been associated with childhood obesity (Malik, Schulze, & Hu, 2006), and the metabolic syndrome (Lustig, 2016). In particular, the consumption of sugar sweetened beverages (SSB) may be a key contributor to the increasing levels of obesity in Canada due to their high and concentrated added sugar content, low satiety of liquid sugars compared to solid sugars, and tendency for people not to compensate for SSB consumption by reducing energy intake from the consumption of other foods (De Ruyter et al., 2014; Hu, 2013; Malik et al., 2006).

Independent of its role in weight gain, sugar intake also contributes to the risk for developing metabolic syndrome and type 2 diabetes through metabolic pathways that cause insulin resistance (which contributes to metabolic disease), the formation of reactive oxygen species (which contribute to premature aging and mutation of cells), and disruptions in hormonal signaling of ghrelin and leptin (which can cause over-consumption of food) (Lustig, 2016).

1.5 Sugar Intake of Children and Adolescents

The Canadian Food Guide was developed by Health Canada as a dietary guideline to help Canadians meet their nutrient requirements, lower their risk of obesity and other chronic conditions, and to contribute to their overall health and vitality (Health Canada, 2007). The guide recommends that the majority of the diet should consist of fruits and vegetables, followed by grain products, milk and alternatives, and meat and alternatives. At the same time, it recommends that consumption of foods that are high in calories, sugar, fat, or salt, (e.g. cakes, ice cream, French fries, sweetened drinks etc.), that are represented in the 'other' food category, should be limited.

However, findings from the Canadian Community Health Survey (CCHS) on Nutrition from 2004, which measured diet by asking participants to report everything they consumed in the past 24-hour period, showed that children and adolescents between the ages of 9 and 18 attained 24% to 25% of their daily calories from total sugar, and the majority of this sugar came from the 'Other' food category, suggesting that added sugars were the main source of sugar, rather than the intrinsic sugars found in the rest of the food groups (fruit and vegetables, milk products, grain products, and meat and alternatives) (Langlois & Garriguet, 2011). Since the majority of daily calories are coming from the 'Other' food category, this suggests that children and adolescents are not meeting Health Canada's dietary recommendations. Additionally, since this study measured total sugar intake, it is also unclear whether Canadian children and adolescents are meeting added sugar intake guidelines that have been published by health organizations such as Diabetes Canada, which recommends that added sugar should be limited to less than 10% of daily energy intake (Diabetes Canada, 2016).

1.6 Study Objectives

This study examines the correlates of added sugar intake in Canadian children and adolescents aged 6 to 17. Using cross-sectional data from the CCHS-Nutrition 2004 and 2015. The first objective of this thesis assesses what percentage of Canadian children and adolescents are meeting added sugar intake guidelines that recommend that added sugar intake should make up less than 10% of daily energy intake. Differences in other dietary habits between children and adolescents that do and do not consume the recommended amount of added sugar were also examined. The second objective was to compare added sugar intake, and other dietary behaviours such as fruit and vegetable intake, and caloric intake, between 2004 and 2015. Detailed information about nutrition from the 24-hour dietary recall data that were collected in the CCHS. The third objective was to develop a model for the relationship between added sugar intake and other behavioural characteristics including time spent engaging in sedentary behaviour and time spent in physical activity, while controlling for other correlates of added sugar intake.

1.7 Thesis Overview

The following chapter contains a review of the literature on the social determinants of dietary sugar intake. Chapter 3 explains the methodology employed in this study. Chapter 4 presents the results of this study, and Chapter 5 includes a discussion of the implications and conclusions that can be made from the findings.

Chapter 2

2 Literature Review

This section provides a review of the literature examining the social determinants of added sugar consumption among children and adolescents. Section 2.1 describes the methodology used to complete a systematic review of the available literature on this topic. Section 2.2 describes the commonly used measurements of added sugar intake in children and adolescents. Section 2.3 describes the relationships between added sugar intake and social determinants of health and 2.4 discusses the gaps in literature and how they will be addressed in this study.

2.1 Search Strategy and Inclusion Criteria

A systematic review of the literature on the social determinants of added sugar intake among children and adolescents was conducted by searching the following databases on September 8th, 2017: Medline, EMBASE, Scopus, CINAHL, and Web of Science. The relevant search terms were selected to reflect the three domains of interest: sugar consumption, determinants, and children. For sugar consumption the search terms, "sugar consumption", OR "sugar intake", OR "dietary sucrose", OR "sugar*", OR sweeten* were used. For determinants, the search terms determinant*, OR "causal factor*", OR correlat*, OR predictor*, OR associat*, OR "risk factor*" were used. Lastly, for the target population of children and adolescents the following search terms were used: youth, OR adolescen*, OR child*. These three domains were searched separately then combined using an 'AND' search statement. Due to the high number of search hits, the results were further limited by searching for the terms sugar* OR sweeten* in the title. The search hits were also limited by year (2007 to 2017), language (English), and by age group (children 6 to 12, and adolescents 13 to 17) in the databases that allowed for search limitation by age group. This search strategy retrieved 4,133 results which were imported into the citation program Mendeley. Of these results, 1,657 duplicates were removed. The remaining 2,476 results were title and abstract screened and studies relating to clinical populations, non-human studies, studies on the health outcomes of sugar consumption, studies that reported levels of sugar consumption but did not discuss causal factors, and other non-relevant studies were removed. This left 170 studies for full text screening, at which stage studies were removed if they focused on specific cohorts such as children with overweight or obesity, children of low-income families, or children from immigrant families. The aim of this screening was to focus on studies utilizing a diverse, population-based sample in order to study how socio-economic status and other causal factors may affect the added sugar consumption of children and adolescents of varying age, sex, race, geographic location, and other relevant factors. The overarching objective of conducting a literature review in this manner was to develop a theoretical model with all the correlates of added sugar consumption in children and adolescents that can be found in the literature.

Of the 170 studies that were full text screened, 123 were excluded, thus leaving 47 studies. The reference lists of these studies were also reviewed; this led to the inclusion of 14 more relevant papers that were not identified by the search strategy. Thus, in total 61 studies were included for data extraction. The data extracted from each study included type of study, sample size, age of the study population, study location, data collection method, the measure of added sugar used, study objectives, and results. Appendix A presents the studies that were extracted.

An overview of the systematic review process is illustrated in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flow diagram presented below.

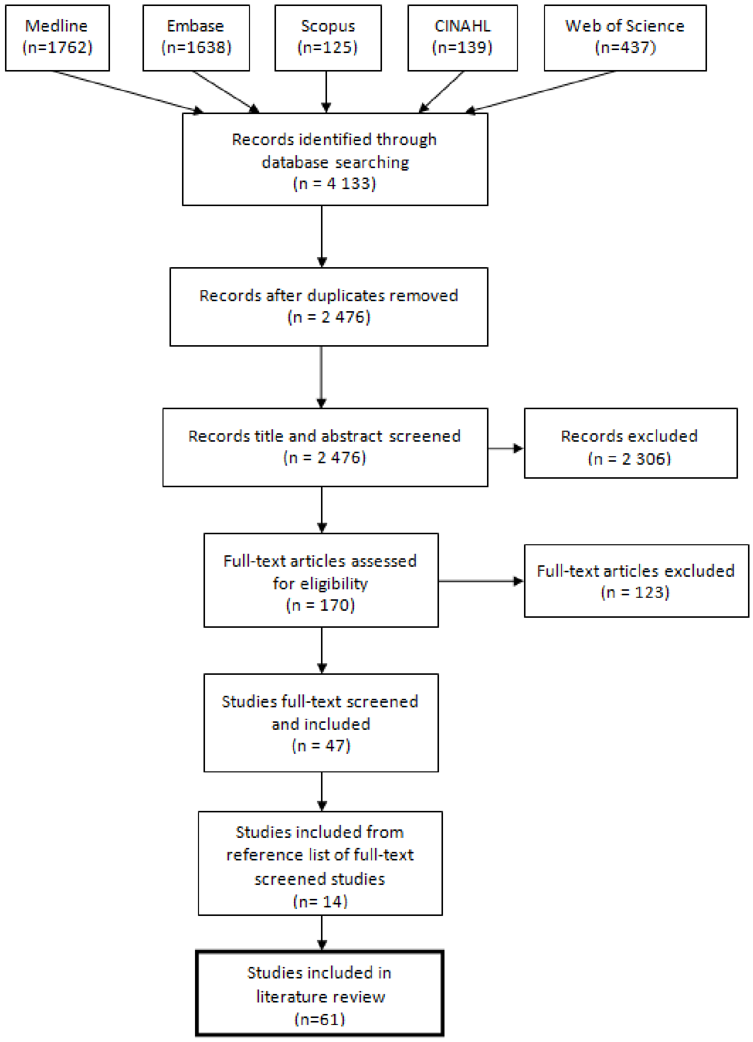

Figure 1: PRISMA Flow Diagram

2.2 Study Population and Design

Seven of the 61 research papers included in this literature review were from Canada, 28 from the United States, 17 from Europe, four from Australia, one from Kuwait, one from South Korea, one from Brazil, one literature review that included papers from English language countries, and another review that was international in scope. The majority were cross-sectional studies, but two analyzed data from longitudinal studies, and two were systematic reviews.

Thirty-four of the papers focused specifically on adolescents between the ages of 12 and 19, while the remaining examined children aged 2 to 11, or had a study population that spanned these two age groups.

The smallest sample size of the studies was 154 in an American study of the effect of sleep duration on adolescent nutrition and weight status (McKnight-Eily et al., 2011). The largest sample size was 108,726 from a paper that published findings of a National School Health Survey in Brazil (Ferreira, Claro, & Souza Lopes, 2015).

2.3 Measurements of Sugar

The most common measure of added sugar intake in the papers included in this literature review was sugar sweetened beverages, with 44 papers solely measuring SSB intake, and an additional 14 papers looking at SSB intake as well as high sugar items such as candy, chocolates and desserts. One paper only measured consumption of desserts, while two research papers examined the overall dietary intake of added sugar.

Ten of the studies collected dietary data through a 24-hour dietary recall, while ten other papers utilized a food frequency questionnaire, and one utilized a food diary. The remaining papers collected data on diet and other health behaviours through surveys that asked specific questions about particular food consumption behaviours such as number of sugary drinks consumed in a week. For these types of surveys, six were completed by parents, 29 self-reported by the study population of children or adolescents, and three combined surveys from parents and children.

2.3.1 Sugar Sweetened Beverages

A sugar sweetened beverage can generally be defined as a beverage that contains added sucrose, high fructose corn syrup, or other caloric sweetener, which include but are not limited to soft drinks, fruit drinks, and energy drinks (Hu & Malik, 2010). SSB are a common measure of sugar intake because they are the largest source of added sugar in both Canadian and American children's diets (Hu & Malik, 2010). For instance, analysis of Canadian Community Health Survey (CCHS) Nutrition 2004 found soft drinks to be the primary source of sugar in the diet of Canadian children aged 9 to 18 (Langlois & Garriguet, 2011).

Additionally, numerous epidemiologic studies have found a positive link between SSB consumption, long term weight gain, and increased risk for numerous chronic diseases (Hu & Malik, 2010). Furthermore a parallel relationship between the obesity epidemic in the United States and increased consumption of SSB has been found in time trend analysis of nutrition data from the past 30 years (Duffey & Popkin, 2007).

For these reasons, SSB intake has been used as a cost-efficient marker of overall added sugar intake in studies that cannot feasibly measure total sugar intake but are still interested in studying SBB intake as an obesogenic behaviour. As such, SSB intake was a common measure in studies that utilized self-report questionnaires to glean information about dietary and other behaviours, rather than studies that used a food frequency questionnaire, food diary, or 24-hour dietary recall as their method of data collection.

2.3.2 Foods High in Added Sugar

One paper reported sugar intake solely through the consumption of high sugar foods such as desserts since principal component analysis was used, even though other sources of sugar including SSB were measured through a food frequency questionnaire (Craig et al., 2010). Meanwhile, 10 papers reported on high sugar foods such as candy, chocolate, and desserts in addition to sugar sweetened beverages.

2.3.3 Added Sugar

Added sugar was measured in two research papers, one utilizing data from a food frequency questionnaire and one using data from the National Health and Nutrition Examination Survey (NHANES), which can be considered the American equivalent of the CCHS since it is an annual population health survey that aims to assess the nutritional and health status of adults and children living in the United States (Centers for Disease Control and Prevention, 2018). The NHANES collects dietary information from a representative sample of Americans through a 24-hour food recall and creates derived variables such as added sugar and total sugar, which can be used by health researchers. While this may be a cost and time intensive measure to collect, and produce, 24-hour dietary recalls, as well as food diaries, are the most comprehensive (yet still not perfect) measures of sugar in the diet.

2.4 Negative Consequences of Sugar

In children, too much sugar intake can contribute to the development of dental caries (Brouns, 2015), metabolic syndrome, type 2 diabetes (Lustig, 2016), as well as childhood obesity (Malik, Pan, Willett, & Hu, 2013). Childhood obesity can contribute to the early development of chronic health conditions such as atherosclerotic heart disease (Ball & McCargar, 2003; Morrison & Chanoine, 2007). Childhood overweight and obesity can also lead to low self-esteem, negative self-image, and internalizing behaviours such as sadness, loneliness, and depression (Pulgarón, 2013). Moreover, childhood obesity increases the risk of adulthood obesity, which in turn is also linked to numerous chronic health illnesses in adulthood such as type II diabetes, cardiovascular disease, hypertension, stroke, gallbladder disease, osteoarthritis, sleep apnoea, and certain cancers (Singh et al., 2008).

2.4.1 Adverse Levels of Sugar Intake

Since sugar is not acutely toxic to humans, there is no research using human subjects that indicates a detrimental level of sugar intake. Rather, health organizations such as Diabetes Canada and the World Health Organization (WHO) present recommendations about sugar intake in order to reduce the risk of weight gain, type 2 diabetes, and dental caries. The WHO strongly recommends that intake of free sugars (all monosaccharides and disaccharides added to foods by the manufacturer, cook, or consumer, plus sugars naturally present in honey, syrups and fruit juices) be less than 10% of total energy intake (Brouns, 2015). The WHO also makes a conditional recommendation that free sugar intake should further be reduced to less than 5% of total energy intake. Diabetes Canada similarly recommends that less than 10% of daily energy intake should be from added sugar, but this definition does not include natural sugars found in 100% fruit juice. For children that consume between 1,400 to 2,200 calories per day, these recommendations for 10% or less of total energy intake from sugar translate to approximately 9 to 14 teaspoons, or 36 to 56 grams of sugar per day. For adolescents that consume between 2,000 to 2,800 calories per day, daily sugar intake should be kept between 12.5 to 17.5 teaspoons, or 50 to 70 grams of sugar per day. These calculations were made using the United States Department of Agriculture (USDA) American Dietary Guidelines on the caloric needs of individuals in given sex and age categories, and converted into teaspoon measures according to the fact that one teaspoon of sugar contains 16 calories. While it is not intuitive to think about calories, teaspoons, or grams of sugar when consuming food, for reference, a can of soft drink has 39 grams or around 10 teaspoons of sugar (United States Department of Agriculture, 2018).

2.5 Determinants of Sugar Intake in Children and Adolescents

The research papers included in this literature review varied in the factors they assessed for association with added sugar intake. The current discussion of the correlates of added sugar intake found in the literature will follow a social-ecological model framework by discussing individual factors, interpersonal factors, environmental factors, and finally, broad factors that depend on geography.

2.5.1 Individual Level Determinants

2.5.1.1 Sex

Information about the sex of study participants was commonly collected in the papers included in this literature review, but sex was often considered a confounding factor and thus most papers either stratified the results by sex or adjusted for it, rather than examine its direct effect. The effect of sex on sugar consumption was not found to occur in one direction. Of the papers that stratified by sex rather than adjust for it, two papers found that males consumed more sugar than females. Meanwhile three other papers found that females had significantly higher intake of sugar.

Park et al. (2012), who used data from 16,188 subjects in the American Youth Risk Behavior Survey, found that being male was significantly associated with greater odds of drinking SSB more than once daily among secondary school students aged 13 to 18 (aOR= 1.47, 95% CI: 1.26, 1.72) (Park et al., 2012). The authors stated that this finding was in line with previous research that they had looked at, but failed to provide any explanation for why this sex difference was observed. The second paper to find a significantly higher intake of sugar among males was also the only paper to attempt to study why gender differences were occurring (Hilsen et al., 2013). This paper investigated the gender differences in soft drink consumption among Norwegian adolescents (ages 13 to 16) and found that girls had a lower consumption frequency than boys (β= -1.06, 95% CI: -1.30, -0.83). They performed mediation analysis and concluded from their findings that gender differences occurred due to differences in attitudes and preferences for soft drinks. These preferences explained 56.9% of the variation in the relationship between gender and soft drink consumption. Attitudes, accessibility, and modelling explained 51.0%, 27.3%, and 12.5% of the variance, respectively. Combined, these mediators explained 63% of the gender variation in soft drink consumption. Yet after adjustment for these factors, the direct effect of gender was still significant, thus indicating that the gender differences observed in this study could not be fully explained by differing attitudes and preferences alone (Hilsen et al., 2013).

Papers that found sugar consumption to be higher in females include a publication by Ferreira and colleagues that analyzed data from 108,726 Brazilian students that completed the National School Health Survey. The authors found that female gender was associated with regular consumption of sweets and/or SSB (aOR=1.36, 95% CI: 1.33, 1.38) (Ferreira et al., 2015). While they noted that this finding is counter to previous research that shows female adolescents to be more concerned about food consumption as a way to control their weight, the authors did not provide a possible explanation of their findings. Two other papers that examined other modifiable factors such as food security and socio-economic factors, found a sex difference in sugar consumption. Mark et al (2012) examined the effect of household income and food security on dietary indicators in Canadian youth (n=8,938, ages 9 to 18). This paper stratified results by sex and found that girls from low income, food insecure families had higher intakes of SSB. Another study including Scottish children and adolescents (n=1,233, ages 5 to 11), found that sedentary behaviours were positively associated with a diet high in sweets for girls (Craig et al., 2010).

Most papers either adjusted for, or stratified by sex while the main objective was to investigate the role of other modifiable factors. As a consequence, discussions about why sex differences occurred was very limited, perhaps because sex is a non-modifiable factor. The research papers in this review tended to focus the discussion on social determinants of dietary sugar intake, rather than individual factors such as sex and age.

2.5.1.2 Age

Similar to sex, age is another non-modifiable factor that was controlled for rather than directly studied in most of the research papers included in this review. Most papers either studied sugar intake in children (aged 6 to 11) or adolescents (aged 12 to 17), while nine papers had a study population that spanned these two age groups.

One research paper from the Netherlands studied the effect of age on sugar consumption among children ages 6 to 13 (n=644), and found age (in years) to be significantly and positively associated with SSB intake (β=0.05, 95% CI: 0.02, 0.07) (van de Gaar, van Grieken, Jansen, & Raat, 2017). Unfortunately, the authors did not discuss why this trend was observed.

Of the studies included in this review, more studies focused on adolescents. This might perhaps be due to findings from previous research that indicate that adolescents tend to have the highest intake of sugar of any age group. Analysis of CCHS Nutrition 2004 data showed that 14 to 18 year old males consumed more sugar than any other age group (Langlois & Garriguet, 2011). It is theorized that adolescents tend to have the highest rates of sugar intake because their increased growth rates lead to higher energy requirements, and calorie dense foods provide a highly palatable and convenient way to meet these increased energy requirements (Ferreira et al., 2015). At this age, adolescents also have greater autonomy to make dietary choices for themselves and purchase the food items of their choice (Han & Powell, 2013). Thus, adolescents may be considered a high-risk group in terms of their sugar intake, leading to a greater research interest in how these high rates of sugar intake can be reduced.

2.5.1.3 Race

Racial background is a factor of interest in relation to sugar intake because the prevalence of obesity has been found to differ by race in children and youth (Freedman et al., 2006; Singh, Siahpush, & Kogan, 2010; van de Gaar et al., 2017). For this reason, some papers included racial identity in their model however, only four papers in this literature review examined the direct effect of racial identity on sugar intake in children and adolescents.

Larson et al. (2015) studied how family and home environments, in relation to the dietary intake of adolescents (n= 2,374, ages 9 to 12) in the United States, varied by race. The authors found that parental encouragement for healthy eating varied by race and was associated with significantly less SSB consumption among White, African American, Asian, and other/mixed racial groups of youth, but not associated with the SSB intake of East African, Hispanic and Native American youth (Larson et al., 2015).

A study by Park et al. (2012) which used 2010 National Youth Physical Activity and Nutrition data and included 11,209 secondary school students (ages 13 to 18) in the United States, found that being non-Hispanic black was associated with higher odds of high SSB intake (three or more times per day) (OR=1.87, 95% CI: 1.52, 2.29), when compared to non-Hispanic white. While being non-Hispanic other/multiracial (compared to non-Hispanic white) was associated with lower odds for high SSB intake (OR=0.67, 95% CI: 0.47, 0.95) (Park et al., 2012). The authors state that this finding is in line with previous research looking at racial differences in dietary intake in a population from the United States.

The third study that examined racial differences in SSB consumption of adolescents in the United States (n=18,281, ages 11 to 14) found that higher SSB consumption was reported by all racial minority groups compared to White adolescents, except for Asians. Additionally, this relationship was not found to be mediated by differential distribution of fast food restaurants and convenience stores in proximity to 47 different schools included in the study (β=0.0001, p-value=0.875) (Richmond et al., 2013).

One paper by van de Gaar et al. (2017) which explored factors associated with racial differences in SSB consumption of children in the Netherlands (n=644, ages 6 to 13) found that children of Surinamese/Antillean background consumed more SSB than their Dutch counterparts (β=0.20, 95% CI: 0.08, 0.31); the other racial backgrounds under study were Moroccan/Turkish, and Other/Unknown (van de Gaar et al., 2017).

The results from studying racial differences in sugar intake may vary depending on the racial makeup of the population being studied. There are also some theories that have been postulated to explain this effect. The eating culture and types of foods consumed may differ, with children of some racial backgrounds growing up in more obesogenic environments where SSB and other sources of added sugar are more readily available (van de Gaar et al., 2017). For example, one theory for why the black population in the United States tends to have higher consumption rates of SSB compared to the white population is that SSB are more frequently marketed towards them (Park et al., 2012). Parenting styles and involvement may also differ depending on ethnic background, and additionally, differences in health literacy of parents may lead to more or less regulation of children's diets (van de Gaar et al., 2017).

2.5.1.4 Immigration Status

Acculturation is the process by which immigrants adapt to the culture and social patterns found in the country to which they migrate. Although it cannot intrinsically be measured, it is often studied by proxy with measures such as time spent in the new country and language spoken at home. A study of the effect of generation status and language acculturation on Mexican American adolescents found that third generation adolescents consumed more SSB than first generation adolescents (β=172mL/d, 95% CI: 104, 241), and this was in line with previous studies on the acculturation process in adults (Liu et al., 2012). Acculturation studies such as this one indicate that immigrants may adopt unhealthy dietary practices prevalent in the country they migrate to, and that the healthy immigrant effect diminishes with time as this acculturation takes place (Liu et al., 2012). No studies which compared added sugar intake of immigrant to Canadian born children and adolescents were found.

2.5.1.5 Sedentary Behaviours and Physical Activity

Sedentary behaviours such as television (TV) viewing, and computer/tablet/phone use were a very commonly examined correlate of added sugar consumption in the studies included in this literature review, and the results consistently indicated that sedentary behaviours have a positive effect on added sugar consumption (Borghese et al., 2014; Bornhorst et al., 2015; Byrd-Williams, Hoelscher, Springer, & Ranjit, 2010; Ferreira, Claro, & Lopes, 2015; Gebremariam et al., 2017; Kenney & Gortmaker, 2017; Lipsky & Iannotti, 2012; Moreira et al., 2010; Park et al. 2012a; Park et al. 2012b; Pearson, Ball, & Crawford, 2011; Santaliestra-Pasias et al., 2012). Various mechanisms have been proposed for why sedentary behaviours may lead to less healthy dietary patterns. One hypothesis is that passive overconsumption of food and drink occurs due to less self-monitoring since attention is diverted to watching TV (Bornhorst et al., 2015). Yet another study that performed mediation analysis for TV snacking still found a significant association between TV viewing and sugar consumption, and did not note any effect modification due to TV snacking (Lipsky & Iannotti, 2012).

Others have proposed that exposure to advertisements of energy rich food and drinks geared directly to children as the underlying cause since advertisements may have the power to influence and shape food preferences (Santaliestra-Pasias et al., 2012). Furthermore, TV viewing was found to be strongly associated with the consumption of highly advertised foods but weakly related to the consumption of infrequently advertised foods (Lipsky & Iannotti, 2012). This susceptibility to advertisements is concerning since advertised foods and drinks tend to be energy rich but nutritionally poor items such as candy, SSB, and fast food (Lipsky & Iannotti, 2012).

While it is difficult to establish causality between sedentary behaviours and added sugar intake due to the cross-sectional nature of most of the studies on this topic, one of the studies included in this literature review examined the longitudinal associations between TV viewing and SSB intake among 9,842 Australian adolescents (ages 12 to 15) and found that those who watched more than two hours of TV per day at baseline had higher consumption rates of SSB two years later (Santaliestra-Pasias et al., 2012). Additionally they noted that this association was mediated by snacking during TV viewing, and the perceived value of TV viewing (i.e. participants' enjoyment of, and belief in the value of watching TV) (Santaliestra-Pasias et al., 2012).

While added sugar intake is typically associated with higher levels of sedentary behaviour, it is also associated with lower levels of physical activity. Park et al. (2012) reported that being physically active for less than 60 minutes per day, on fewer than 5 days a week was associated with higher daily SSB intake (aOR=1.19, 95% CI: 1.08, 1.30). Another paper found similar results for soft drink consumption but noted that while soft drink consumption was lower in more physically active children, sport drink consumption was significantly higher. This finding is possibly due to the misperception that sport drinks are healthier, while in reality they still contain added sugar (Ranjit et al., 2010). This paper also noted that the distinction between soft drink and sport drink consumption would be missed by research that more broadly classifies both types of drinks as sugar sweetened beverages (Ranjit et al., 2010). Borghese et al. (2014) also noted that sedentary behaviours were negatively associated with soft drink consumption in a study of Canadian children (n=523, ages 9 to 11).

2.5.1.6 Sleep Duration

Of the five research papers in this literature review that assessed the relationship between sleep duration and added sugar intake, all found a negative association such that shorter sleep duration or higher variability in sleep was associated with higher intake of added sugar (Al-Haifi et al., 2016; Clarke et al., 2014; Kjeldsen et al., 2014; McKnight-Eily et al., 2011; Park et al., 2012). These papers greatly varied in the population they studied and how sleep and dietary intake was measured, yet all came to the same conclusion. A cross-sectional study of Kuwaiti adolescents (n=906, ages 14 to 19) found that consumption of SSB and sweets was negatively associated with sleep duration in males (Al-Haifi et al., 2016). Another cross-sectional study of American adolescents (n=581, ages 11 to 19), observed that females who slept 8 to 9 hours a night consumed significantly less added sugar compared to females who slept less than 8 hours, or more than 9 hours a night (Clarke et al., 2014). Analysis of the 2009 Youth Risk Behaviour Survey data indicated that adolescents (n=16,188, ages 13 to 18) that consumed one or more SSB drink per day, obtained less than 8 hours of sleep (OR=1.18, 95% CI: 1.08, 1.29) (Park et al., 2012). A similar study of American adolescents (ages 13 to 18, n=12,154) found that insufficient sleep (i.e. less than eight hours a night) was associated with higher odds of consuming SSB more than once daily (aOR=1.14, 95% CI: 1.03, 1.28) (McKnight-Eily et al., 2011). Lastly, a study of children aged 8 to 11 (n=676) in Denmark found that sleep duration (hours per night) was negatively associated with added sugar (β= -1.50 (% energy), 95% CI: -2.27, -0.73), and SSB (β= -1.07(% energy), 95% CI -1.61, -0.54) (Kjeldsen et al., 2013). Variability in sleep was also found to be associated with SSB consumption, and these associations were found despite adjustment for potential confounders including age, sex, pubertal status, height, weight, screen time, physical activity, parental education, and ethnicity (Kjeldsen et al., 2013).

Literature focused on the link between sleep duration and unhealthy diet in children and adolescents presents both physiological and behavioural explanations as to why these two factors may be associated with one another. A short sleep duration is thought to negatively impact metabolism by increasing the levels of the hormone ghrelin and decreasing the levels of leptin, which stimulate and suppress appetite, respectively (Cappuccio et al., 2008). This enhanced stimulus to eat may have an additive effect, with more time available to eat as less time is spent sleeping (Kjeldsen et al., 2013). Short sleep duration has also been shown to be associated with a preference for energy dense foods in children and adolescents, which could be explained by increased neural activity in the areas of the brain associated with reward as a response to food stimuli in sleep deprived individuals (St-Onge et al., 2012).

From a behavioural perspective, short sleep duration might also be an indicator of a household in which sleep, diet, and other lifestyle habits are less regulated by parents (Kjeldsen et al., 2013), leaving children and adolescents more responsible to make lifestyle choices for themselves which may result in less healthy choices.

2.5.1.7 Other Factors

Other correlates of added sugar consumption in adolescents found in the literature included skipping breakfast (Skeie & Sandvaer, 2015; Vagstrand et al., 2009), and smoking (Park et al., 2012; Vagstrand et al., 2009). Both factors indicate a clustering of unhealthy behaviours, suggesting that adolescents who are high consumers of SSB are not health-conscious in regards to their dietary and other lifestyle habits. Yet these specific factors have not been studied in as much depth, as for example, the effects of socio-economic status, or sedentary behaviours.

2.5.2 Family Level Determinants

2.5.2.1 Socio-Economic Status

The effect of socio-economic status (SES) on added sugar intake in children and adolescents was examined using a variety of measures including household income, parental education, cultural capital, food insecurity, and micro-level economic factors. Interestingly, SES was always assessed through multiple markers rather than a single marker. Low income was commonly studied in parallel with parental education (Han & Powell, 2013), while others looked at low income and food security (Mark, Lambert, & O'Loughlin, 2012), and low income and other measures of deprivation such as living in a deprived area (Craig et al., 2010).

SES is a complex construct and one reason it is often assessed through multiple measures is because it is unclear which aspects of SES most affect, or differentially affect, added sugar consumption (Zarnowiecki, Ball, Parletta, & Dollman, 2014). Zarnowiecki et al. (2014) assessed how various SES measures are associated with diet, as there is no consensus on which measure is most indicative of differences in added sugar consumption among children and adolescents. The study measured multiple SES factors including maternal education, maternal occupation, household income, home postal code, parent age, and parent marital status. It found maternal education to be the most consistent and strongest correlate of children's dietary intake, while postal code was the least frequent correlate of children's dietary intake (Zarnowiecki et al., 2014). The results of the associations between different SES measures and added sugar consumption in children and adolescents are presented below.

2.5.2.1.1 Income

The studies that assessed the effect of low income on added sugar intake consistently found that children with lower household income had significantly higher sugar consumption (Craig et al., 2010; Han & Powell, 2013; Jensen et al., 2012; Mark et al., 2012; Zarnowiecki et al., 2014). This implies that greater consumption of sugar dense items may be due to the accessibility and affordability of these items (Han & Powell, 2013). Previous research has proposed that obesity and unhealthy dietary patterns tend to be more prevalent in lower income groups because the high energy density of sugar, as well as fats, oils, refined grains, and potatoes, provides a low cost option so that dietary energy needs can still be met under budgetary constraints (Drewnowski & Specter, 2004). For example, the energy cost of soft drinks is approximately 875kcal/$, while that of orange juice is 179kal/$ (Drewnowski & Specter, 2004). Also, energy dense items tend to have a longer shelf life, and coupled with other factors such as convenience and taste, may explain why children, as well as adults from low income groups tend to consume significantly more sugar than their peers with higher incomes (Drewnowski & Specter, 2004).

Alternatively, a study on the effect of micro-level economic factors (such as pocket money available to children, restrictions on food and drink due to cost considerations) on SSB intake found that pocket money was a strong positive correlate of SSB consumption in children (n=7,234, ages 10 to 12). This finding contradicts the studies that assessed the relationship between household income and sugar intake, as pocket money was found more readily available to children from households with higher income (Jensen et al., 2012).

2.5.2.1.2 Parental Education

Parental education is a common measure of SES. Ahmadi et al. (2015) justified the use of parental education as a measure of SES in the self-report survey of adolescents used in his research paper because it may be difficult for adolescents to accurately report their household income, or the occupations of their parents (Ahmadi et al., 2015).

In a study that examined three different indicators of SES including the Scottish Index of Social Deprivation, household income, and the educational level of the main food provider, it was found that parental education was associated with dietary patterns (Craig et al., 2010). Children of parents with university/college degree level education had higher quality dietary patterns, while the children of parents with no educational qualifications tended to follow dietary patterns high in snacks and desserts (Craig et al., 2010). This paper employed a study population ranging in age from 5 to 17 years which was separated into two groups, 5 to 11 years and 12 to 17 years. The authors noted that parental education was the socio-economic factor most associated with dietary patterns in 5 to 11 year olds. For 12 to 17 year olds on the other hand, household income was the only significant socio-economic indicator of observed dietary patterns. The authors went on to hypothesize that as children gain independence with age, the spending money available to them may influence their dietary choices more than parental education. With adolescents' own education, rather than their parents' becoming more influential at this age (Craig et al., 2010).

Socio-economic indicators such as parental education are thought to have an influence on dietary quality due to social and psychological processes that affect nutritional knowledge, budgetary constraints, and peer group influence (Fernandez-Alvira et al., 2013). Additionally, parents can influence their child's dietary choices through the food modelling via their own eating behaviours, and also by making certain foods available and accessible to their children (Fernandez-Alvira et al., 2013). While the effect of parental modelling is discussed in further detail later in this chapter, Fernandez-Alvira et al (2013) noted that parental modelling can be influenced by parental education. Parents with higher education may have more health-related knowledge that they may be utilizing when raising their children. It is for this reason that parental education has often been found to be more strongly related to childhood dietary quality and obesity than other socio-economic indicators such as parental occupation or income (Fernandez-Alvira et al., 2013).

Out of the six research papers that examined the effect of parental education on the sugar consumption of children and adolescents, only one paper found sugar consumption to be higher in the children of more highly educated parents, rather than parents with lower levels of educational attainment (OR=1.29, 95% CI: 1.19, 1.39) (Ferreira et al., 2015). This difference can be attributed to the fact that the population being studied was Brazilian adolescents, while the other papers were focused on high income countries including Canada and several countries in Europe. In middle income countries such as Brazil, the consumption of SSB and other more calorie dense foods is considered a sign of wealth, as such, higher parental education may signify easier economic access to items high in sugar (Ferreira et al., 2015). Whereas in high income countries, high consumption of SSB has consistently been found to be associated with lower purchasing power (Ferreira et al., 2015).

In a study that examined the association between screen based sedentary behaviours and SSB consumption, it was found that parental education had a moderating effect on the positive association between time spent in sedentary activity and SSB consumption in two of the eight countries that were studied (Gebremariam et al., 2017). The association between sedentary activity and SSB was the strongest in children with low parental education compared to those with high parental education (Gebremariam et al., 2017). The authors reasoned that this moderating effect may be explained by previous research that has found that eating and drinking while watching TV is more common in children of parents with low education (Gebremariam et al., 2017).

2.5.2.1.3 Food Insecurity

Food insecurity is the inability to consistently and dependably access enough food for an active and healthy lifestyle, and can exacerbate the effects of low income on an individual's diet (Rossen & Kobernik, 2016). The papers that examined the association between food insecurity and sugar consumption consistently found that children and adolescents from food insecure households had a higher intake of sugar compared to their food secure counterparts (Ahmadi et al., 2015; Calloway et al., 2016; Mark et al., 2012; Rossen & Kobernik, 2016). Yet, all noted the difficulty of accurately measuring food insecurity since children may experience food insecurity differently than their parents (as parents may shield their children from hunger by providing available food to children while personally going hungry). Also, food secure and food insecure children may differ from each other in many other factors such a household income, neighbourhood level socio-economic factors, parental education, and household size (with a trend that food insecure children are more likely to live in larger households) (Rossen & Kobernik, 2016). For this reason, Rossen and Kobernik (2016) used propensity score matching to compare food secure and insecure children (n=5,136, ages 2 to 15), and found that while other measures of dietary intake were attenuated by propensity matching, sugar consumption remained significantly different with very food insecure children consuming more sugar. The authors went on to suggest that due to the small sample size of children that were very food insecure, limited conclusions should be drawn from the data (Rossen & Kobernik, 2016).

The papers that examined food insecurity in Canadian populations also noted that there is a limited effect of food insecurity for low income families on the diet quality of children due to the availability of subsidies such as the Universal Child Care Benefit and Canadian Child Tax Benefit that help shield children from facing greater nutritional deprivation (Ahmadi et al., 2015; Mark et al., 2012). However, they still found sugar consumption to be significantly higher in food insecure children and adolescents in Canada (Ahmadi et al., 2015; Mark et al., 2012).

2.5.2.1.4 Cultural Capital

Cultural capital is defined as social assets including perceptions, behavioural norms, and operational skills that are needed to effectively deal with health issues (Fismen et al., 2012). Cultural capital was used as an SES measure by one paper, that rationalized the use of this measure by noting that there is a weak understanding of the underlying mechanism by which the SES factors mentioned above (household income, parental education, etc.) affect diet quality (Fismen et al., 2012). Additionally, the paper argued that there can also be issues of systematic missing data on parental education, occupation, and income from study participants with low SES (Fismen et al., 2012).

In the Fismen et al. (2012) paper, cultural capital was measured by asking adolescents (ages 12 to 16, n=6,447) about the number of books in their household. Cultural capital is thought to vary across social classes and status groups and influence health behaviour through the operational skills, knowledge, health considerations and norms acquired through education and socialization (Fismen et al., 2012). In this paper, cultural capital was used to gain a better understanding of the formation of taste and consumption, and to provide a different dimension to the effect of SES on diet quality. Meanwhile, family affluence was also measured as a more conventional indicator of material wealth. It was assessed using the Family Affluence Scale which asked adolescents questions about the number of cars, holidays, computers, and bedrooms in their household (Fismen et al., 2012).

The authors found that cultural capital was significantly associated with lower consumption of sweets (OR=0.45, 95% CI: 0.33, 0.61) and soft drinks (OR=0.26, 95% CI: 0.17, 0.34). Family affluence significantly correlated with the consumption of more fruit, vegetables, breakfast, and dinner, but did not have a significant effect on the consumption of sweets and/or soft drinks. These findings highlight the differences between social capital and material capital measures of SES, indicating that perhaps both measures capture a different dimension of how SES affects health (Fismen et al., 2012).

2.5.2.2 Parental Modelling

The effect of parental modelling, involvement, and regulation of their children's diet was measured using a variety of indicators in the studies included in this review. The overarching theory was that parents facilitate the sugar intake of their children in terms of how strict they are, whether sugary items are readily available in the home environment, parental attitudes towards sugar, parental intake of sugar, whether parents act as role models of healthy behaviours, and parental encouragement of healthy eating for their children (Fink et al., 2014; Larson et al., 2015; Lee et al., 2014; Lippevelde et al., 2013; Melbye et al., 2016; Park, Li, & Birch, 2015; Pettigrew, Jongenelis, Chapman, & Miller, 2015; van Ansem et al., 2014; van de Gaar, van Grieken, Jansen, & Raat, 2017; Van Der Horst et al., 2007).

It is difficult to amalgamate the results of these findings due to the variety of measures, and methods of analysis used, but a brief summary of the findings related to parental effects on sugar intake of children and adolescents is presented below.

Frequency of family meals was found to be related to the diet quality of children and adolescents (ages 0 to 17 years, n=1,992) in a study conducted in North Carolina, United States (Fink et al., 2014). In their analysis, the authors adjusted for children's age, gender, race, levels of sedentary activity, and parental education, and found that participating in five or more family meals per week was associated with less SSB intake among children ages 6 to 11 (OR: 2.12, 95% CI 1.27, 3.55) (Fink et al., 2014). The authors postulated that this link may occur due to children eating the same food as their caregivers during family meals, compared to the dietary choices they would independently make for themselves in the absence of family meals (Fink et al., 2014). Yet, a study examining the effect of family meal frequency on the diet quality of children (ages 8 to 9, n=3,435) in South Korea found that family meal frequency is associated with healthy eating behaviours but not with the consumption of sweets or SSB (Lee et al., 2014). The authors noted that this finding could be due to sweets and SSB being available in the home environment but not typically being consumed during family meals (Lee et al., 2014).

In a study of child feeding practices among 1,350 American children (age 6), it was found that consuming SSB more than once daily (compared to no SSB consumption) was significantly lower in children whose mothers reported setting limits on sweets/junk foods (aOR: 0.29; 95% CI: 0.15, 0.58 for underweight/normal-weight children; aOR: 0.16; 95% CI: 0.03, 0.79 for overweight/obese children). Yet alternatively, SSB intake was higher among underweight/normal-weight children whose mothers reported trying to keep their child from eating too much of their favorite foods (aOR: 2.03; 95% CI: 1.25, 3.29). Additionally, mothers' tendencies to pressure their children to consume more food or to ‘‘clean the plate’’ was not associated with children's SSB intake (Park, Li, & Birch, 2015).

Parental factors were analyzed through mediation analysis by three separate papers. One paper found that the positive association between adolescent impulsivity and soft drink consumption was mediated by adolescents' perception of parental legitimate authority (Melbye et al., 2016). In terms of understanding how parental factors may interact with SES influences on sugar intake, one paper found that while children of mothers with a low education level were found to consume more SSB than those of mothers with a high education level (β= 0.63, 95% CI: 0.36, 0.91), this association was mediated by parental intake of snacks and SSB, and home availability of SSB (van Ansem et al., 2014). Lastly, a study of adolescents in the Netherlands (ages 12 to 17, n=383) found that more restrictive parenting practices were associated with lower consumption of sugar-sweetened beverages (β= -38.0 ml; 95% CI -48.1, -28.0). This association was highly mediated (~55%) by attitude, self-efficacy and modeling from parents. Nevertheless, there was still a significant direct effect of restrictive parenting practices on SSB intake (β= -17.1 ml; 95% CI: -27.2, -6.90) (Van Der Horst et al., 2007).

A study of the association between eleven different family-related factors (parental modeling, automaticity, availability, parental monitoring, allowing, negotiating, communicating health benefits, avoiding negative role modeling, parental self-efficacy, allowing SSB as a reward, and drinking SSB together) and children's SSB consumption found that modeling, availability of SSB, drinking SSB together, permissiveness, monitoring, and self-efficacy were the family related factors significantly associated with children's SSB consumption (ages 11 to 12, n=7,915, in eight European countries) (Lippevelde et al., 2013). In another paper, parental support for healthy eating and parents' attitudes towards SSB were found to have a significant relationship with their children's sugar consumption (Pettigrew et al., 2015).

Overall, despite differences in how parental influence was measured and assessed, these research papers indicate that the diet quality of children is not simply tied to parental education and income, but also how active of a role parents take in creating a healthy food environment for their children.

2.5.3 Environmental Determinants

2.5.3.1 Food Environment

Five papers found that eating at fast food establishments significantly increased the odds of SSB consumption (Demissie et al., 2015; Jones, Hammond, & Reid, 2015; Lopez et al., 2012; Park et al., 2012; Powell & Nguyen, 2013). One of these papers found that fast-food and full-service restaurant consumption, were associated with higher intake of SSB (73.77g and 88.28g for children, respectively; 163.67g and 107.25g for adolescents, respectively). Fast-food consumption also increased intake of sugar (5.71 to 16.24 g) for both age groups (Powell & Nguyen, 2013). This correlation is likely due to the increased availability and low cost of SSB in fast food outlets, (Demissie et al., 2015; Jones et al., 2015; Park et al., 2012). In line with these findings, other papers chose to examine the effect of neighbourhood food environments since they are thought to have an influence on dietary behaviours (An & Sturm, 2012; Deierlein et al., 2014; Hearst, Pasch, & Laska, 2012; Laska et al., 2010; van de Gaar et al., 2017). It is hypothesized that greater access to restaurants, convenience stores, and fast food outlets encourages obesogenic behaviours such as the high consumption of energy rich foods, while greater access to grocery stores encourages better dietary intake (Laska et al., 2010).

In an observational cohort study of girls ages 6 to 8 (n=1,010) in the United States, it was found that girls with access to only one type of local snack-food outlet reported consuming SSB and sweets less frequently than girls with access to two or three types of outlets, and that intake of sugary items increased with greater use of snack outlets (Deierlein et al., 2014). Similar results were observed in a study that specifically assessed the differences between urban and suburban food environments (Hearst et al., 2012). This study of adolescents in the United States (ages 11 to 17, n=634) found that greater perceived time to walk to food outlets was associated with less frequent purchasing of SSB. Multivariate models showed that a perceived shorter walking time to food outlets (i.e. 1 to 5 minutes vs. +31 minutes) was significantly associated with more SSB purchasing. SSB purchases were also significantly associated with the number of food outlets within a 10 min walk; these finding were observed after adjustment for clustering at the school and study level, gender, age, qualifying for reduced cost school lunches, race, perceptions of neighbourhood safety, ease of mobility in the neighbourhood, and urban versus suburban neighbourhood classification (Hearst et al., 2012).

These findings highlight the impact of environmental exposure to food outlets on the sugar intake of children and adolescents.

2.5.3.2 School Food Environment

2.5.3.2.1 Retail Food Environment Surrounding Schools

When studying the effect of the food environment on youth's dietary behaviours, the retail density surrounding schools was often studied in addition to studying the effect of residential areas, since youth spend the majority of their time in school. In a study of school and residential food environments on the diet of youth in California (ages, 5 to 11, n=8,226), wherein food environments were measured by the number and density of food outlets from varying distances from the respondents school and home, no robust relationship with sugar consumption was found (An & Sturm, 2012). Another American study assessed whether racial differences in SSB consumption among adolescents (ages 11 to 14, n=18,281) could be explained by differential distribution of food outlets surrounding schools. The authors did not find the retail food density surrounding schools to be associated with individual SSB consumption, nor did it mediate the association between race and SSB consumption (Richmond et al., 2014). A Canadian study from

Sherbrooke, Quebec found no significant relationship between six different measures of the food environment surrounding schools, but did note that students (ages 5 to 12, n=8,612) attending schools with lower urban density had a significantly lower risk of SSB consumption compared to students in other school environments (Lebel et al., 2016). Another study that examined both the residential and school food environments of adolescents (ages 10 to 17, n=334), in the United States did find a significant association of SSB intake with residential proximity to restaurants, convenience stores, grocery stores and other retail facilities within 800 and/or 1600 meters, but the school food environment had no significant association with SSB intake (Laska et al., 2010). Lastly, a systematic review that included some of the papers mentioned above (An & Sturm, 2012; Laska et al., 2010; Richmond et al., 2014) in addition to 27 other papers found little evidence for the effect of food outlets near schools on children and adolescent's (ages 5 to 18) food purchases, consumption, and body weight (Williams et al., 2014).

The inconsistency of these findings could potentially be due to differences in the age of the study populations in these research papers. The studies that looked at children between 5 to 11 years, and 5 to 12 years, did not find strong associations (An & Sturm, 2012; Lebel et al., 2016) but the paper that studied adolescents 10 to 17 years did find a significant association between the food environment and sugar consumption (Laska et al., 2010). Adolescence marks a time of greater independence both for youth to go places they want to go, and make their own dietary choices thus, food environment may have a greater impact at this age compared to younger children that rely more heavily on their parents to make dietary choices for them (Laska et al., 2010). Additionally, Williams et al. (2014) noted that is it difficult to establish causality due to the cross-sectional nature of most of the studies, and that the inability to pool results due to the multiple definitions and measures of food environment surrounding schools further weakens the results (Williams et al., 2014).

2.5.3.2.2 Food Environment Within Schools

While no robust relationship was found between the food environment surrounding schools and sugar intake in the studies mentioned above, studies that analyzed the food environment within schools (rather than outside schools) did have robust findings. For example, one study that used propensity score stratification of students who did and did not have vending machines in their schools, showed that American adolescents (ages 12 to 17, n=3,983) who had access to SSB through their school vending machines consumed 0.170 (p-value < 0.05) more SSB than those who did not have a school vending machine with SSB (Shi, 2010). Another American study that examined the association between food sold in vending machines and dietary behaviours among students (ages 11 to 16, n=5,930) found that vending machine content was positively related to corresponding food intake (for both the intake of healthy foods such as fruits and vegetables, and items high in sugar such as chocolates and SSB) in younger adolescents ages 11 to 13, but not among older adolescents aged 14 to 16 (Rovner, Nansel, Wang, & Iannotti, 2011). An additional study of the effect of vending machines on the dietary behaviours of adolescents (ages 12 to 14, n=4,322) found that when vending machines are available in a school, more students chose to purchase unhealthy snacks such as candy and SSBs rather than buying a school lunch (aOR=3.5, 95% CI: 2.2, 5.7) (Park et al., 2010). A study that did not focus directly on the presence of vending machines in schools but rather the overall SSB availability, school based purchases, and overall consumption of SSB (not just in school) found that 26% of adolescents (age 11, n=10,215) that had access to SSB at school consumed them, and those that consumed more SSB at school were more likely to consume more SSB overall (Fernandes & Rand, 2008). In summation, the results of these studies indicate that vending machines and other sources of sugary foods and drinks within the school environment facilitate the purchase and consumption of these items (Park et al., 2010).

For this reason, other studies of the effect of school food environment on added sugar intake focused on the impact of limiting the availability of sugary items in schools. A study from the United States that assessed the sugar intake of children and adolescents (ages 6 to 18, n= 2,314) found that attending a school without stores or snack bars was estimated to significantly reduce SSB consumption by 22 kcal (p-value < 0.05) per school day in middle school children and by 28 kcal (p-value < 0.05) in high school children (Briefel, Wilson, & Gleason, 2009). Johnson and colleagues examined the association between SSB consumption and other predictive school factors such as school size, racial composition, and proportion of students qualifying for free lunches, and determined that exposure to SSB in school was the only factor that correlated with SSB intake among students ($\rho=0.40$, p-value < 0.001) (ages 11 to 14, n=9,151) (Johnson et al., 2009). While the studies mentioned above all analyzed American populations of students, this finding was also replicated in a study of 11,385 students from 174 different schools in British Columbia (Masse et al., 2014). When school setting, neighbourhood education level, and students age and sex were controlled for, school availability of SSBs was positively associated with one drink in the past day (OR = 1.15, 95% CI 1.02 to 1.30) and two or more SSB in the past day (OR = 1.43, 95% CI = 1.13 to 1.80) (Masse et al., 2014). Lastly, findings from a literature review on the effect of school nutrition and price policies on SSB consumption in youth from English language countries indicated that policies to limit SSB availability in schools have generally been associated with reduced SSB consumption in adolescents (Levy et al., 2011). The review also found that the additional benefit of school policies limiting SSB availability is that adolescents did not increase SSB consumption outside of schools as a response to the implementation of these policies, thus school policies can have a net positive effect on reducing sugar intake in children and adolescents (Levy et al., 2011).

2.5.4 Geographical Determinants

Of the 61 papers included in this review only seven analyzed a population of Canadian children and adolescents, thus it is possible that the determinants of added sugar intake exert a different effect, or different size of effect, than discussed above. For example, the presence of social programs such as the Canadian Child Care Benefit may attenuate the effect of low income and food insecurity on a Canadian population of children and adolescents, compared to children from other countries that do not offer such programs. Rather than a child tax benefit, in America, for instance, food assistance programs are utilized to address food insecurity and may affect food insecurity specifically in children and adolescents differently than in Canada (Rossen & Kobernik, 2016). Canada is also very diverse; in 2011, 20.6% of the Canadian population was foreign-born (Statistics Canada, 2011), thus the effects of race and acculturation could possibly be more pronounced in a Canadian data set. In addition, there may be differences by province and other geographical measures.

2.6 Gaps in the Literature

Since only seven out of the 61 studies in this literature review utilized a sample population of Canadian children and adolescents, there is a need for more research to understand the levels and causes of added sugar intake in this population. Of the cross-sectional population-based studies of added sugar intake in Canadian children and adolescents that do exist, all of them have only studied SSB consumption, rather than total amount of added sugar in the diet (Ahmadi et al., 2015; Borghese et al., 2014; Jones et al., 2015; Lebel et al., 2016; Mark et al., 2012; Masse et al., 2014; Sampasa-Kanyinga & Chaput, 2015). While SSB may act as a proxy measure of sugar consumption, it is in no way a comprehensive measure of the daily energy that youth derive from added sugar and more information is needed about total added sugar intake.

Diabetes Canada has developed a guideline for added sugar intake in children and adults and recommends that the intake of added sugar should be less than 10% of daily energy intake (Diabetes Canada, 2016). In order to assess how Canadian children and adolescents are performing according to these guidelines, information on SSB intake is not enough. Information on total added sugar intake is needed, and the Nutrition component of the 2015 Canadian Community Health Survey provides this information via a 24-hour dietary recall. Thus far, no studies have used this recall to study added sugar intake in children and adolescents.

Additionally, most of the papers discussed in this literature review only assessed the effects of a few of the determinants of added sugar intake mentioned above; very few had the capacity to assess a large number of factors at once. Analysis of the data available in the 2015 Canadian Community Health Survey on Nutrition provides the unique opportunity for multiple correlates of sugar consumption at the individual, family, socio-economic and geographical level to be assessed at once on a large representative sample of Canadian children and adolescents.

2.7 Study Rationale

It is important to gain a better understanding of exactly how much added sugar Canadian children and adolescents are consuming, what the correlates of consumption are, and how the consumption of added sugar differs across age and geographical location. A better understanding of added sugar consumption and its determinants will inform more effective policies to reduce added sugar intake to the levels recommended by Diabetes Canada, and also help reduce the risk of childhood obesity.

Yet despite the important contribution of diet and particularly added sugar intake to the risk of obesity for Canadian children and adolescents, there is limited population level data on the dietary and added sugar consumption behaviours of Canadian children and adolescents aside from the information provided by the CCHS on Nutrition from 2004, and now from the CCHS

2015. This study addresses this gap in knowledge by utilizing the CCHS 2015 data on nutrition to examine the dietary patterns and added sugar intake of Canadian children and adolescents.

Chapter 3

3 Methods

This chapter details the methodology used to complete this study. Section 3.1 provides a description of the data source, the Canadian Community Health Survey (CCHS) on Nutrition 2004 and 2015, including an overview of the sampling design and data collection methodology. Section 3.2 details the correlates of added sugar intake used in the analysis and how they were measured. Section 3.3 describes important statistical considerations such as the application of sampling weights, and the methods used to handle missing data.

3.1 Data Source

The data used in this study came from the CCHS-Nutrition 2015. In addition, the CCHS-Nutrition 2004 was also used to address study objective two; that is, to evaluate any changes in dietary intake between 2004 and 2015. The CCHS-Nutrition is a national cross-sectional health survey that collects information from a representative sample of Canadians about their eating habits, use of nutritional supplements, and other health information (Statistics Canada, 2017b). The nutrition component of the CCHS was first conducted in 2004, and again in 2015 to allow for evaluation of changes in dietary intake between these years (Statistics Canada, 2017b). The CCHS-Nutrition survey was developed by Statistics Canada in collaboration with various stakeholders including Health Canada, the Public Health Agency of Canada, and provincial health ministries. The survey data were accessed through Statistics Canada's Research Data Centre at Western University.

3.1.1 Content of Data Source

The specific objectives of the CCHS-Nutrition 2015 are to a) collect detailed data on the consumption of foods and dietary supplements among a representative sample of Canadians at national and provincial levels; b) estimate the distribution of usual dietary intake in terms of nutrients from foods, food groups, dietary supplements, and eating patterns; c) gather anthropometric measurements for accurate body weight and height assessment to interpret dietary intake; d) support the interpretation and analysis of dietary intake data by collecting information on selected health conditions and socio-economic and demographic characteristics; and e) evaluate changes in dietary intake from the CCHS-Nutrition 2004.

The survey questionnaire consists of two components, the 24-hour dietary recall, and the general health questionnaire. The 24-hour dietary recall was completed using computer assisted personal interview (CAPI) which allows for the logical flow in and out of interview questions to be programmed and also prompts the interviewee to provide a detailed recall (Statistics Canada, 2017b). The general health component focuses on disease, health, lifestyle, and social conditions, as well as height and weight measurements (Statistics Canada, 2017b). Approximately 37% of the sample also completed a second dietary recall on a different date using a computer assisted telephone interview (CATI). The present analysis uses data from the first 24-hour recall, and general health components only.

3.1.2 CCHS Nutrition Sampling Design

The target population of CCHS Nutrition 2015 was individuals 1 year of age and older living in the ten Canadian provinces (Statistics Canada, 2017b). Persons from the Canadian territories, those living on reserves and other Aboriginal settlements, those living in certain remote areas, full-time members of the Canadian Forces, and those that are institutionalized were excluded from the target population (Statistics Canada, 2017b).

This cross-sectional survey utilized stratified three-stage sampling to obtain one person from each dwelling in each of the 10 provinces (Statistics Canada, 2017b). The objective was to obtain a sample of 24,000 respondents nationally (Statistics Canada, 2017b). To achieve this goal, 80 sample units were first allocated to each of 12 Dietary Reference Intake (DRI) age and sex groups (The DRI groups are ages 1-3, 4-8, males 9-13, females 9-13, males 14-18, females 14-18, males 19-50, females 19-50, males 51-70, females 51-70, males 71+, and females 71+) in each province (Statistics Canada, 2017b). The remaining 14,400 sample units were allocated to provinces depending on their population size (Statistics Canada, 2017b).

Geographical clusters were first defined using Census Dissemination Areas (DAs) that were slightly modified to ensure each possible geographical cluster had a minimum of 200 dwellings, but were also not too large in area (e.g. some neighbouring DAs were combined, and the Labour

Force Survey was used to identify areas of exclusion and remote areas) (Statistics Canada, 2017b). After the first stage in which clusters were selected, a list frame of households was used to select a sample of households in each cluster (Statistics Canada, 2017b). At the third stage, one person was selected from the household depending on the household roster obtained at the beginning of the interview (Statistics Canada, 2017b). This stratified three-stage sampling design was used for all provinces except Prince Edward Island (PEI). In PEI two-stage sampling was conducted by forgoing the sampling of geographical clusters (Statistics Canada, 2017b).

Interviews were conducted using CAPI, and the format of the interview varied by the age of the respondents. Interviews of children ages 1 to 5 were conducted in proxy by their parent or guardian. Interviews of children 6 to 11 were parent assisted, whereby children completed the survey with the aid of their parents. Respondents ages 12 and up provided their own information without aids. Proxy interviews for those over the age of 6 were only conducted when mental or physical limitations prevented the respondents from providing the information themselves.

3.1.3 24-Hour Dietary Recall

The 24-hour dietary recall is the main component of CCHS-Nutrition. All the diet related variables investigated in this study, including added sugar intake, fruit and vegetable intake, caloric intake, and energy intake from added sugar, are derived from the information provided by the dietary recall. The dietary recall component used the Automated Multiple-Pass Method (AMPM), which is a computer based interviewing tool that helps respondents accurately report all food and drink consumed in the previous 24-hours, and also helps glean more specific details about foods consumed (Statistics Canada, 2017b). While AMPM was originally developed by the USDA, it has been modified in CCHS-Nutrition to better reflect the foods available to, and consumed by the Canadian population.

The AMPM has five distinct interview components that were designed to keep respondents engaged in the interview and to help them remember all foods and beverages they consumed in the past 24 hours (Statistics Canada, 2017b).

1. The 'quick list' step allows the respondent to list all foods and beverages in any order they remember, without being interrupted by the interviewer. This allows for a quick collection of easily remembered foods.

2. The 'forgotten foods' step aims to help the respondent report foods that may have been forgotten in the 'quick list' step. The interviewer probes the respondent on whether they consumed any non-alcoholic beverages, alcoholic beverages, sweets, savoury snacks, fruits, vegetables, cheese, breads and rolls, and any other types of foods.

3. The 'time and occasion' step asks the respondents the time when they were eating or drinking each of the reported foods, and how they would classify the eating occasion (e.g. breakfast, lunch, etc.). This step is designed to help the respondent remember their eating patterns for the past 24-hours, and to allow the interviewer to group together foods and drink consumed in one eating occasion.

4. In the 'detail cycle' step, the interviewer asks standardized questions in order the gain more details about the foods and beverages that have been reported earlier. The aim is to collect more information about food descriptions, food amounts, additions to foods, preparation methods, and whether the food was fortified. A 'Food Model Booklet' is used to help the respondent accurately report the quantity of food consumed. This booklet contains pictures of glasses, mugs, bowls, mounds/pats/spreads, circles, and other images to help them accurately describe portions. Eating occasions and times are also reviewed in this step to ensure there were no foods that were forgotten. Lastly, respondents are asked where their meal was consumed.

5. The 'final review' step includes a final probe for foods that may have been consumed but not remembered earlier.

After this last step, the respondents are asked trailing questions about their dietary habits including questions about their salt consumption, and any food exclusions to which they adhere (e.g. meat, eggs, dairy products, gluten, etc.).

3.1.4 Study Population

For the purposes of the current study, the study population was limited to children and adolescents between the ages of 6 and 17. Pregnant individuals were excluded because they have altered dietary and nutrient requirements. After these exclusions were applied, the 2004 cohort had a sample size of 10,028 and the 2015 cohort had a sample size of 4,359.

3.2 Measurement Instruments

This study was conducted to analyze the amount and correlates of added sugar in the diet of Canadian children and adolescents in 2004 and 2015, as well as dietary habits related to added sugar intake. The following section describes each of the instruments used in the analysis and how it was measured.

3.2.1 Added Sugar Intake

Added sugar from all food sources is the main outcome variable used in this study. Added sugar is defined as any sugar added during the processing and preparing of foods, or at the table, but does not include intrinsic sugars found in fruit, fruit juices, vegetables, milk, and so on (Yang et al., 2014).

The added sugar variable was created for the purposes of this study by utilizing two important features of how the food recall data are processed and reported: the Bureau of Nutritional Sciences (BNS) food group codes that are assigned to each reported food item, and the sugar intake in grams calculated by Statistics Canada for every food and drink item reported in the recall.

The Bureau of Nutritional Sciences at Health Canada has food group codes for basic foods and recipes that are assigned to every food item reported in CCHS-Nutrition. For this study, the 24-hour recall data were limited to food items that are processed and/or may contain added sugar; while foods with BNS codes for intrinsic sources of sugar such as fruit, fruit juice, vegetables, meat, milk, and so on, were excluded. Detailed information on BNS food group codes included in the calculation of added sugar intake for every subject is available in Appendix B.

Once the recall data were limited to any food and drink with added sources of sugar, the nutrient value of added sugar that corresponds to the reported amount of food consumed, was converted to grams and summed to create a total added sugar intake in grams per day variable for each subject.

The variable of added sugar from food sources shows a right-skewed distribution, with a small number of outliers. To deal with this issue, the original variable was recoded into categories representing 10g intervals, with the last category of 350+g including all outliers; this produced a more normal distribution with a smaller skew.

3.2.2 Fruit and Vegetable Intake

To gain a more comprehensive understanding of both the healthy and unhealthy aspects of the diet of Canadian children and adolescents, the second objective of this analysis is to compare the dietary behaviours (added sugar intake, energy intake from added sugar, caloric intake, fruit intake, and vegetable intake) of Canadian children and adolescents in 2004 and 2015. The CCHS-Nutrition 2004 provides fruit and vegetable intake as a derived variable by summing the reported frequency of intake of fruit, fruit juice, green salad, carrots, potatoes, and other vegetables. This variable uses data from the general health survey component and measures the total number of times per day (frequency) fruits and vegetables are consumed, not the amount consumed. In 2004, respondents were asked how often they usually eat a given type of fruit or vegetable, and respondents had the option of choosing the reporting period (e.g. per day, week, month, year). These types of questions were not included in the general health component of the CCHS-Nutrition 2015. Thus, to create a corresponding measure of fruit and vegetable intake in 2004 and 2015, new composite variables for both CCHS cycles were created using the information available in the 24-hour dietary recall portion of the surveys.

Similar to the process used to create the added sugar variable, the BNS food codes assigned to every food item reported in the 24-hour recall were combined to create the fruit and vegetable variables. The fruit intake variable reflects how many servings of fruit and fruit juice were consumed and reported in the 24-hour food recall. The vegetable intake variable reflects how many servings of green salad, carrots, potatoes, and all other vegetables were consumed and reported. This measure does not include potatoes that were deep-fried or roasted, but does included potatoes prepared using other methods. The decision was made to exclude deep-fried potatoes from the measure of vegetables because their high fat and salt content undermines their nutritional value and the Canadian Food Guide recommends that vegetables should be prepared with minimal fat and salt (Health Canada, 2007). Deep-fried potatoes and roasted potatoes are assigned the same BNS food code, that is why roasted potatoes had to be excluded as well. It should be noted that the fruit and vegetable variables reflect how frequently they were consumed during the food recall day, not a specific amount consumed.

3.2.3 Individual Characteristics

3.2.3.1 Sex

Sex was included in the predictive model developed for this study because previous research shows added sugar intake can vary by sex (Al-Haifi et al., 2016; Clarke et al., 2014; Ferreira et al., 2015; Mark et al., 2012; Park et al., 2012; Santaliestra-Pasias et al., 2012; Vagstrand, Linne, Karlsson, Elfhag, & Lindroos, 2009b). In the CCHS-Nutrition, sex is reported as 'male' or 'female', and in the analysis, it is coded as a binary variable.

3.2.3.2 Age

The CCHS-Nutrition reports every respondent's age in years by asking respondents their age and also their date of birth. Age is relevant to the current analysis because children and adolescents' nutritional requirements and growth rates can vary greatly by age (Ferreira et al., 2015). In this analysis, age was kept as a continuous variable with values between 6 and 17.

3.2.3.3 Race

The race that respondents identify with was determined in CCHS-Nutrition by asking which racial or cultural groups respondents feel they belong to. As respondents may identify with more than one group, they were individually probed about each racial and cultural group including White, South Asian, Chinese, Black, Filipino, Latin American, Arab, Southeast Asian, West Asian, Korean, Japanese, or Other. Race was included in the present analysis as a binary variable depending on whether or not respondents identified themselves as White or not White, since White is the largest racial group in Canada (Statistics Canada, 2017).

3.2.3.4 Immigration Status

Previous research has shown that recent immigrants may possess different dietary patterns than the native population or less recent immigrants to a country, but may over time adopt local dietary patterns through acculturation (Liu et al., 2012). In order to assess the impact of immigration status on the added sugar intake of children and adolescents living in Canada, recent immigrant status was included in this analysis as a binary variable. Respondents were first asked if they are, or had ever been, landed immigrants to Canada. Those that responded yes were additionally asked how long they have been in Canada. Subjects were coded as recent immigrants if they came to Canada in the last five years. Immigrants that have been in Canada for longer than five years, and non-immigrants were grouped together and coded as not recent immigrants.

3.2.3.5 Physical Activity

Previous research has proposed that higher sugar intake is associated with lower physical activity levels, thus pointing to a clustering of unhealthy behaviours (Byrd-Williams et al, 2010, Park et al, 2012). To explore this association in a Canadian setting, hours spent in physical activity per day was included in the statistical model. Physical activity is defined in the CCHS-Nutrition as "Any activity that increases heart rate and causes temporary shortness of breath, such as running, swimming, dancing, brisk walking, rollerblading, biking, soccer, basketball, etc.". Respondents were asked about physical activity during free time at school, during class time, organized sports outside of school, and leisure time (unorganized) physical activity outside of school. While CCHS-Nutrition reports physical activity as a continuous variable in hours per week, for this analysis this measure was converted to hours per day to keep consistent with the measure of sedentary behaviour, which is reported in hours per day.

3.2.3.6 Sedentary Activity

High levels of sedentary activity have been positively linked to the higher consumption of added sugar among children and adolescents in numerous studies (Borghese et al., 2014; Bornhorst et al., 2015; Byrd-Williams, Hoelscher, Springer, & Ranjit, 2010; Ferreira, Claro, & Souza Lopes, 2015; Gebremariam et al., 2017; Kenney & Gortmaker, 2017; Lipsky & Iannotti, 2012; Moreira et al., 2010; Park et al., 2012a; Park et al. 2012b; Pearson, Ball, & Crawford, 2011; Santaliestra-

Pasias et al., 2012). Information on sedentary activity was gathered by asking respondents how many hours per day they spend watching TV, using a game console, computer, tablet, or hand-held device, including time spent playing games, emailing, chatting and surfing the Internet. Sedentary behaviour is a continuous variable expressed in hours per day.

3.2.4 Family Level Characteristics/ Social Determinants of Health

3.2.4.1 Household Income

Total household income was included in the model as previous research indicates that added sugar intake may be higher among children and adolescents from low income families (Han & Powell, 2013; Mark et al., 2012). In the CCHS-Nutrition, total household income was ascertained by asking the person most knowledgeable about the household situation to report total income, before taxes and deductions, from all sources including wages and salaries, income from self-employment, dividends and interest, employment insurance, worker's compensation, benefits from Canada or Quebec pension plan, retirement pensions, superannuation and annuities, RRSP/RRIF, Old Age Security and Guaranteed Income Supplement, provincial or municipal social assistance or welfare, Child Tax Benefit or family allowances, child support, alimony, or other sources such as rental income or scholarships.

In the CCHS-Nutrition total household income was reported as an absolute value, and also in adjusted deciles at the provincial and federal levels. For this analysis, deciles of income at the federal level were used. This derived variable distributes the respondents into 10 categories of income (10 deciles) with approximately the same percentage of residents from each province, based on their value of adjusted household income ratio. Adjusted household income ratio is a ratio of total household income to the low-income cut-off corresponding to their household and community size. For each respondent, this ratio helps provide a relative measure of their household income to the household incomes of all other respondents.

3.2.4.2 Household Education

Parental education is another indicator of socio-economic status that has been found in previous research to be inversely related to added sugar intake in children and adolescents, (Ahmadi et al., 2015; Craig et al., 2010; Fernandez-Alvira et al., 2013; Han & Powell, 2013; van Ansem et al., 2014). For this analysis the variable of 'Highest educational attainment in the household' was used. In the CCHS-Nutrition this is a categorical variable with the following seven options: Less than High School diploma or its equivalent, High School diploma or a High School equivalency certificate, Trade certificate or diploma, College/CEGEP/ other non-University certificate or diploma, University certificate or diploma below the Bachelors level, Bachelors degree (e.g. BA, BSc, LLB), or University certificate, diploma, degree above Bachelors level. For the purposes of this study, these seven categories were collapsed into three categories (Trade certificate or diploma/High School diploma or less, College/CEGEP/other certification below the Bachelors level, and Bachelors degree or higher).

3.2.4.3 Food Security

Due to the lower cost and higher energy density of sugar rich foods, researchers suggest that added sugar intake may be higher in food insecure households (Ahmadi et al., 2015; Calloway et al., 2016; Rossen & Kobernik, 2016b). To explore this relationship in a Canadian population, a measure of food insecurity in children and adolescents was created by asking eight questions about food security as they relate to children and adolescents. If the person most knowledgeable about the household situation gave zero affirmative answers, the child was classified as 'Food secure'. Two to four affirmative responses translated into a classification of 'Moderately food insecure', and five or more affirmative responses translated to 'Severely food insecure'.

3.2.5 Geographic Location

3.2.5.1 Province

Province of residence was included in the model in order to assess whether there are geographical differences in added sugar intake. As mentioned earlier, the CCHS-Nutrition survey does not sample from the Canadian territories, thus there are ten categories for province of residence. These ten categories were condensed by grouping together the Maritime provinces (Newfoundland and Labrador, Prince Edward Island, Nova Scotia, and New Brunswick), and the Prairie provinces (Alberta, Saskatchewan, and Manitoba).

3.3 Statistical Analysis

3.3.1 Descriptive Statistics

Descriptive statistics were produced to understand the basic characteristics of the 2004 and 2015 datasets. Frequency distributions were calculated for sex, age, race, recent immigrant status, sedentary activity, physical activity, household income, household education, food security, region of residence, added sugar intake, fruit intake, vegetable intake, caloric intake, and energy intake from added sugar for variables from both the 2004 and 2015 CCHS-Nutrition surveys.

3.3.2 Analyses for Objective 1

The first objective of this study was to determine the amount of added sugar in the diet of children and adolescents in 2015, and to assess whether children and adolescents are meeting added sugar intake guidelines published by various health agencies including the American Heart Association, and Diabetes Canada. These guidelines relate to what percentage of daily energy intake should be derived from added sugar. These guidelines recommend that daily energy derived from added sugar should not exceed 10% of total energy intake (Diabetes Canada, 2016; Johnson et al., 2009).

Bivariate analysis was also conducted in order to gain a better understanding of the relationship between the amount of added sugar intake and dietary habits associated with added sugar intake. For this analysis, the variable measuring the amount of added sugar intake was divided into quartiles based on what percentage of energy intake was from sources of added sugar. The categories for this assessment were 5% or less daily energy from added sugar, 5% to 10%, 10% to 25%, and more than 25% of daily energy intake from added sugar. How individuals across these categories differed in terms of their fruit, vegetable, and total caloric intake was also assessed.

3.3.3 Analyses for Objective 2

The second objective of this study was to compare select dietary habits of children and adolescents across 2004 and 2015. The variables compared include added sugar intake, fruit intake, vegetable intake, daily caloric intake, and percentage of daily energy intake derived from added sugar. Student T-tests were computed to statistically assess time differences in these dietary habits. Statistical significance was defined as p-value < 0.05.

3.3.4 Analyses for Objective 3

The third objective of this study was to develop and test a model to assess the relationship between added sugar intake and other unhealthy behaviours such as sedentary behaviour and physical inactivity. This objective was achieved by performing linear regression analyses and by entering correlates in groups depending on how they are related to the outcome variable. In this analysis, the first group of correlates entered into the regression model included the behavioural variables related to sedentary activity and physical activity. The second block of covariates included the demographic and socio-economic characteristics of age, sex, ethnicity, immigrant status, household income, household education, food security, and region of residence. Statistical significance was defined as a p-value < 0.05.

3.4 Other Statistical Considerations

3.4.1 Sample Weights

Sample weights were applied to all statistical tests in order for the results of this study to be representative of all children and adolescents in Canada. CCHS-Nutrition assigns a unique survey weight to each respondent included in the final sampling frame. The sample weight corresponds to the number of people in the population that are represented by each respondent. The sample weights were rescaled to represent the actual size of the selected sample.

3.4.2 Bootstrap Weights

Bootstrap weights were used for variance estimation in this study in order to assess the quality of the estimates produced. Bootstrap weights were created by CCHS-Nutrition through random resampling with replacement from the original sample, and by applying similar adjustments as those that were applied to the sample weights.

3.4.3 Missing Data

Missing data patterns were analyzed for both the CCHS-Nutrition 2004 and 2015 datasets. For the variables of interest from the 2004 survey (added sugar intake, age, sex, race, immigrant status, valid food recall), 99.80% of the respondents responded to all survey questions, and the variable with the most missing data was recent immigration status, with 0.11% of the respondents have missing data points. For the variables of interest in the 2015 survey (added sugar intake, age, sex, race, immigrant status, physical activity, sedentary behaviour, household income, household education, food security, and region of residence), 91.33% of those who responded had a complete data pattern. The variable with the highest frequency of missing data was white race, with 6.19% of respondents having a missing data point for this variable. Listwise deletion was used to circumvent the problem of missing data in this study. In listwise deletion, an observation is not used in the analysis if it has one or more missing values. After listwise deletion of all subjects with any missing values for the variables of interest, the 2004 dataset had a sample size of 10,008, and the 2015 dataset had a sample size of 3,972.

Imputation for missing data on household income was completed by Statistics Canada using statistical techniques, and was necessary for 25% of the sample. Donor imputation was used for 3% of missing data in regard to the respondent's postal code.

3.4.4 Software

All statistical analyses were completed using SAS software version 9.4 (SAS Institute Inc., 2012). Regression models were produced using the PROC SURVEYREG procedures.

Chapter 4

4 Results

This chapter presents the findings of this study. Section 4.1 provides a description of the study sample, and an assessment of what proportion of children and adolescents are meeting added sugar intake guidelines. Section 4.2 examines the changes in added sugar intake and other dietary behaviours between 2004 and 2015. Section 4.3 presents bivariate associations between added sugar intake and its correlates. Lastly, Section 4.4 presents the results from the multivariable regression analysis that assessed the relationship between added sugar intake and other behavioural characteristics.

4.1 Description of Study Sample

4.1.1 Sample Characteristics

CCHS-Nutrition 2004 had 10,038 respondents between the ages of 6 and 17 with valid food recalls. Out of these, 10 respondents were excluded from the analysis on account of them being pregnant at the time of the survey, thus leaving a study sample size of 10,028. CCHS-Nutrition 2015 had 4,360 respondents between the ages of 6 and 17. One respondent was pregnant at the time of survey completion and was thus excluded leaving a study sample size of 4,359. The specific characteristics of the 2004 and 2015 samples are presented in Table 1. The presented characteristics (sex, age, race, immigration status, time spent engaging in sedentary behaviour, time spent in physical activity, household income, household education, food security status, and region of residence) were selected based on previous literature that indicates that these factors are associated with added sugar intake. There were some inconsistencies between the measurement tools used in 2004 and 2015 and thus, sedentary activity, physical activity, household income, and food security cannot be directly compared.

In CCHS-Nutrition 2004, respondents were asked to report their time spent in sedentary activity in the past three months in terms of how many hours in a typical week were spent in sedentary activity, and the response options were in ranges (e.g. less than 1 hour, from 1 to 2 hours, etc.), thus this measure cannot accurately be converted or compared to the hours per day spent in sedentary activity measure that was used in CCHS-Nutrition 2015. A similar problem arose when trying to compare data on physical activity levels between 2004 and 2015. Similarly, in both 2004 and 2015, respondents were asked to report their household income in income brackets; however these brackets were formatted differently at each time point. Brackets were larger in 2015, and the upper bracket in 2004 was $80 000 or higher, while in 2015 it was $90 000 or higher, thus preventing direct comparison between the samples in 2004 and 2015. Lastly, food security also cannot be directly compared because the food security measure in 2004 is a household measure that is based on 18 questions, and indicates whether households with and without children were able to afford the food they needed in the previous 12 months. Whereas in 2015, the food security measure was based on 8 child-referenced questions and describes the food security of the child and adolescent members of a household in the previous 12 months, since children in a household may experience food insecurity differently than adult members of a household.

There are some notable differences between the characteristics of the samples in CCHS-Nutrition 2004 and 2015. A larger proportion of non-White individuals were sampled in 2015; in 2004, 17.66% of the sample identified as non-White, while this number rose to 29.6% in 2015. Mean household income also varied greatly between these two samples. Average household income for the 2004 sample was $70,189, and for the 2015 sample it was $100,368. These income values are quite high, especially for the 2015 sample since according to Canadian Census', mean household income in 2005 was $63,457, and in 2015 it was $70,366 (Statistics Canada, 2017a). This may indicate a non-response bias since participation in the survey was completely voluntary. In terms of household education, the sample was more balanced between the different categories of household education in 2015, while in 2004 73.85% of the sample had a University Bachelor degree or higher.

Table 1: Characteristics of CCHS-Nutrition 2004 and 2015 Study Samples

	2004		2015	
Variable	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
Sex				
Male	4846	48.32	2126	48.78
Female	5182	51.68	2233	51.22
Age				
6	767	7.65	352	8.08
7	751	7.49	335	7.67
8	831	8.28	384	8.82
9	778	7.75	399	9.16
10	816	8.14	329	7.54
11	869	8.67	349	8.00
12	901	8.99	338	7.75
13	842	8.40	338	7.76
14	899	8.96	433	9.93
15	962	9.60	402	9.22
16	838	8.35	329	7.54
17	775	7.73	372	8.55
Race				
White	8248	82.34	2945	70.4
Not White	1769	17.66	1238	29.6
Missing	11		176	
Immigration Status				
Recent Immigrant	344	3.44	217	4.98
Not a Recent Immigrant	9669	96.56	4135	95.02
Missing	15		7	
Sedentary Activity (h/week)				
≤ 9.9	1768	17.68		
10 to 19.9	3616	36.16		
20 to 29.9	2745	27.45		
30 to 39.9	990	9.90		
40+	882	8.82		
Missing	27			
Sedentary Activity (h/day)				
≤ 1.9			1224	28.15
2 to 3.9			1780	40.94
4 to 5.9			792	18.23
6 to 7.9			329	7.57
8+			222	5.11
Missing			12	
Physical Activity (h/week)				
≤ 4.9	5294	53.05		
5 to 9.9	1331	13.33		

10 to 14.9	1332	13.35		
15 to 19.9	1372	13.75		
20+	651	6.53		
Missing	48			
Physical Activity (h/day)				
≤ 0.9			1127	26.18
1 to 1.9			1670	38.82
2 to 2.9			1102	25.6
3 to 3.9			335	7.78
4+			70	1.62
Missing			56	
Income ($)				
9,999 or less	162	1.87	48	1.1
10,000 to 29,999	1312	15.14	420	9.63
30,000 to 49,999	1676	19.35		
30,000 to 59,999			862	19.79
50,000 to 79,999	2597	29.97		
60,000 to 89,999			959	21.99
80,000+	2917	33.67		
90,000+			2070	47.49
Missing	1364			
Education				
Trade, High School or less	1767	17.93	1033	23.73
College/University below Bachelors level	809	8.21	1437	32.99
Bachelors or more	7276	73.85	1885	43.28
Missing	176		4	
Food Security				
Food Secure	9139	92.05	4054	94.08
Food Insecure without Hunger	573	5.77		
Food Insecure with Moderate Hunger	185	1.86		
Food Insecure with Severe Hunger	32	0.32		
Moderately Food Insecure			242	5.61
Severely Food Insecure			13	0.31
Missing	99		50	
Region				
Maritimes	709	7.07	269	6.17
Quebec	2217	22.11	944	21.65
Ontario	4075	40.64	1714	39.33
Prairies	1748	17.43	893	20.48
British Columbia	1279	12.75	539	12.36

4.1.2 Recommended Intake of Added Sugar

Various health associations including Diabetes Canada make a strong recommendation that in order to prevent the development of various chronic diseases including obesity, daily added sugar intake should make up less than 10% of daily energy intake. According to CCHS-Nutrition 2004, mean added sugar intake was 98.48 grams (g) and mean energy intake from added sugar was 17.29%. In 2015 mean added sugar intake was 80.48g and mean daily energy intake from added sugar was 16.66%. Table 2 indicates the frequency distribution of energy intake from added sugar and it shows that distribution across the categories of energy intake has remained stable from 2004 to 2015. Five percent or less energy intake from added sugar is the optimal level of added sugar intake recommended by health agencies yet only around 13 to 15% of children and adolescents fall into this category both in 2004 and 2015, while the majority of children and adolescents attain 10% to 25% of their daily energy intake from added sugar. Overall, in 2004, 32.83% of Canadian children and adolescents were meeting added sugar intake guidelines, and this number rose only very slightly to 35.66% in 2015.

Table 2: Daily Energy Intake from Added Sugar of CCHS-Nutrition 2004 and 2015 Study Samples

	2004		2015	
Variable	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
Energy Intake from Added Sugar (%)				
≤ 5%	1324	13.22	664	15.25
5.1% to 10%	1965	19.61	889	20.40
10.1% to 25%	4555	45.46	1960	45.00
≥ 25.1%	2176	21.71	842	19.34
Missing	8			

4.1.3 Sugar Intake and Other Dietary Behaviours in 2015

In order to investigate how energy intake from added sugar is related to other dietary behaviours, the 2015 sample was sorted into quartiles depending on their percentage of energy intake from added sugar, and dietary behaviours were compared across categories. The results are presented in Figures 2 and 3.

Fruit and vegetable intake did not vary greatly by added sugar intake category, but the number of servings of both fruits and vegetables was higher than average in the '10% to 25%,' and 'More than 25%' categories of added sugar intake. When examining caloric intake, children in the 'More than 25%' category consumed less than the average amount of calories, possibly indicating that added sugar was being consumed at the expense of calories from other more nutritious sources.

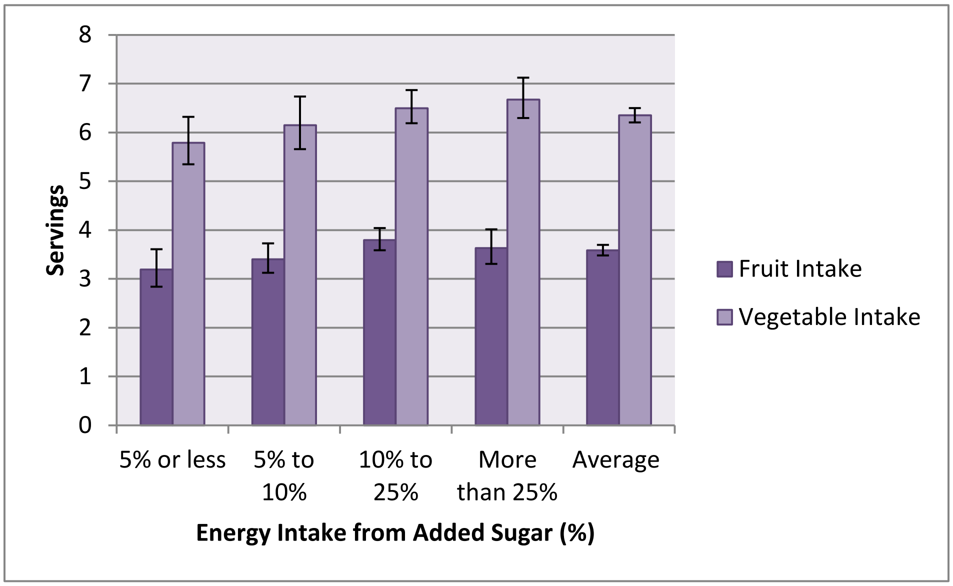

Figure 2: Fruit and Vegetable Intake by Energy Intake from Added Sugar

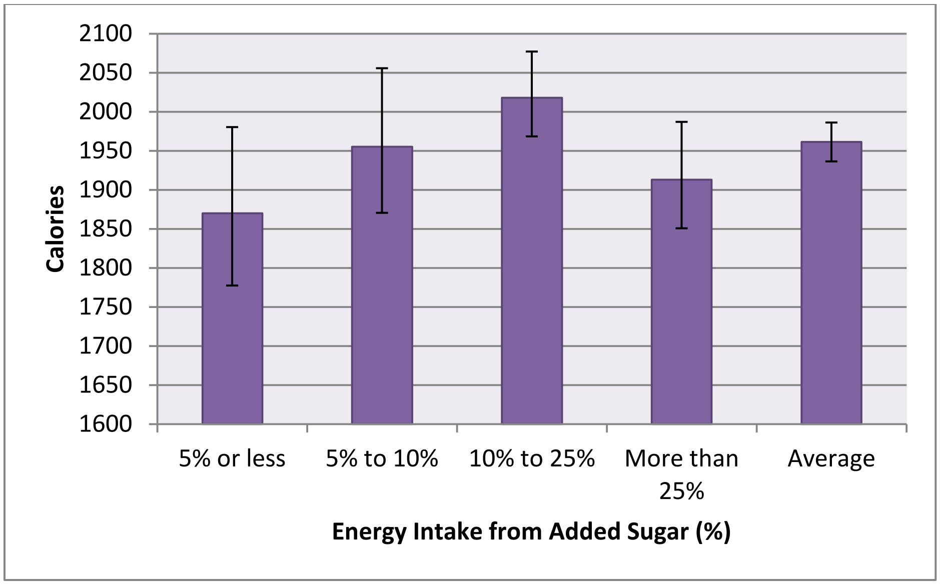

Figure 3: Caloric Intake by Energy Intake from Added Sugar

4.2 Changes in Dietary Behaviours from 2004 to 2015

Table 3 indicates the frequency distribution of fruit and vegetable intake in 2004 and 2015. In both years, the majority of children and adolescents consumed 0 to 2 fruit servings per day, and 0 to 4 vegetable servings per day. Student's T-tests were used to statistically assess change in fruit and vegetable intake, as well as added sugar, caloric, and daily energy intake from added sugar from 2004 to 2015. The results of these tests are presented in Table 4. In 2015, children and adolescents were consuming 0.93 more servings of fruit ($p < 0.0001$), 0.7 more servings of vegetables ($p < 0.0001$), 17.99g less of added sugar ($p < 0.0001$), 292.6 kcal less of calories ($p < 0.0001$), and 0.63% less energy from added sugar ($p < 0.05$), than in 2004.

Altogether these results indicate that the diets of Canadian children and adolescents are generally improving since fruit and vegetable intake is higher, while added sugar, caloric intake, and energy intake from added sugar is lower. However, the finding that, on average 16% of daily energy intake is from added sugar indicates that added sugar is still a substantial proportion of their overall diet and more needs to be done to lower this value to less than 10% of daily energy intake.

Table 3: Fruit and Vegetable Intake of CCHS-Nutrition 2004 and 2015 Study Samples

	2004		2015	
Variable	**Frequency**	**Percentage (%)**	**Frequency**	**Percentage (%)**
Fruit Intake (Number of Servings)				
0 to 2	5968	59.53	2156	49.46
3 to 5	2866	28.59	1310	30.04
6 to 8	775	7.73	492	11.30
9 to 11	294	2.94	224	5.13
12+	123	1.23	177	4.07
Missing	2			
Vegetable Intake (Number of Servings)				
0 to 4	5101	50.88	1846	42.34
5 to 9	3134	31.25	1569	36.00
10 to 14	1174	11.71	646	14.82
15 to 19	442	4.41	223	5.13
20+	175	1.73	74	1.70
Missing	2			

Table 4: Dietary Habits of CCHS-Nutrition 2004 and 2015 Study Samples

Dietary Measure	**2004 (mean (SE))**	**2015 (mean (SE))**	**t-value**	**P > |t|**
Added Sugar (grams)	98.48 (0.87)	80.48 (1.07)	13.06	<0.0001
Fruit Intake (servings)	2.66 (0.03)	3.59 (0.06)	-15.14	<0.0001
Vegetable Intake (servings)	5.65 (0.05)	6.35 (0.08)	-7.93	<0.0001
Caloric Intake (kcal)	2253.87 (9.68)	1961.27 (12.69)	18.34	<0.0001
Energy from Added Sugar (%)	17.29 (0.13)	16.66 (0.21)	2.56	<0.05

n=4,359

4.3 Correlates of Added Sugar Intake: Bivariate Associations

The following section describes the bivariate associations between added sugar intake and its correlates using CCHS-Nutrition 2015 data. Added sugar is defined as any sugar added during the processing or cooking of a food or drink product (Wang et al., 2013). In this study, total added sugar intake was determined by summing the values of sugar attributed to each food item reported in the 24-hour food recall that was assumed to contain added sugar according to the BNS Food Code. The BNS food codes included in the added sugar measure are detailed in Appendix B. Mean added sugar intake was determined to be equal to 80.48g in 2015. Bivariate associations were tested through regression analysis, and mean added sugar intake values for each category of a correlate are presented below.

4.3.1 Sex and Added Sugar Intake

Figure 4 shows that in 2015 there is a statistically significant difference between males and females in their added sugar intake, with males consuming more added sugar than females. Mean intake for males is 84.45g (95% CI: 80.38, 88.52) while for females it is 76.32g (95% CI: 72.51, 80.12).

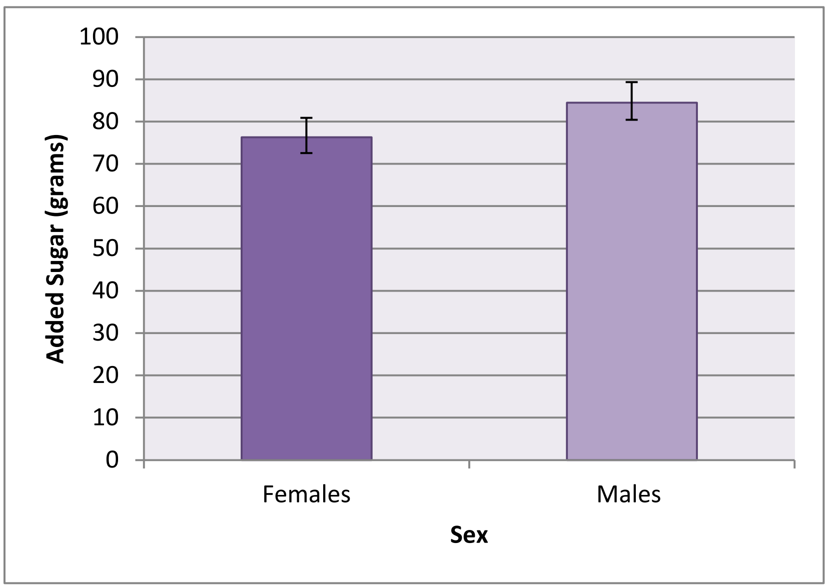

Figure 4: Sex and Added Sugar Intake, Children aged 6 to 17, CCHS-Nutrition 2015

4.3.2 Age and Added Sugar Intake

Overall age was found to be a significant correlate of added sugar intake. Figure 5 demonstrates that the relationship between added sugar intake and age is not straightforward; there is a statistically significant positive linear relationship between age and added sugar intake, as well as a statistically significant negative quadratic relationship, such that the relationship is parabolic in nature.

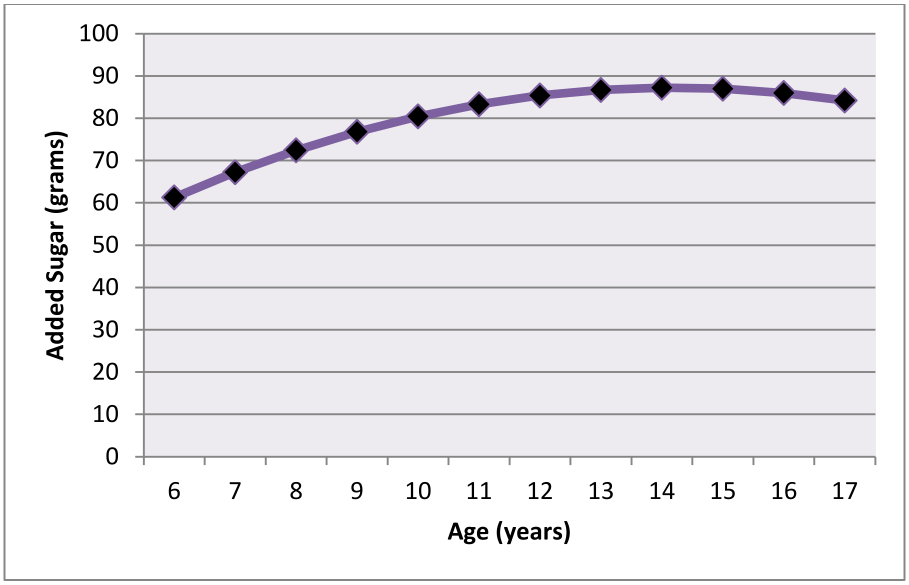

Figure 5: Age and Added Sugar Intake, in CCHS-Nutrition 2015

4.3.3 Race and Added Sugar Intake

Children and adolescents who identified themselves as having White race consumed significantly more added sugar than children and adolescents who identified with any other ethnic or racial group. Mean intake for White subjects was 87.36g (95% CI: 83.78, 90.93), while non-White subjects consumed an average of 62.53g (95% CI: 57.81, 67.25) according to their 24-hour dietary recall.

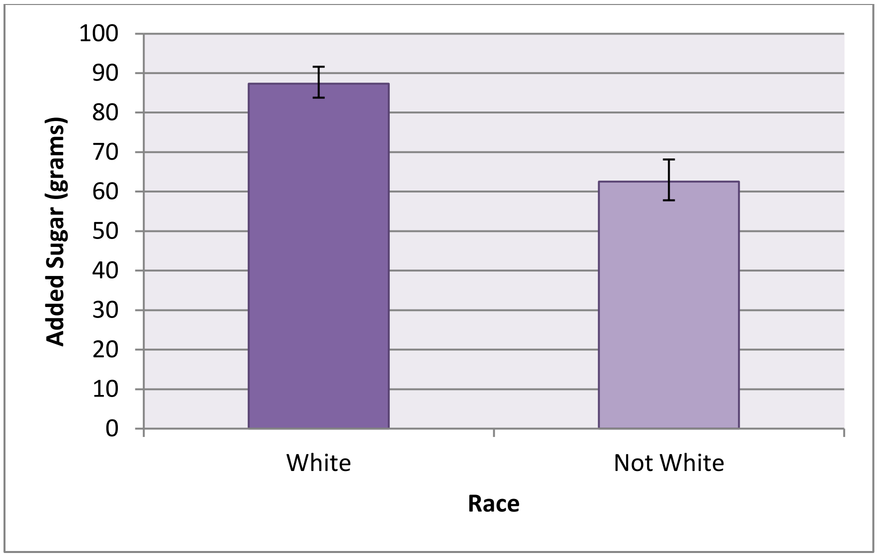

Figure 6: Race and Added Sugar Intake, Children aged 6 to 17, CCHS-Nutrition 2015

4.3.4 Immigration Status and Added Sugar Intake

Respondents that identified as having immigrated to Canada in the last 5 years consumed significantly less added sugar than those that migrated to Canada more than 5 years ago, or are Canadian born citizens. Mean intake for non-recent immigrants and Canadian born citizen was 81.30g (95% CI: 78.32, 84.28) while recent immigrants consumed an average of 65.23g (95% CI: 52.61, 77.86) of added sugar.

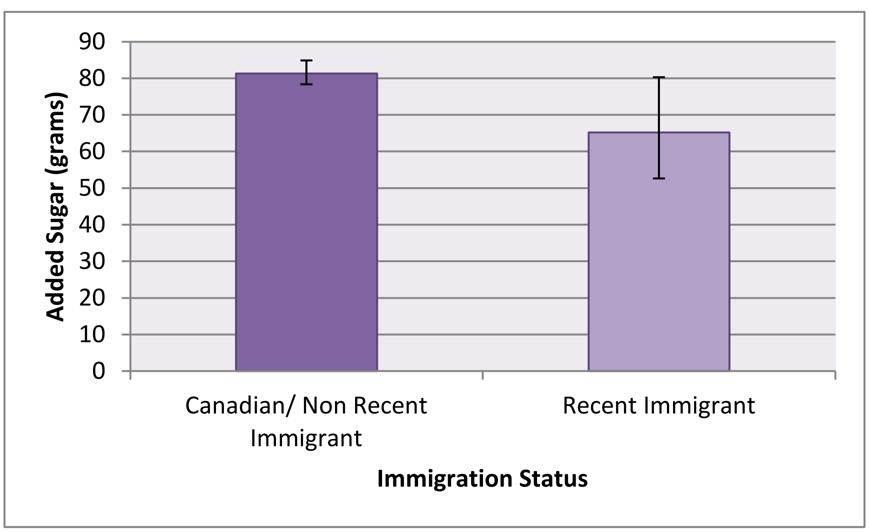

Figure 7: Immigration Status and Added Sugar Intake, Children aged 6 to 17, CCHS-Nutrition 2015

4.3.5 Sedentary Behaviour and Added Sugar Intake

A positive linear relationship was found between hours per day spent in sedentary behaviours such as watching TV or spending time on a computer, and added sugar intake, with added sugar intake increasing by 7g with every time-bracket for sedentary behaviour.

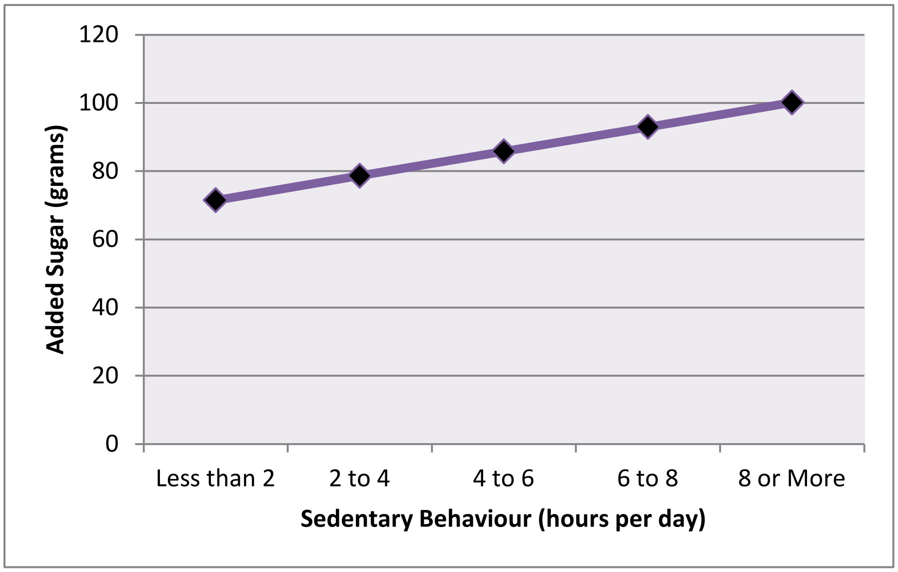

Figure 8: Sedentary Behaviours and Added Sugar Intake, Children aged 6 to 17, CCHS-Nutrition 2015

4.3.6 Physical Activity and Added Sugar Intake

The relationship between hours per day spent participating in physical activity and added sugar intake was tested and although it is a positive linear relationship in nature, it was not statistically significant.

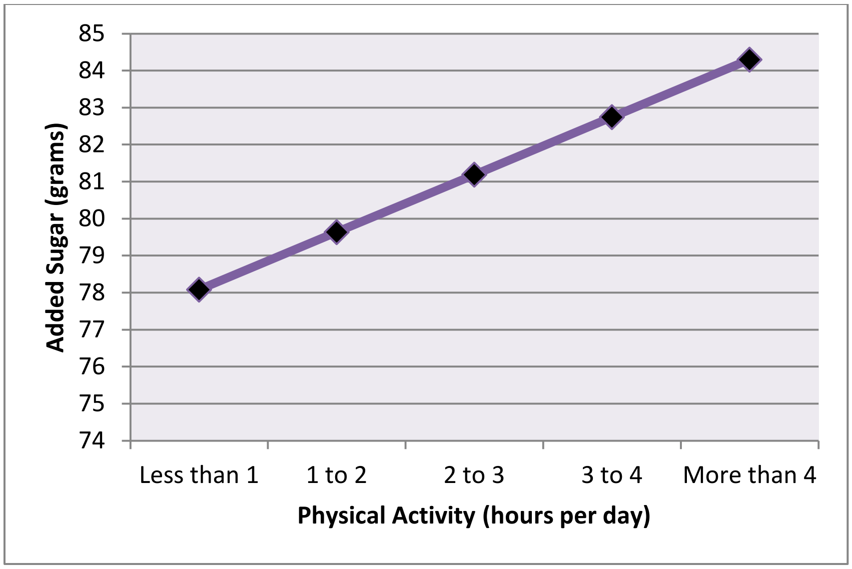

Figure 9: Physical Activity and Added Sugar Intake, Children aged 6 to 17, CCHS-Nutrition 2015

4.3.7 Household Income and Added Sugar Intake

Income was a significant correlate of added sugar intake, added sugar intake increases by 2.6g with each income decile, such that individuals in Decile 1 consumed 63.64g (95% CI: 58.45,68.84) of added sugar, and individuals in Decile 10 consumed 93.84g (95% CI: 78.79, 108.89).

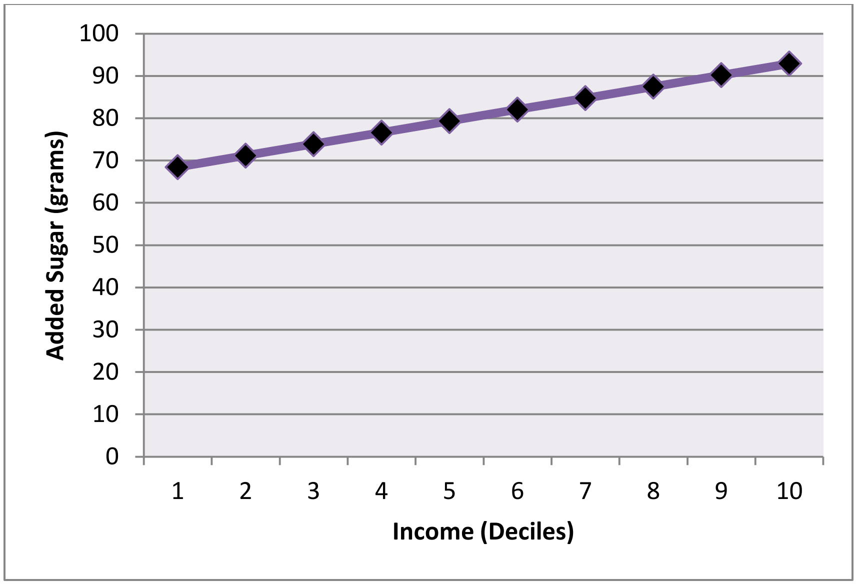

Figure 10: Household Income and Added Sugar Intake, Children aged 6 to 17, CCHS-Nutrition 2015

4.3.8 Household Education and Added Sugar Intake

Children and adolescents from households where the highest level of education was trade certification, High School diploma, or less consumed 84.84g (95% CI: 79.49, 90.19) of added sugar. Those from households with College or University education below the Bachelors level consumed 82.68g (95% CI: 78.17, 87.19), and those from households where the highest level of education was a University education at the Bachelors level or higher consumed 76.38g (95% CI 71.78, 80.99). While it may seem like added sugar intake decreases with increasing household education, this relationship was not statistically significant.

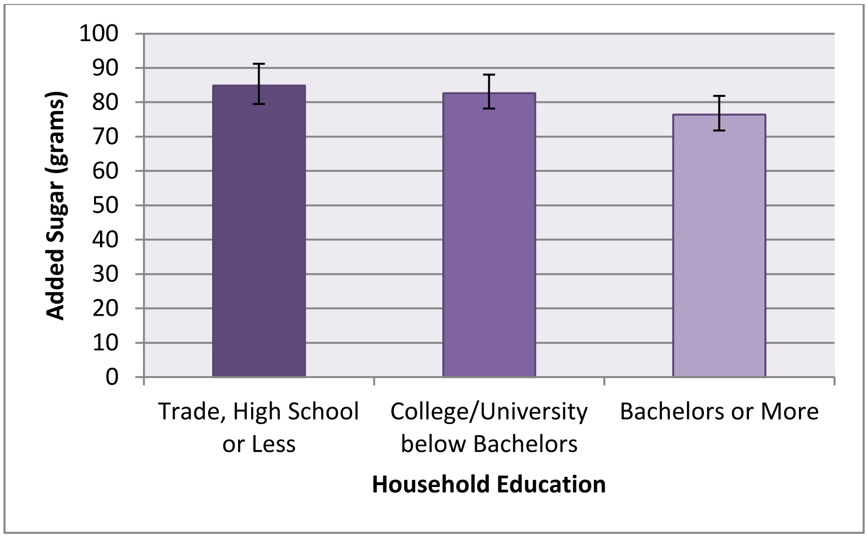

Figure 11: Household Education and Added Sugar Intake, Children aged 6 to 17, CCHS-Nutrition 2015

4.3.9 Food Security and Added Sugar Intake

Children and adolescents from food secure households consumed 80.49g (95% CI: 77.51, 83.47). Moderately food insecure individuals consumed 83.36g (95% CI: 70.32, 96.39), and severely food insecure consumed 105.65g (95% CI: 37.35, 173.95). Yet the relationship between food security status and added sugar intake did not reach statistical significance.

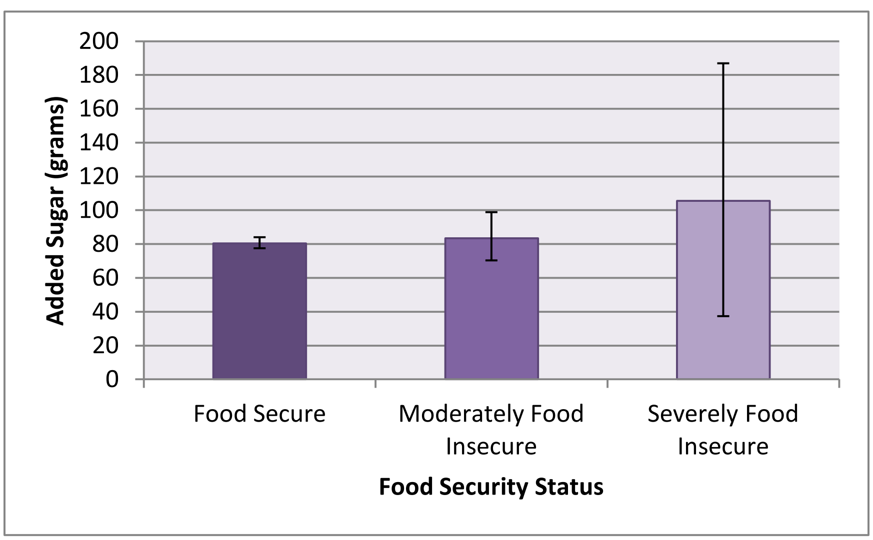

Figure 12: Food Security and Added Sugar Intake, Children aged 6 to 17, CCHS-Nutrition 2015

4.3.10 Region of Residence and Added Sugar Intake

In bivariate analysis, added sugar intake in the Maritime provinces (90.98g, 95% CI: 86.85, 95.11), Quebec (88.62g, 95% CI: 82.51, 94.74), the Prairie provinces (80.36g, 95% CI: 75.79, 84.98), and British Columbia (86.81g, 95% CI: 80.65, 92.97) was compared to added sugar intake of children and adolescents in Ontario (72.42g, 95% CI: 66.63, 78.20). It was found that children and adolescents in the Maritime provinces, Quebec, and British Columbia all consume significantly more added sugar than their counterparts in Ontario, but the difference in intake between Ontario residents and those in the Prairies was not statistically significant.

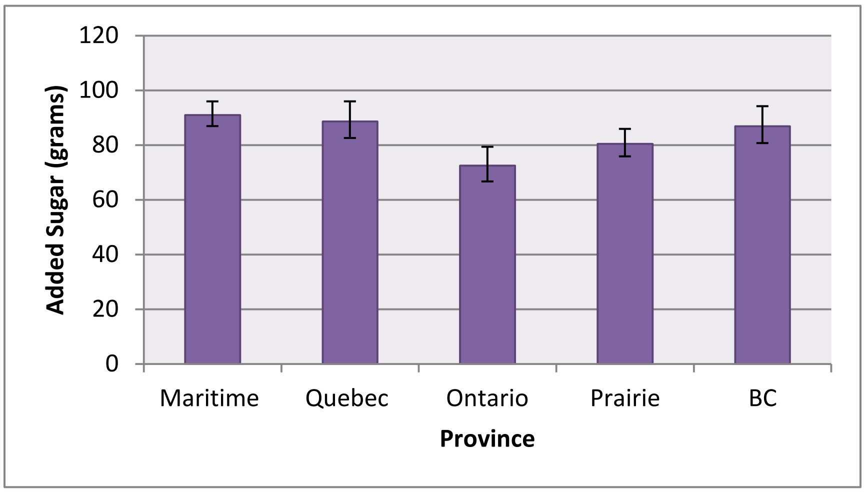

Figure 13: Region of Residence and Added Sugar Intake, Children aged 6 to 17, CCHS-Nutrition 2015

4.4 Associations Between Added Sugar Intake and Other Behavioural Characteristics

Multivariable linear regressions were run to address the third objective of this study, which was to assess the relationship between sedentary behaviour, physical activity, and added sugar intake. The first regression model assessed the unadjusted relationship between sedentary behaviour, physical activity, and added sugar intake. The second regression model also aims to assess the relationship between added sugar intake and sedentary and physical activity, but additionally adjusts for demographic and socio-economic factors including sex, age, race, immigration status, household income, household education, food security, and region of residence. For the purpose of this analysis, added sugar was recoded into 10g intervals, the last interval representing 350g or more added sugar includes all outliers. This recoding was done to create an approximately normal distribution for the added sugar variable.

Table 5 presents the results of the first, unadjusted regression model, and indicates that the base level of added sugar intake, when time spent in sedentary behaviours and physical activity is 0, is 63.03g (95% CI: 56.38, 69.68). With every hour spent participating in sedentary behaviours such as watching TV, using a computer, etc. added sugar intake increases by 7.18g (95% CI: 3.56, 10.80). The association between added sugar intake and physical activity is not statistically significant, (2.43g, 95% CI: -0.89, 5.76).

Table 6 presents the results of the second, adjusted regression model. In the second model, the base level of added sugar intake is 17.00g, and after the addition of demographic and socio-economic control factors, the relationship between physical activity and added sugar intake remains statistically insignificant (0.20g, 95% CI: -3.13, 3.53). Meanwhile, even after controlling for additional factors, sedentary activity is a significant positive correlate of added sugar intake. With every hour spent participating in sedentary behaviours added sugar intake increases by 5.35g (95% CI: 1.79, 9.11). Controlling for sex, age, race, immigration status, household income, household education, food security, and region of residence only decreased the effect of sedentary behaviour on added sugar intake by 2g (predicted intake decreased from 7.18g to 5.35g).

The adjusted model indicates that aside from sedentary behaviour, sex, age, race, household income, and region of residence are all statistically significant correlates of added sugar intake. On average, male children and adolescents consume 7.40g (95% CI: 1.39, 13.41) more added sugar than female children and adolescents when all other correlates are adjusted for. Age had a positive linear relationship with added sugar intake (5.61g increase with every year, 95% CI: 2.42, 8.81) as well as a small but statistically significant negative quadratic relationship (-0.39g decrease with every year, 95% CI: -0.68, -0.10). White race is the correlate with the greatest effect size on added sugar intake; with children and adolescents of White race consuming 19.42g (95% CI: 11.74, 27.09) more added sugar than non-white children and adolescents. Household income and household education are often used interchangeably to study the impact of socio-economic position on added sugar intake (Han & Powell, 2013; Zarnowiecki et al, 2014), but in this study household income was a significant correlate while household education was not. Household income had a significant positive association with added sugar intake, with added sugar intake increasing with every decile (2.15g, 95% CI: 0.08,3.50), while household education was not associated with added sugar intake. Lastly, when comparing added sugar intake by province of residence, the Maritime provinces (11.57g, 95% CI: 2.66g, 20.49g), Quebec (14.49g, 95% CI: 5.20, 23.78), and British Columbia (10.13g, 95% CI: 0.48, 19.79) all have significantly higher intake rates compared to Ontario. While children and adolescents in the Prairie provinces also consume more added sugar than their counterparts in Ontario (4.67g, 95% CI: -3.72, 13.06) this difference was not statistically significant.

The difference between the added sugar intake of recent immigrants and of non-recent immigrants/Canadian born citizens was not statistically significant (-1.41g, 95% CI: -18.57g, 15.75g). Food security was also not a significant correlate of added sugar intake in the multivariable model.

Table 5: Unadjusted Model of the Relationship Between Sedentary Activity, Physical Activity, and Added Sugar Intake of Canadian Children and Adolescents in 2015

Variable	β	S.E.	t-value	P > |t|	95% CI
Intercept	6.3031	0.3393	18.58	<0.0001	5.638, 6.968
Sedentary (hours/day)	0.7182	0.1845	3.89	<0.0001	0.357, 1.080
Physical (hours/day)	0.2432	0.1695	1.44	0.1519	-0.089, 0.575

n=3,972
R-square = 0.01368

Table 6: Adjusted Model of the Relationship Between Sedentary Activity, Physical Activity, and Added Sugar Intake of Canadian Children and Adolescents in 2015

Variable	Category	β	S.E.	t-value	P > |t|	95% CI
Intercept		1.7001	0.6333	2.68	0.0075	0.458, 2.941
Sedentary (hours/day)		0.5349	0.1818	2.94	0.0034	0.179, 0.891
Physical (hours/day)		0.0200	0.1697	0.12	0.9059	-0.313, 0.352
Sex						
	Female*					
	Male	0.7400	0.3064	2.42	0.0161	0.139, 1.341
Age (linear)		0.5613	0.1629	3.45	0.0006	0.242, 0.881
Age (quadratic)		-0.0387	0.0147	-2.62	0.009	-0.068,-0.010
Race						

	White	1.9418	0.3914	5.96	<0.0001	1.174, 2.709
	Not White*					
Immigration Status						
	Recent Immigrant	-0.1408	0.8757	-0.16	0.8723	-1.857,-1.575
	Not a Recent Immigrant*					
Household Income (decile)		0.2148	0.0690	3.11	0.002	0.079, 0.350
Household Education						
	Trade, High School, or less	0.7935	0.4129	1.92	0.0552	-0.016. 1.603
	College/University below Bachelors level	0.4330	0.3651	1.19	0.2361	-0.282, 1.149
	University at Bachelors level or higher*					
Food Security						
	Food Secure*					
	Moderately Food Insecure	0.6099	0.7108	0.86	0.3912	-0.783, 2.003
	Severely Food Insecure	2.8318	4.3685	0.65	0.5171	-5.730,11.394
Province						
	Ontario*					
	Maritime	1.1574	0.4548	2.54	0.0112	0.265,2.049
	Quebec	1.4487	0.4739	3.06	0.0024	0.519, 2.378
	Prairie	0.4672	0.4279	1.09	0.2754	-0.372,1.306
	BC	1.0131	0.4925	2.06	0.0402	0.0477, 1.979

*Reference category

n=3,972

R-square = 0.07005

Chapter 5

5 Discussion

In this chapter the key findings of this study are provided in Section 5.1, the implications for health policy are discussed in Section 5.2, and study limitations are addressed in Section 5.3. A conclusion for the results is provided in Section 5.4.

5.1 Key Findings

5.1.1 Comparison of Dietary Behaviours Between 2004 and 2015

When comparing dietary habits of children and adolescents between 2004 and 2015, it was found that added sugar intake decreased significantly from 98.48g to 80.48g per day. Fruit intake was significantly higher in 2015 compared to 2004; in 2004 the mean intake was 2.66 servings, while in 2015 it was 3.59 servings per day. Vegetable intake also rose significantly from 5.65 servings to 6.35 servings in a day. Caloric intake was significantly lower in 2015 compared to 2004. In 2004 the average caloric intake, as calculated using the 24-hour dietary recall, was 2253.87 kcal, and in 2015 the average intake was 1961.27 kcal. Energy intake from added sugar was also significantly lower in 2015, dropping from 17.29% to 16.66%.

Overall, these dietary indicators suggest that the diet of Canadian children and adolescents is improving since fruit and vegetable intake is higher, and added sugar, caloric intake, and energy intake from added sugar is lower in 2015 compared to 2004. Despite these improvements in diet, added sugar still accounts for 16% of daily energy intake, and this is a much higher percentage of daily energy intake than is ideal for preventing the development of chronic disease (Brouns, 2015).

It is difficult to compare the results from this study concerning energy intake from added sugar of Canadian children and adolescents to other studies since past research has either examined total sugar intake from all sources (Langlois & Garriguet, 2011), or has used different methods to calculate energy intake from added sugar (Brisbois et al., 2014). Brisbois et al. (2014) used CCHS-Nutrition 2004 data to estimate that Canadian children and adolescents attain 10% and 14% of their daily energy intake from added sugar, respectively. However, they only included added sugar intake from the top 10 sources of sugars in the diet of Canadians (Langlois & Garriguet, 2011) rather than examine all possible sources of added sugar using the data available in the 24-hour food recall. The authors argue that sources of added sugar not included in their measure (such as ice cream, or baked goods) contain a mix of intrinsic and added sugars, making it impossible to distinguish exactly how much energy was being derived specifically from added sugars (Brisbois et al., 2014). In this study, food and drink items that were thought to contain any amount of added sugar were included in the measure of added sugar, even if intrinsic sugar was also likely present. As such, the estimate presented by Brisbois et al. (2014) may underestimate the true amount of energy intake from added sugar, while this study may overestimate that amount, such that the true amount of energy intake from added sugar may be somewhere between these two estimates.

5.1.2 Correlates of Added Sugar Intake

In this study the relationship between added sugar intake and two health related behaviours, sedentary behaviour and physical activity, was assessed using two statistical models. The first model assessed unadjusted associations between time spent engaging in sedentary behaviour, physical activity, and added sugar intake. The second model included these two factors but additionally controlled for sex, age, race, immigration status, household income, household education, food security, and region of residence. The findings of this study are congruent with previous research that has consistently found a strong correlation between time spent engaging in sedentary behaviours and added sugar intake (Borghese et al., 2014; Bornhorst et al., 2015; Byrd-Williams, Hoelscher, Springer, & Ranjit, 2010; Kenney & Gortmaker, 2017; Lipsky & Iannotti, 2012; Moreira et al., 2010; Park et al., 2012a; Park et al., 2012b; Pearson et al., 2011; Rey-Lopez et al., 2011; Sampasa-Kanyinga, Chaput, & Hamilton, 2015; Santaliestra-Pasias et al., 2012).

The studies mentioned above examined populations of children and adolescents in Europe, the United States, and in Canada; yet this particular study is the largest study of the correlation between sedentary behaviour and added sugar intake in a Canadian population of children and adolescents thus far. Additionally, this study examines total added sugar intake, rather than relying on a dietary marker for added sugar intake such as sugar sweetened beverages.

As discussed in previous literature, it is believed that sedentary behaviours are correlated with unhealthy eating patterns such as high added sugar intake due to passive snacking while engaging in sedentary behaviours such as TV viewing, and also because of exposure to advertisements to unhealthy foods (Bornhorst et al., 2015; Lipsky & Iannotti, 2012; Santaliestra-Pasias et al., 2015).

Previous literature suggests that high added sugar intake is also related to low physical activity (Park et al., 2012), yet this relationship was not found in the present study. Thus, while physical activity is a health behaviour that should be encouraged in general, it is not necessarily a protective factor against high added sugar intake. Children and adolescents that participate in more physical activity may still be consuming as much added sugar as their more sedentary counterparts.

This study also found a disparity in added sugar intake between males and females (with males consuming more added sugar than females), adjusting for other demographic and socio-economic factors. There is no consensus in previous literature about which sex consumes more added sugar or why (Al-Haifi et al., 2016; Clarke et al., 2014; Ferreira, Claro, & Souza Lopes, 2015; Mark, Lambert, & O'Loughlin, 2012; Park et al., 2012a; Park et al., 2012b; Santaliestra-Pasias et al., 2012; Vagstrand et al., 2009), but given the small effect size and wide confidence interval (7.84g, 95% CI: 1.62, 14.05) this disparity could be a result of males having higher energy requirements than females.

Since there is a statistically significant positive linear, and negative quadratic correlation between age and added sugar intake, the relationship is parabolic in nature with added sugar intake peaking between the ages of 11 to 15. This finding is also in line with previous literature that has indicated that young adolescents tend to have the highest rates of added sugar intake due to an accelerated growth rate at this age that leads to higher energy requirements, which in turn are quickly and easily met by energy dense foods such as products with added sugar (Ferreira et al., 2015; Han & Powell, 2013; Langlois & Garriguet, 2011).

In this study, race was a strong correlate of added sugar intake, with White children and adolescents found to consume an average of 19.42g more added sugar than their counterparts who did not self-identify as having White race. This finding varies from previous literature that suggests that minorities tend to consume more sugar than their ethnic majority counterparts (Larson et al., 2015; Park et al., 2012; Richmond et al., 2013; van de Gaar et al., 2017). The previous studies that found this relationship were based on European or American populations, while the present study is the first to note an ethnic disparity in added sugar intake in a Canadian study population.

Despite the fact that recent immigrants had significantly lower added sugar intake than non-recent immigrants/Canadian born in bivariate analysis, it was not a significant relationship in the multivariable model. This indicates that the disparity observed in the bivariate model is actually due to the presence of another factor or factors that were accounted for in the multivariable model. For example, children and adolescents that are recent immigrants to Canada may consume less added sugar than their counterparts because their families have a lower household income, or because they have different attitudes towards participating in sedentary behaviours.

Previous literature has consistently reported that household income is inversely related to added sugar intake (Craig et al., 2010; Han & Powell, 2013; Jensen et al., 2012; Mark, Lambert, & O'Loughlin, 2012; Zarnowiecki, Dollman, & Parletta, 2014), yet this observation was not replicated in the present study. In this study, every decile increase in household income is associated with a 2.15g increase in added sugar intake. While the effect size is small, the fact that it is statistically significant and in the opposite direction than the previously found relationship is interesting. Some literature indicates that the availability of pocket money to children and adolescents gives them greater autonomy to make their own dietary choices (Jensen et al., 2012). Unfortunately, in this case it is not possible to determine if the availability of pocket money is a mediator or the true cause of the positive relationship between household income and added sugar intake.

In this study, highest level of education in the household did not have a significant effect on added sugar intake. This finding is contradictory to previous findings that indicated that parental education has a positive effect on the diet of children and adolescents through a multitude of pathways including parents with higher education having greater nutritional knowledge, less budgetary constraints, peer group influence to eat healthy, and positive food modeling (Fernandez-Alvira et al., 2013). It is possible that the effect of parental education on added sugar intake was not seen in this study since the parent or guardian with the highest level of education in the household may not be the same parent or guardian that is making dietary choices for the children and adolescents in the household.

Compared to Ontario, children in the Maritime provinces, Quebec, and British Columbia all consumed significantly more added sugar. The determinants of added sugar intake in children and adolescents in Canada have not been studied greatly, and differences by region in particular have not been addressed. Thus, this finding cannot currently be compared to any other body of literature. While it can be speculated that these regional differences are driven by socio-economic status or ethnic background of the population, these differences were significant even in the multivariable model when adjustments were made for household income, household education, race, and immigration status. When mean added sugar intake by region was compared to the overweight and obesity rate by region for this sample, a correlation was only found for the Maritime provinces. Children and adolescents in the Maritime provinces have the highest added sugar intake, and the highest prevalence of overweight or obesity; with 39.55% of the children and adolescents in the Maritime provinces beings either overweight or obese. Yet, this correlation does not necessarily extend to the other provinces. Ontario has the second highest prevalence of overweight or obesity but the lowest added sugar intake; while British Columbia has the third highest added sugar intake but lowest levels of overweight and obesity out of all the other provinces.

5.2 Implications of Study Findings

One of the major findings of this study is that 64% of Canadian children and adolescents are not meeting added sugar intake guidelines because they are getting more than 10% of their daily energy intake from added sugar. This is very alarming considering the link between high added sugar intake and the development of obesity, type 2 diabetes and other chronic diseases, and dental caries. This study also adds to the body of literature that points to a strong link between the unhealthy behaviours of high levels of sedentary activity and high added sugar intake. As such, the findings of this study lend support to Bill S-228: The Child Health Protection Act, which aims to restrict the marketing of unhealthy foods to children. The Bill was introduced to the Canadian Senate in 2016, and Health Canada is currently developing regulations for its implementation.

Further public health initiatives should focus on discouraging added sugar intake from processed foods such as candy, cakes, desserts, and sugar sweetened beverages; such as through a sugar tax. Many countries have implemented an excise tax on SSB in order to discourage their intake, and to offset the economic burden of increasing rates of obesity and other chronic illnesses linked to high added sugar intake (Colchero et al., 2016). Mexico, a country with some of the highest rates of obesity, diabetes, and ischemic heart disease in the world, saw a 6% decrease in the purchases of SSB one year after implementation of an excise tax on SSB (Colchero et al., 2016).

Other education and intervention initiatives may be most effective when geared towards young adolescents between the ages of 11 to 15 since they were shown to have the highest added sugar intake out of the whole study population that ranged in age from 6 years to 17 years. Particular focus could also be given to the other high intake groups identified in this study.

It is encouraging that for Canadian children and adolescents, socio-economic factors such as household education and food security did not have a significant impact on added sugar intake, while household income only had a small effect. This implies that in Canada, a poor diet may not strictly be a result of embedded health inequities, but rather have more to do with personal choices (such as time spent engaging in sedentary behaviour), that can be improved with the right public health intervention and education.

Future studies should aim to study the determinants of added sugar intake longitudinally in order to accurately establish causality between the factors discussed above. Much of the literature base on added sugar intake in children and adolescents is based on studies that examined study populations in the United States and Europe, and some of the unique findings of this study go against the relationships reported in the literature. This highlights the need for more studies that use Canadian data to understand how behavioural and socio-economic factors uniquely affect added sugar intake of Canadian children and adolescents. For example, unlike previous research that indicates that racial minorities consume more added sugar than the racial majority group, in this study using Canadian data it was found that racial minorities consumed less added sugar than their White counterparts. Household income was also a positive correlate of added sugar intake in this study, unlike in past literature that has found a negative correlation between these two factors (Craig et al., 2010; Han & Powell, 2013; Jensen et al., 2012; Mark, Lambert, & O'Loughlin, 2012; Zarnowiecki, Dollman, & Parletta, 2014). Lastly, it is important for the regional variations in added sugar intake to be explored further since this study indicates that children and adolescents in Ontario consume significantly less added sugar than their counterparts in the Maritime provinces, Quebec, and British Columbia. It is not currently clear as to why this discrepancy is occurring since geographical variations in added sugar intake at the regional level have not previously been explored.

5.3 Study Limitations

This study gives an in depth analysis of the correlates of added sugar intake of children and adolescents in Canada by using 24-hour dietary recall data to gain a more comprehensive look at added sugar intake. It also explores the role of factors that have not been studied in a Canadian population before, such as immigration status, race, and region of residence. Despite these advantages, there are certain study limitations that must be acknowledged.

Firstly, the study data is cross-sectional in nature which makes it difficult to establish the direction of effect. For example, it cannot be concluded that sedentary behaviour is causing high intake of added sugar, rather than higher added sugar intake leading to more sedentary behaviour. As well as being a cross-sectional survey, the CCHS has other features that lead to additional limitations in this study. The CCHS attains its samples from private households in the provinces; as a result, children and adolescents living in the territories, on Aboriginal reserves and settlements, those living in certain remote areas, those that are institutionalized, and those that are homeless were excluded from the survey, and likewise from the study. What is concerning about this exclusion is that these populations, particularly the First Nations populations, may experience food security differently, and have a different nutrition status than those that were included in the survey. Another study limitation that results from the study design of the data source is that only selected correlates of added sugar intake could be studied. Correlates discussed in the literature review, such as sleep quality, home and school environment, neighbourhood factors etc. could not be studied because they were not measured in CCHS. Thus, this study was limited to the analysis of correlates that have frequently been studied before.

The 24-hour dietary recall that is a part of CCHS-Nutrition 2004 and 2015 is an invaluable source of information about the diet of Canadians but dietary recalls are known to be susceptible to response bias, recall bias, and social desirability bias (Castell, Serra-Majem, & Ribas-Barba, 2015; Hebert et al., 1995; Ventura et al., & Birch, 2006). Respondents may have difficulty in accurately reporting all the foods they consumed in the previous 24 hours, and they may choose to alter their responses if they are embarrassed of their dietary behaviours, or in order to provide answers they believe are socially acceptable. In a study of the SSB intake of Canadian children and adolescents using CCHS-Nutrition 2004 data, Mark et al noted that dietary under-reporting is common in youth that are concerned with body image such as girls from high income families (2012). Ventura et al (2006) examined reporting bias in 11 year old girls and also noted that under-reporters on dietary recalls had a higher weight status and significantly higher levels of weight concern and dietary restraint when compared to those that plausibly or over-reported their dietary intake. It is possible that similar issues affected accurate reporting by subjects included in CCHS-Nutrition 2015.

An additional limitation of this study concerns the outcome measure that was created to assess added sugar intake. While the CCHS-Nutrition 2015 provides a total sugar intake measure using the information provided in the 24-hour dietary recalls, this measure was not used because it includes healthy as well as unhealthy sources of sugar. Instead, the added sugar variable was created for the purposes of this study by summing the amount of sugar consumed from foods that likely have had sugar added to them. The products included in the measure are detailed in Appendix B. Since this measure is dependent on respondents accurately reporting what foods they consumed and their quantity, on manufacturers of processed foods accurately reporting the nutrient values of their products, as well as on the assumption that the majority of the sugar in these foods was added sugar and not intrinsic sugar, this measure provides an approximation of added sugar intake at best, rather than an exact measure.

5.4 Conclusions

The aim of this study was to assess how many Canadian children and adolescents are meeting added sugar intake guidelines, how dietary behaviours have changed in the past decade, and also to assess the relationship between the added sugar intake and other behavioural characteristics that include time spent in sedentary behaviour and time spent in physical activity. It was found that 64% of the study population is attaining more than 10% of their daily energy intake from added sugar. Children and adolescents who attain between 10% to 25% of energy intake from added sugar consumed the most calories when compared to those that consumed less than 10% or more than 25%, but other dietary habits such as fruit and vegetable intake did not vary greatly by percentage of energy from added sugar.

Between 2004 and 2015, children and adolescents in Canada increased their intake of fruit and vegetable servings, and decreased their intake of added sugar and calories, yet added sugar still contributes 16.66% of their daily energy intake.

When examining the relationship between added sugar intake and the other behavioural characteristics, it was found that there is a significant positive correlation between sedentary behaviour and added sugar intake. Male sex, age, White race, household income, and province of residence were also found to significantly influence added sugar intake.

Endeavours to discourage added sugar intake should encourage children and adolescents to spend less time participating in sedentary activity. Parents of all income backgrounds should also be educated on the importance of limiting the added sugar intake, and time in sedentary activity, of their children and adolescents.

Further research should focus on gaining a deeper understanding of how the demographic and socio-economic factors unique to Canada help influence dietary behaviours, and longitudinal assessments would also be beneficial since the majority of available research is cross-sectional.

References

Abete, I., Astrup, A., Martínez, J. A., Thorsdottir, I., & Zulet, M. A. (2010). Obesity and the metabolic syndrome: Role of different dietary macronutrient distribution patterns and specific nutritional components on weight loss and maintenance. *Nutrition Reviews*, *68*(4), 214–231. https://doi.org/10.1111/j.1753-4887.2010.00280.x

Ahmadi, N., Black, J. L., Velazquez, C. E., Chapman, G. E., & Veenstra, G. (2015). Associations between socio-economic status and school-day dietary intake in a sample of grade 5-8 students in Vancouver, Canada. *Public Health Nutrition*, *18*(5), 764–773. https://doi.org/10.1017/S1368980014001499

Al-Haifi, A. A., AlMajed, H. T., Al-Hazzaa, H. M., Musaiger, A. O., Arab, M. A., Hasan, R. A., … M.A., A. (2016). Relative Contribution of Obesity, Sedentary Behaviors and Dietary Habits to Sleep Duration Among Kuwaiti Adolescents. *Global Journal of Health Science*, *8*(1), 107–117. https://doi.org/http://dx.doi.org/10.5539/gjhs.v8n1p107

Altman, M., Cahill Holland, J., Lundeen, D., Kolko, R. P., Stein, R. I., Saelens, B. E., … Wilfley, D. E. (2015). Reduction in Food Away from Home Is Associated with Improved Child Relative Weight and Body Composition Outcomes and This Relation Is Mediated by Changes in Diet Quality. *Journal of the Academy of Nutrition and Dietetics*, *115*(9), 1400–1407. https://doi.org/10.1016/j.jand.2015.03.009

An, R., & Sturm, R. (2012). School and residential neighborhood food environment and diet among California youth. *American Journal of Preventive Medicine*, *42*(2), 129–135. https://doi.org/http://dx.doi.org/10.1016/j.amepre.2011.10.012

An, R., Yang, Y., Hoschke, A., Xue, H., & Wang, Y. (2017). Influence of neighbourhood safety on childhood obesity: a systematic review and meta-analysis of longitudinal studies. *Obesity Reviews*, *18*(11), 1289–1309. https://doi.org/10.1111/obr.12585

Anis, A. H., Zhang, W., Bansback, N., Guh, D. P., Amarsi, Z., & Birmingham, C. L. (2010). Obesity and overweight in Canada: An updated cost-of-illness study. *Obesity Reviews*, *11*(1), 31–40. https://doi.org/10.1111/j.1467-789X.2009.00579.x

Baird, J. (2005). Being big or growing fast: systematic review of size and growth in infancy and later obesity. *British Medical Journal*, *331*(7522), 929–0. https://doi.org/10.1136/bmj.38586.411273.E0

Ball, G., & McCargar, L. (2003). Childhood obesity in Canada: a review of prevalence estimates and risk factors for cardiovascular diseases and type 2 diabetes. *Canadian Journal of Applied*, 117–140. Retrieved from http://www.nrcresearchpress.com/doi/abs/10.1139/h03-010

Bassett, D. R., John, D., Conger, S. A., Fitzhugh, E. C., & Coe, D. P. (2015). Trends in Physical Activity and Sedentary Behaviors of United States Youth. *Journal of Physical Activity and Health*, *12*(8), 1102–1111. https://doi.org/10.1123/jpah.2014-0050

Batada, A., Seitz, M. D., Wootan, M. G., & Story, M. (2008). Nine out of 10 Food Advertisements Shown During Saturday Morning Children's Television Programming Are for Foods High in Fat, Sodium, or Added Sugars, or Low in Nutrients. *Journal of the American Dietetic Association*, *108*(4), 673–678. https://doi.org/10.1016/j.jada.2008.01.015

Battram, D. S., Piche, L., Beynon, C., Kurtz, J., & He, M. (2016). Sugar-Sweetened Beverages: Children's Perceptions, Factors of Influence, and Suggestions for Reducing Intake. *Journal of Nutrition Education and Behavior*, *48*(1), 27–34.e1. https://doi.org/https://dx.doi.org/10.1016/j.jneb.2015.08.015

Borghese, M. M., Tremblay, M. S., Leduc, G., Boyer, C., Belanger, P., LeBlanc, A. G., … Chaput, J.-P. (2014). Independent and combined associations of total sedentary time and television viewing time with food intake patterns of 9-to 11-year-old Canadian children. *Applied Physiology Nutrition and Metabolism* , *39*(8), 937–943. https://doi.org/10.1139/apnm-2013-0551

Bornhorst, C., Wijnhoven, T. M. A., Kunesova, M., Yngve, A., Rito, A. I., Lissner, L., … Breda, J. (2015). WHO European Childhood Obesity Surveillance Initiative: associations between sleep duration, screen time and food consumption frequencies. *BMC Public Health*, *15*, 442. https://doi.org/https://dx.doi.org/10.1186/s12889-015-1793-3

Briefel, R. R., Wilson, A., & Gleason, P. M. (2009). Consumption of Low-Nutrient, Energy-Dense Foods and Beverages at School, Home, and Other Locations among School Lunch Participants and Nonparticipants. *Journal of the American Dietetic Association* , *109*(2), S79–S90. https://doi.org/10.1016/j.jada.2008.10.064

Brisbois, T. D., Marsden, S. L., Harvey Anderson, G., & Sievenpiper, J. L. (2014). Estimated intakes and sources of total and added sugars in the Canadian diet. *Nutrients*, *6*(5), 1899–1912. https://doi.org/10.3390/nu6051899

Brouns, F. (2015). WHO Guideline: "Sugars intake for adults and children" raises some question marks. *Agro Food Industry Hi-Tech*, *26*(4), 34–36. https://doi.org/978 92 4 154902 8

Byrd-Williams, C. E., Hoelscher, D. M., Springer, A., & Ranjit, N. (2010). Physical activity and sedentary behaviors associated with sugar-sweetened beverage (SSB) consumption among 8th grade middle school students. *Obesity*, *18*, S130. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed12&NEWS=N&AN=71774868

Calloway, E., Smith, T., Pinard, C., Oh, A., Nebeling, L., & Hennessy, E. (2016). Differential associations of food insecurity risk on dietary intake-frequency among parents and their adolescent children. *FASEB Journal*, *30*. Retrieved from http://www.fasebj.org/content/30/1_Supplement/149.1.abstract?sid=223dbfb0-3c81-4c72-bd1d-ebfa5f7b6742

Cappuccio, F. P., Taggart, F. M., Kandala, N., Currie, A., Chb, M. B., Peile, E., & Miller, M. A. (2007). Meta-Analysis of Short Sleep Duration and Obesity in Children and Adults, *12*(Figure 1).

Casey, R., Oppert, J. M., Weber, C., Charreire, H., Salze, P., Badariotti, D., … Simon, C. (2014). Determinants of childhood obesity: What can we learn from built environment studies? *Food Quality and Preference*, *31*(1), 164–172. https://doi.org/10.1016/j.foodqual.2011.06.003

Castell, G. S., Serra-Majem, L., & Ribas-Barba, L. (2015). What and how much do we eat? 24-hour dietary recall method. *Nutricion Hospitalaria*, *31*, 46–48. https://doi.org/10.3305/nh.2015.31.sup3.8750

Clarke, A., Phang, C., Sirirat, R., Heskey, C., & Siapco, G. (2014). Association between sleep patterns and food choices among adolescents. *FASEB Journal*, *28*(1 SUPPL. 1). Retrieved from http://www.fasebj.org/content/28/1_Supplement/47.7.abstract?sid=1bb52f47-ea67-4314-b728-2a34547b0533

Colchero, M. A., Popkin, B. M., Rivera, J. A., & Ng, S. W. (2016). Beverage purchases from stores in Mexico under the excise tax on sugar sweetened beverages: Observational study. *British Medical Journal*, *352*, 1–9. https://doi.org/10.1136/bmj.h6704

Colley, Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011). Physical activity of Canadian children and youth : Accelerometer results from the Survey. *Statistics Canada*, *Health Reports*, *22*(1), 15–24.

Craig, L.C., McNeill, G., MacDiarmid, J.I., & Masson, L.F. (2010). Dietary patterns of school-age children in Scotland: Association with socio-economic indicators, physical activity and obesity. *British Journal of Nutrition*, *103*(3), 319–334.

https://doi.org/http://dx.doi.org/10.1017/S0007114509991942

Craig, L. C. A., McNeill, G., Macdiarmid, J. I., Masson, L. F., & Holmes, B. A. (2010). Dietary patterns of school-age children in Scotland: association with socio-economic indicators, physical activity and obesity. *British Journal of Nutrition*, *103*(3), 319–334. https://doi.org/10.1017/S0007114509991942

Datar, A., Nicosia, N., & Shier, V. (2013). Parent perceptions of neighborhood safety and children's physical activity, sedentary behavior, and obesity: Evidence from a national longitudinal study. *American Journal of Epidemiology*, *177*(10), 1065–1073. https://doi.org/10.1093/aje/kws353

De Onis, M., Onyango, A. W., Borghi, E., Siyam, A., Nishida, C., & Siekmann, J. (2007). Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organisation*, *85*(10), 812–819. https://doi.org/10.2471/BLT.

De Ruyter, J. C., Olthof, M. R., Seidell, J. C., & Katan, M. B. (2014). A trial of sugar-free or sugar-sweetened beverages and body weight in children. *World Review of Nutrition and Dietetics*, *109*, 4–5. https://doi.org/10.1159/000356352

Deierlein, A. L., Galvez, M. P., Yen, I. H., Pinney, S. M., Biro, F. M., Kushi, L. H., … Wolff, M. S. (2014). Local food environments are associated with girls' energy, sugar-sweetened beverage and snack-food intakes. *Public Health Nutrition*, *17*(10), 2194–2200. https://doi.org/10.1017/S1368980014000639

Demissie, Z., Eaton, D. K., Lowry, R., Kim, S. A., Park, S., Grimm, K. A., … C., M. (2015). The Association of Meal Practices and Other Dietary Correlates With Dietary Intake Among High School Students in the United States, 2010. *American Journal of Health Promotion : AJHP*, *29*(6), e203-13. https://doi.org/https://dx.doi.org/10.4278/ajhp.131211-QUAN-632

Diabetes Canada. (2016). Diabetes Canada: Sugars Position Statement, 1–17. Retrieved from http://www.diabetes.ca/getattachment/About-CDA/Position-Statements/Sugars/Sugar-Statement_Sugar-Position-Statement.PDF.aspx

Dietitians of Canada, & Canadian Pediatric Society. (2014). WHO Growth Chart Assessment and Counselling – Key Messages and Actions, (April).

Drewnowski, A. (2003). Fat and sugar: An economic analysis. *Journal of Nutrition*, *133*(3), 838S–840S. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-0037372899&partnerID=40&md5=ec376ede9661f95531ec85ff50db9727

Drewnowski, A., Mennella, J. A., Johnson, S. L., & Bellisle, F. (2012). Sweetness and Food

Preference 1 – 3. *Journal of Nutrition*, (7), 1142–1148. https://doi.org/10.3945/jn.111.149575.1142S

Drewnowski, A., & Specter, S. E. (2004). Poverty and obesity: The role of energy density and energy costs. *American Journal of Clinical Nutrition*, *79*(1), 6–16. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-1542370542&partnerID=40&md5=0cc3f4208466daa5de02c51b1a1d36dc

Duffey, K. J., & Popkin, B. M. (2007). Shifts in patterns and consumption of beverages between 1965 and 2002. *Obesity*, *15*(11), 2739–2747. https://doi.org/10.1038/oby.2007.326

Ebbelin, C. B., Pawlak, D. B., & Lugwig, D. S. (2002). Childhood obesity: public health crisis, common sense cure. *Lancet*, *360*, 473–482. https://doi.org/10.1016/S0140-6736(02)09678-2

Fernandes, M. M., & Rand, P. (2008). The Effect of Soft Drink Availability in Elementary Schools on Consumption, 1445–1452. https://doi.org/10.1016/j.jada.2008.06.436

Fernandez-Alvira, J. M., Mouratidou, T., Bammann, K., Hebestreit, A., Barba, G., Sieri, S., … Moreno, L. A. (2013). Parental education and frequency of food consumption in European children: the IDEFICS study. *Public Health Nutrition*, *16*(3), 487–498. https://doi.org/https://dx.doi.org/10.1017/S136898001200290X

Ferreira, N. L., Claro, R. M., & Souza Lopes, A. C. (2015). Consumption of sugar-rich food products among Brazilian students: National School Health Survey (PeNSE 2012). *Cadernos de Saude Publica*, *31*(12), 2493–2504. https://doi.org/10.1590/0102-311X00014515

Fink, S. K., Racine, E. F., Mueffelmann, R. E., Dean, M. N., & Herman-Smith, R. (2014). Family Meals and Diet Quality Among Children and Adolescents in North Carolina. *Journal of Nutrition Education and Behaviour*, *46*(5), 418–422. https://doi.org/10.1016/j.jneb.2014.05.004

Fismen, A. S., Samdal, O., & Torsheim, T. (2012). Family affluence and cultural capital as indicators of social inequalities in adolescent’s eating behaviours: A population-based survey. *BMC Public Health*, *12*(1), 1036. https://doi.org/10.1186/1471-2458-12-1036

Foley, N. H., Bray, I., Watters, K. M., Das, S., Bernas, T., Prehn, J. H. M., & Stallings, R. L. (2012). NIH Public Access. *Cell*, *18*(7), 1089–1098. https://doi.org/10.1038/cdd.2010.172.MicroRNAs

Freedman, D. S., Khan, L. K., Serdula, M. K., Ogden, C. L., & Dietz, W. H. (2006). Racial and ethnic differences in secular trends for childhood BMI, weight, and height. *Obesity (Silver*

Spring, Md.), *14*, 301–308. https://doi.org/10.1038/oby.2006.39

Gebremariam, M. K., Chinapaw, M. J., Bringolf-Isler, B., Bere, E., Kovacs, E., Verloigne, M., … Lien, N. (2017). Screen-based sedentary time: Association with soft drink consumption and the moderating effect of parental education in European children: The ENERGY study. *PLOS ONE*, *12*(2). https://doi.org/10.1371/journal.pone.0171537

Gilliland, J. A., Rangel, C. Y., Healy, M. A., Tucker, P., Loebach, J. E., Hess, P. M., … Wilk, P. (2012). Linking Childhood Obesity to the Built Environment: A Multi-level Analysis of Home and School Neighbourhood Factors Associated With Body Mass Index. *Can J Public Health*, *103*(9), 15–21. https://doi.org/10.17269/CJPH.103.3283

Han, E., & Powell, L. M. (2013). Consumption Patterns of Sugar-Sweetened Beverages in the United States. *Journal of the Academy of Nutrition and Dietetics*, *113*(1), 43–53. https://doi.org/10.1016/j.jand.2012.09.016

Hearst, M. O., Pasch, K. E., & Laska, M. N. (2012). Urban v. suburban perceptions of the neighbourhood food environment as correlates of adolescent food purchasing. *PUBLIC HEALTH NUTRITION*, *15*(2), 299–306. https://doi.org/10.1017/S1368980011002114

Health Canada. (2007). Canada’s Food Guide. Retrieved from http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/basics-base/index-eng.php

Hebert, J. R., Clemow, L., Pbert, L., Ockene, I. S., Ockene, J. K., & R, H. J. (1995). Social Desirability Bias in Dietary Self-Report May Compromise the Validity of Dietary Intake Measures. *International Journal of Epidemiology*, *24*(24), 389–398. https://doi.org/10.1093/ije/24.2.389

Heid, I. M., Jackson, A. U., Randall, J. C., Winkler, T. W., Qi, L., Steinthorsdottir, V., … White, C. C. (2011). NIH Public Access distribution, *42*(11), 949–960. https://doi.org/10.1038/ng.685.Meta-analysis

Hillier, T. a, Pedula, K. L., Schmidt, M. M., Mullen, J. a, Charles, M.-A., & Pettitt, D. J. (2007). Childhood Obesity and Metabolic Imprinting. *Diabetes Care*, *30*(9), 2287–2292. https://doi.org/10.2337/dc06-2361.Additional

Hilsen, M., te Velde, S. J., Bere, E., & Brug, J. (2013). Predictors and mediators of differences in soft drinks consumption according to gender and plans of further education among Norwegian secondary-school children. *Public Health Nutrition*, *16*(7), 1250–1256. https://doi.org/10.1017/S1368980011002953

Hu, F. B. (2013). Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. *Obesity Reviews*, *14*(8), 606–619. https://doi.org/10.1111/obr.12040

Hu, F. B., & Malik, V. S. (2010). Sugar-sweetened beverages and risk of obesity and type 2 diabetes: Epidemiologic evidence. *Physiology and Behavior*, *100*(1), 47–54. https://doi.org/10.1016/j.physbeh.2010.01.036.Sugar-sweetened

Jackson, S. L., & Cunningham, S. A. (2017). The stability of children's weight status over time, and the role of television, physical activity, and diet. *Preventive Medicine*, *100*, 229–234. https://doi.org/10.1016/j.ypmed.2017.04.026

Jago, R., Baranowski, T., & Baranowski, J. C. (2007). Fruit and vegetable availability: a micro environmental mediating variable? *Public Health Nutrition*, *10*(07), 681–689. https://doi.org/10.1017/S1368980007441441

Jensen, B. W., Nichols, M., Allender, S., de Silva-Sanigorski, A., Millar, L., Kremer, P., … Swinburn, B. (2012). Consumption patterns of sweet drinks in a population of Australian children and adolescents (2003-2008). *BMC Public Health*, *12*, 771. https://doi.org/https://dx.doi.org/10.1186/1471-2458-12-771

Jensen, J. D., Bere, E., De Bourdeaudhuij, I., Jan, N., Maes, L., Manios, Y., … Brug, J. (2012). Micro-level economic factors and incentives in Children's energy balance related behaviours findings from the ENERGY European cross-section questionnaire survey. *International Journal of Behavioral Nutrition and Physical Activity*, *9*. https://doi.org/10.1186/1479-5868-9-136

Johnson, D. B., Bruemmer, B., Lund, A. E., Evens, C. C., Mar, C. M., DB, J., … Mar, C. M. (2009). Impact of school district sugar-sweetened beverage policies on student beverage exposure and consumption in middle schools. *The Journal of Adolescent Health : Official Publication of the Society for Adolescent Medicine*, *45*(3 Suppl), S30-7. https://doi.org/https://dx.doi.org/10.1016/j.jadohealth.2009.03.008

Johnson, R. K., Appel, L. J., Brands, M., Howard, B. V, Lefevre, M., Lustig, R. H., … Wylie-Rosett, J. (2009). Dietary sugars intake and cardiovascular health a scientific statement from the american heart association. *Circulation*, *120*(11), 1011–1020. https://doi.org/10.1161/CIRCULATIONAHA.109.192627

Jones, A. ., Hammond, D., & Reid, J. . (2015). Where Should We Eat? Lunch Source and Dietary Measures Among Youth During the School Week. *Canadian Journal of Dietetic Practice and Research : A Publication of Dietitians of*, *76*(4), 157–165. https://doi.org/http://dx.doi.org/10.3148/cjdpr-2015-019

Kenney, E. L., & Gortmaker, S. L. (2017). United States Adolescents' Television, Computer, Videogame, Smartphone, and Tablet Use: Associations with Sugary Drinks, Sleep, Physical Activity, and Obesity. *Journal of Pediatrics*, *182*, 144–149. https://doi.org/10.1016/j.jpeds.2016.11.015

Kjeldsen, J. S., Hjorth, M. F., Andersen, R., Michaelsen, K. F., Tetens, I., Astrup, A., & Chaput, J. P. (2013). Short sleep duration and large variability in sleep duration are associated with dietary risk factors for obesity in Danish school children. *Obesity Facts*, *6*, 138. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed15&NEWS=N&AN=71300406

Kjeldsen, J. S., Hjorth, M. F., Andersen, R., Michaelsen, K. F., Tetens, I., Astrup, A., … Sjodin, A. (2014). Short sleep duration and large variability in sleep duration are independently associated with dietary risk factors for obesity in Danish school children. *International Journal of Obesity*, *38*(1), 32–39. https://doi.org/10.1038/ijo.2013.147

Langlois, K., & Garriguet, D. (2011). Sugar consumption among Canadians of all ages. *Statistics Canada*, *22*(3), 1–6.

Larsen, K., Cook, B., Stone, M. R., & Faulkner, G. E. J. (2014). Food access and children???s BMI in Toronto, Ontario: assessing how the food environment relates to overweight and obesity. *International Journal of Public Health*, *60*(1), 69–77. https://doi.org/10.1007/s00038-014-0620-4

Larson, N., Eisenberg, M. E., Berge, J. M., & Arcan, C. (2015). Family and home food environments of ethnically/racially diverse adolescents in Minnesota: Disparities and linkages to dietary intake and weight status. *Journal of Adolescent Health*, *56*(2 SUPPL. 1), S91–S92. https://doi.org/http://dx.doi.org/10.1016/j.jadohealth.2014.10.183

Larson, N., Eisenberg, M. E., Berge, J. M., Arcan, C., Neumark-Sztainer, D., N., L., … C., A. (2015). Ethnic/racial disparities in adolescents' home food environments and linkages to dietary intake and weight status. *Eating Behaviors*, *16*, 43–46. https://doi.org/https://dx.doi.org/10.1016/j.eatbeh.2014.10.010

Larson, N. I., Wall, M. M., Story, M. T., & Neumark-Sztainer, D. R. (2013). Home/family, peer, school, and neighborhood correlates of obesity in adolescents. *Obesity*, *21*(9), 1858–1869. https://doi.org/10.1002/oby.20360

Laska, M. N., Hearst, M. O., Forsyth, A., Pasch, K. E., & Lytle, L. (2010). Neighbourhood food environments: are they associated with adolescent dietary intake, food purchases and weight status? *Public Health Nutrition*, *13*(11), 1757–1763. https://doi.org/10.1017/S1368980010001564

Lebel, A., Morin, P., Robitaille, E., Lalonde, B., Fratu, R. F., & Bisset, S. (2016). Sugar Sweetened Beverage Consumption among Primary School Students: Influence of the Schools' Vicinity. *Journal of Environmental and Public Health*. https://doi.org/10.1155/2016/1416384

Lee, S. Y., Ha, S. A., Seo, J. S., Sohn, C. M., Park, H. R., & Kim, K. W. (2014). Eating habits and eating behaviors by family dinner frequency in the lower-grade elementary school students, *8*(6), 679–687. https://doi.org/10.4162/nrp.2014.8.6.679

Levy, D. T., Friend, K. B., & Wang, Y. C. (2011). A Review of the Literature on Policies Directed at the Youth Consumption of Sugar Sweetened Beverages. https://doi.org/10.3945/an.111.000356.on

Lippevelde, W. Van, Saskia, J., Verloigne, M., Bourdeaudhuij, I. De, Manios, Y., Bere, E., … Maes, L. (2013). Associations between home- and family-related factors and fruit juice and soft drink intake among 10- to 12-year old children . The ENERGY project q. *Appetite*, *61*, 59–65. https://doi.org/10.1016/j.appet.2012.10.019

Lipsky, L. M., & Iannotti, R. J. (2012). Associations of Television Viewing With Eating Behaviors in the 2009 Health Behaviour in School-aged Children Study. *Archives of Pediatrics and Adolescent Medicine 166*(5, SI), 465–472.

Lipsky, L. M., Nansel, T. R., Haynie, D. L., Liu, D., Li, K., Pratt, C. A., … Dempster, K. W. (2017). Diet quality of US adolescents during the transition to adulthood: Changes and predictors. *American Journal of Clinical Nutrition*, *105*(6), 1424–1432. https://doi.org/http://dx.doi.org/10.3945/ajcn.116.150029

Liu, J.-H., Chu, Y. H., Frongillo, E. A., & Probst, J. C. (2012). Generation and acculturation status are associated with dietary intake and body weight in Mexican American adolescents. *The Journal of Nutrition*, *142*(2), 298–305. https://doi.org/https://dx.doi.org/10.3945/jn.111.145516

Lopez, N. V, Ayala, G. X., Corder, K., Eisenberg, C. M., Zive, M. M., Wood, C., & Elder, J. P. (2012). Parent support and parent-mediated behaviors are associated with children's sugary beverage consumption. *Journal of the Academy of Nutrition and Dietetics*, *112*(4), 541–547. https://doi.org/https://dx.doi.org/10.1016/j.jand.2011.11.013

Ludwig, D., & Currie, J. (2010). The Relationship Between Pregnancy Weight Gain and Birth

Weight: A Within Family Comparison. *Lancet*, *376*(9745), 984–990. https://doi.org/10.1016/S0140-6736(10)60751-9.The

Lustig, R. H. (2016). Sickeningly Sweet: Does Sugar Cause Type 2 Diabetes? Yes. *Canadian Journal of Diabetes*, *40*(4), 282–286. https://doi.org/10.1016/j.jcjd.2016.01.004

Malik, V. S., Pan, A., Willett, W. C., & Hu, F. B. (2013). Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *American Journal of Clinical Nutrition*, *98*(4), 1084–1102. https://doi.org/10.3945/ajcn.113.058362

Malik, V. S., Schulze, M. B., & Hu, F. B. (2006). Intake of sugar-sweetened beverages and weight gain: a systematic review. *American Journal of Clinical Nutrition*, *84*(2), 274–288. https://doi.org/84/2/274 [pii]

Malik, V. S., Willett, W. C., & Hu, F. B. (2013). Global obesity: Trends, risk factors and policy implications. *Nature Reviews Endocrinology*, *9*(1), 13–27. https://doi.org/10.1038/nrendo.2012.199

Mark, S., Lambert, M., & O'Loughlin, J. (2012). Household income, food insecurity and nutrition in Canadian youth. *Canadian Journal of Public Health. Revue Canadienne de Sante Publique*, *103*(2), 94–99. Retrieved from http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=med7&NEWS=N&AN=22530529

Masse, L. C., de Niet-Fitzgerald, J. E., Watts, A. W., Naylor, P.-J., & Saewyc, E. M. (2014). Associations between the school food environment, student consumption and body mass index of Canadian adolescents. *International Journal of Behavioral Nutrition and Physical Activity,*, *11*. https://doi.org/10.1186/1479-5868-11-29

McKnight-Eily, L. R., Eaton, D. K., Lowry, R., Croft, J. B., Presley-Cantrell, L., & Perry, G. S. (2011). Relationships between hours of sleep and health-risk behaviors in US adolescent students. *Preventive Medicine*, *53*(4–5), 271–273. https://doi.org/10.1016/j.ypmed.2011.06.020

Melbye, E. L., Bergh, I. H., Hausken, S. E. S., Sleddens, E. F. C., Glavin, K., & Lien, N. (2016). Adolescent impulsivity and soft drink consumption: The role of parental regulation. *Appetite*, *96*, 432–442. https://doi.org/http://dx.doi.org/10.1016/j.appet.2015.09.040

Mennella, J. A., Finkbeiner, S., Lipchock, S. V, Hwang, L.-D., & Reed, D. R. (2014). Preferences for salty and sweet tastes are elevated and related to each other during childhood. *PloS One*, *9*(3), e92201.

https://doi.org/https://dx.doi.org/10.1371/journal.pone.0092201

Moreira, P., Santos, S., Padrao, P., Cordeiro, T., Bessa, M., Valente, H., … Moreira, A. (2010). Food Patterns According to Sociodemographics, Physical Activity, Sleeping and Obesity in Portuguese Children. *International Journal of Environmental Research and Public Health*, *7*(3), 1121–1138. https://doi.org/10.3390/ijerph7031121

Morrison, K., & Chanoine, J.-P. (2007). Clinical Evaluation of Obese Children and Adolescents. *Canadian Medical Association Journal*, *176*(8), 45–49.

Ng, M., Fleming, T., Robinson, M., Thomson, B., & Graetz, N. (2014). Global, regional and national prevalence of overweight and obesity in children and adults 1980-2013: A systematic analysis. *Lancet*, *384*(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8.Global

Oken, E., Levitan, E. B., & Gillman, M. W. (2008). Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis. *International Journal of Obesity*, *32*(2), 201–210. https://doi.org/10.1038/sj.ijo.0803760

Park, S., Blanck, H. M., Sherry, B., Brener, N., & O’Toole, T. (2012). Factors Associated with Sugar-Sweetened Beverage Intake among United States High School Students. *Journal of Nutrition*, *142*(2), 306–312. https://doi.org/10.3945/jn.111.148536

Park, S., Li, R., & Birch, L. (2015). Mothers’ Child-Feeding Practices Are Associated with Children’s Sugar-Sweetened Beverage Intake. *Journal of Nutrition*, *145*(4), 806–812. https://doi.org/10.3945/jn.114.207233

Park, S., Sappenfield, W. M., Huang, Y., Sherry, B., Bensyl, D. M., S., P., … B., S. (2010). The Impact of the Availability of School Vending Machines on Eating Behavior during Lunch: The Youth Physical Activity and Nutrition Survey. *Journal of the American Dietetic Association*, *110*(10), 1532–1536. https://doi.org/http://dx.doi.org/10.1016/j.jada.2010.07.003

Park, S., Sherry, B., Foti, K., & Blanck, H. M. (2012). Self-reported academic grades and other correlates of sugar-sweetened soda intake among US adolescents. *Journal of the Academy of Nutrition and Dietetics*, *112*(1), 125–131. https://doi.org/http://dx.doi.org/10.1016/j.jada.2011.08.045

Pearson, N., Ball, K., & Crawford, D. (2011). Mediators of longitudinal associations between television viewing and eating behaviours in adolescents. *International Journal of Behavioural Nutrition and Physical Activity*, *8*. https://doi.org/10.1186/1479-5868-8-23

Pearson, N., Braithwaite, R. E., Biddle, S. J. H., van Sluijs, E. M. F., & Atkin, A. J. (2014). Associations between sedentary behaviour and physical activity in children and adolescents: A meta-analysis. *Obesity Reviews*, *15*(8), 666–675. https://doi.org/10.1111/obr.12188

Pearson, N., Salmon, J., Campbell, K., Crawford, D., & Timperio, A. (2011). Tracking of children's body-mass index, television viewing and dietary intake over five-years. *Preventive Medicine*, *53*(4–5), 268–270. https://doi.org/https://dx.doi.org/10.1016/j.ypmed.2011.07.014

Pettigrew, S., Jongenelis, M., Chapman, K., & Miller, C. (2015). Factors influencing the frequency of children's consumption of soft drinks. *Appetite*, *91*, 393–398. https://doi.org/10.1016/j.appet.2015.04.080

Powell, L. M., & Nguyen, B. T. (2013). Fast-food and full-service restaurant consumption among children and adolescents: Effect on energy, beverage, and nutrient intake. *JAMA Pediatrics*, *167*(1), 14–20. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84873507149&partnerID=40&md5=58db1fd143eb7a6a67f43fd2d6286004

Pulgarón, E. R. (2013). Childhood Obesity: A Review of Increased Risk for Physical and Psychological Comorbidities. *Clinical Therapeutics*, *35*(1), A18–A32. https://doi.org/10.1016/j.clinthera.2012.12.014

Qi, L., & Cho, Y. (2008). Gene environment interaction and obesity. *Nutrition Reviews*, *66*(12), 684–694. https://doi.org/10.1111/j.1753-4887.2008.00128.x.Gene-environment

Ranjit, N., Evans, M. H., Byrd-Williams, C., Evans, A. E., & Hoelscher, D. M. (2010). Dietary and Activity Correlates of Sugar-Sweetened Beverage Consumption Among Adolescents. *Pediatrics 126*(4), E754–E761. https://doi.org/10.1542/peds.2010-1229

Rey-López, J. P., Vicente-Rodríguez, G., Biosca, M., & Moreno, L. A. (2008). Sedentary behaviour and obesity development in children and adolescents. *Nutrition, Metabolism and Cardiovascular Diseases*, *18*(3), 242–251. https://doi.org/10.1016/j.numecd.2007.07.008

Rey-Lopez, J. P., Vicente-Rodriguez, G., Repasy, J., Mesana, M. I., Ruiz, J. R., Ortega, F. B., … I., de B. (2011). Food and drink intake during television viewing in adolescents: the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study. *Public Health Nutrition*, *14*(9), 1563–1569. https://doi.org/https://dx.doi.org/10.1017/S1368980011000383

Richmond, T. ., Spadano-Gasbarro, J. L., Walls, C. E., Austin, S. B., Greaney, M. L., & Wang,

M. L. (2014). Middle school food environments and racial/ethnic differences in sugar-sweetened beverage consumption: Findings from the Healthy Choices study, *57*(5), 735–738. https://doi.org/10.1016/j.ypmed.2013.09.001.Middle

Richmond, T. K., Spadano-Gasbarro, J. L., Walls, C. E., Austin, S. B., Greaney, M. L., Wang, M. L., … Peterson, K. E. (2013). Middle school food environments and racial/ethnic differences in sugar-sweetened beverage consumption: Findings from the Healthy Choices study. *Preventive Medicine*, *57*(5), 735–738. https://doi.org/10.1016/j.ypmed.2013.09.001

Rodd, C., & Sharma, A. K. (2016). Recent trends in the prevalence of overweight and obesity among Canadian children. *CMAJ : Canadian Medical Association Journal*, *188*(13), 933–934. https://doi.org/10.1503/cmaj.160043

Rossen, L. M., & Kobernik, E. K. (2016). Food insecurity and dietary intake among US youth, 2007-2010. *Pediatric Obesity*, *11*(3), 187–193. https://doi.org/10.1111/ijpo.12044

Rovner, A. J., Nansel, T. R., Wang, J., & Iannotti, R. J. (2011). Food sold in school vending machines is associated with overall student dietary intake. *The Journal of Adolescent Health : Official Publication of the Society for Adolescent Medicine*, *48*(1), 13–19. https://doi.org/https://dx.doi.org/10.1016/j.jadohealth.2010.08.021

Sampasa-Kanyinga, H., & Chaput, J. P. (2015). Associations between the use of social networking sites and unhealthy eating behaviours and excess body weight in adolescents. *British Journal of Nutrition*, *114*(11), 1941–1947. https://doi.org/http://dx.doi.org/10.1017/S0007114515003566

Santaliestra-Pasias, A. M., Mouratidou, T., Reisch, L., Pigeot, I., Ahrens, W., Marild, S., … Moreno, L. A. (2015). Clustering of lifestyle behaviours and relation to body composition in European children. The IDEFICS study. *European Journal of Clinical Nutrition*, *69*(7), 811–816. https://doi.org/10.1038/ejcn.2015.76

Santaliestra-Pasias, A. M., Mouratidou, T., Verbestel, V., Huybrechts, I., Gottrand, F., Le Donne, C., … Nutr, H. L. E. (2012). Food Consumption and Screen-Based Sedentary Behaviors in European Adolescents The HELENA Study. *Archives of Pediatrics and Adolescent Medicine*, *166*(11), 1010–1020. https://doi.org/10.1001/archpediatrics.2012.646

Shi, L. (2010). The association between the availability of sugar-sweetened beverage in school vending machines and its consumption among adolescents in california: A propensity score matching approach. *Journal of Environmental and Public Health*, *2010*, 735613. https://doi.org/http://dx.doi.org/10.1155/2010/735613

Singh, A. S., Mulder, C., Twisk, J. W. R., Van Mechelen, W., & Chinapaw, M. J. M. (2008). Tracking of childhood overweight into adulthood: A systematic review of the literature. *Obesity Reviews*, *9*(5), 474–488. https://doi.org/10.1111/j.1467-789X.2008.00475.x

Singh, G. K., Siahpush, M., & Kogan, M. D. (2010a). Neighborhood socioeconomic conditions, built environments, and childhood obesity. *Health Affairs*, *29*(3), 503–512. https://doi.org/10.1377/hlthaff.2009.0730

Singh, G. K., Siahpush, M., & Kogan, M. D. (2010b). Rising Social Inequalities in US Childhood Obesity, 2003-2007. *Annals of Epidemiology*, *20*(1), 40–52. https://doi.org/10.1016/j.annepidem.2009.09.008

Skeie, G., & Sandvaer, V. (2015). Intake of sugar-sweetened beverages in adolescents from Troms, Norway. *Annals of Nutrition and Metabolism*, *67*, 341–342. https://doi.org/http://dx.doi.org/10.1159/000440895

Speliotes, E. K., Willer, C. J., Berndt, S. I., Monda, K. L., Thorleifsson, G., Jackson, A. U., … Kaakinen, M. (2011). Association analyses of 249,796 individuals reveal eighteen new loci associated with body mass index. *Nature Genetics*, *42*(11), 937–948. https://doi.org/10.1038/ng.686.Association

St-Onge, M.-P., Mcreynolds, A., Trivedi, Z. B., Roberts, A. L., Sy, M., & Hirsch, J. (2012). Sleep restriction leads to increased activation of brain regions sensitive, 818–824. https://doi.org/10.3945/ajcn.111.027383.818

Statistics Canada. (2011). Analytical document Immigration and Ethnocultural Diversity in Canada, (99), 1–23.

Statistics Canada. (2017). Household income in Canada: Key results from the 2016 Census. *The Daily*. Retrieved from https://www.statcan.gc.ca/daily-quotidien/170913/dq170913a-eng.pdf

The Academy of American Pediatrics. (2011). Children, Adolescents, Obesity, and the Media. *Pediatrics*, *128*(1), 201–208. https://doi.org/10.1542/peds.2011-1066

Vagstrand, K., Linne, Y., Karlsson, J., Elfhag, K., & Lindroos, A. K. (2009b). Correlates of soft drink and fruit juice consumption among Swedish adolescents, (2009), 1541–1548. https://doi.org/10.1017/S0007114508083542

van Ansem, W. J. C., van Lenthe, F. J., Schrijvers, C. T. M., Rodenburg, G., & van de Mheen, D. (2014). Socio-economic inequalities in children’s snack consumption and sugar-sweetened beverage consumption: the contribution of home environmental factors. *British Journal of*

Nutrition, *112*(3), 467–476. https://doi.org/10.1017/S0007114514001007

van de Gaar, V. M., van Grieken, A., Jansen, W., & Raat, H. (2017). Children's sugar-sweetened beverages consumption: associations with family and home-related factors, differences within ethnic groups explored. *BMC Public Health*, *17*. https://doi.org/10.1186/s12889-017-4095-0

Van Der Horst, K., Kremers, S., Ferreira, I., Singh, A., & Oenema, A. (2007). Perceived parenting style and practices and the consumption of sugar-sweetened beverages by adolescents. *Health Education Research*, *22*(2), 295–304. https://doi.org/http://dx.doi.org/10.1093/her/cyl080

van Grieken, A., Ezendam, N. P., Paulis, W. D., van der Wouden, J. C., & Raat, H. (2012). Primary prevention of overweight in children and adolescents: a meta-analysis of the effectiveness of interventions aiming to decrease sedentary behaviour. *International Journal of Behavioral Nutrition and Physical Activity*, *9*(1), 61. https://doi.org/10.1186/1479-5868-9-61

Ventura, A. K., Loken, E., Mitchell, D. C., Smiciklas-Wright, H., & Birch, L. L. (2006). Understanding reporting bias in the dietary recall data of 11-year-old girls. *Obesity*, *14*(6), 1073–1084. https://doi.org/10.1038/oby.2006.123

Wang, L., Dalton, W. T., Schetzina, K. E., Fulton-Robinson, H., Holt, N., Ho, A.-L., … Wu, T. (2013). Home food environment, dietary intake, and weight among overweight and obese children in southern appalachia. *Southern Medical Journal*, *106*(10), 550–557. https://doi.org/10.1097/SMJ.0000000000000008

Williams, J., Scarborough, P., Matthews, A., Cowburn, G., Foster, C., Roberts, N., & Rayner, M. (2014). A systematic review of the influence of the retail food environment around schools on obesity-related outcomes. *Obesity Reviews*, *15*(5), 359–374. https://doi.org/10.1111/obr.12142

Yan, J., Liu, L., Zhu, Y., Huang, G., & Wang, P. P. (2016). The association between breastfeeding and childhood obesity: A meta-analysis. *World Review of Nutrition and Dietetics*, *114*, 110–111. https://doi.org/10.1159/000441820

Yang, Q., Zhang, Z., Gregg, E. W., Flanders, W. D., Merritt, R., & Hu, F. B. (2014). Added sugar intake and cardiovascular diseases mortality among us adults. *JAMA Internal Medicine*, *174*(4), 516–524. https://doi.org/10.1001/jamainternmed.2013.13563

Zarnowiecki, D., Ball, K., Parletta, N., & Dollman, J. (2014). Describing socioeconomic gradients in children’s diets - does the socioeconomic indicator used matter? *International Journal of Behavioral Nutrition and Physical Activity*, *11*(1), 44. https://doi.org/http://dx.doi.org/10.1186/1479-5868-11-44

Zarnowiecki, D. M., Dollman, J., & Parletta, N. (2014). Associations between predictors of children’s dietary intake and socioeconomic position: a systematic review of the literature. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, *15*(5), 375–391. https://doi.org/https://dx.doi.org/10.1111/obr.12139

Appendices

Appendix A: Summary of Previous Studies on the Determinants of Added Sugar Intake in Children and Adolescents

Reference Type	Population Location	Method Measure	Objective	Results
Ahmadi N. et al 2015 Cross-sectional	Children grade 5 to 8 (n=950) Canada	Survey SSB	To examine associations between students' SES and school day dietary intake, and the role of parents and peers in shaping these associations.	Students whose parents completed college or university, and food secure students were significantly less likely to consume SSB daily.
Al-Haifi A. et al 2016 Cross-sectional	Adolescents ages 14 to 19 (n=906) Kuwait	Self-report questionnaire SSB, high sugar foods	The aim of this study was to investigate whether body mass index (BMI), eating habits and sedentary behaviours were associated with sleep duration among Kuwaiti adolescents.	The consumption of fast foods (both genders), sugar-sweetened drinks and sweets (boys only) potatoes (girls only) were negatively associated with sleep duration (p<0.05).
An R. et al 2012 Cross-sectional	Children ages 5 to11 (n=8226) United States	California Health Interview Survey (parent reported) SSB, high sugar foods	To examine the relationship between school and residential neighbourhood food environment and diet among youth in California.	No robust relationship between food environment and consumption.
Borghese M.M. et al 2013 Cross-sectional	Children ages 9 to 11 (n=523) Canada	Food Frequency Questionnaire (self reported) SSB, high sugar foods	The aim of this paper was to determine which of self-reported television viewing time or objectively measured sedentary time is a better correlate of the frequency of consumption of healthy and unhealthy foods.	Television viewing was positively associated with the frequency of consumption of sweets, soft drinks, diet soft drinks, pastries, potato chips, French fries, fruit juices, ice cream, fried foods, and fast food. Total sedentary time was negatively associated with the frequency of

				consumption of sports drinks, independent of covariates, including television viewing. In combined sedentary time and television viewing analyses, children watching >2 h of television per day consumed several unhealthy food items more frequently than did children watching ≤2 h of television, regardless of sedentary time. In conclusion, this paper provides evidence to suggest that television viewing time is more strongly associated with unhealthy dietary patterns than is total sedentary time.
Bornhorst C. et al 2015 Cross-sectional	Children ages 6 to 9 (n=10 453) Bulgaria, Czech Republic, Lithuania, Portugal, Sweden	Food Frequency Questionnaire (self reported), Parents completed questionnaire SSB, high sugar foods	To simultaneously investigate the associations between sleep duration, screen time, and food consumption.	One additional hour of screen time was associated with increased consumption frequencies of SSB, candy bars or chocolates, and baked sweets.

Briefel R.R. et al 2009 Cross-sectional	Children and Adolescents grades 1 to 12 (n=2314) United States	24-hour food recall SSB	To estimate the effects of school food environments and practices on children's consumption of sugar-sweetened beverages, low-nutrient energy-dense foods, and fruits/ vegetables at school.	Attending a school without stores or snack bars was estimated to reduce sugar-sweetened beverage consumption by 22 kcal per school day in middle school children (P<0.01) and by 28 kcal in high school children (P<0.01). The lack of a pouring rights contract in a school reduced sugar-sweetened beverage consumption by 16 kcal (P<0.05), and no à la carte offerings in a school reduced consumption by 52 kcal (P<0.001) in middle school children.
Brug J. et al 2012 Cross-sectional	Children ages 10 to 12 (n=7307) Belguim, Greece, Hungary, Netherlands, Norway, Slovenia, Spain	24-hour food recall SSB	The aim of this study was to explore differences in weight status and energy balance behaviours according to ethnic background among adolescents across Europe.	Non-native adolescents had less favourable behavioural patterns (sugary drinks, breakfast skipping, sport, TV and computer time, hours of sleep) with the exception of active transport to school. After adjustment for parental education, most differences remained significant according to country of origin of the parents, but not according to language spoken at home.
Byrd-Williams C.E. et al 2010 Cross-sectional	Adolescents in grade 8 (n=1721) United States	Questionnaire (self reported) SSB	To identify how physical activity and sedentary behaviours are associated with SSB consumption.	Students who consumed more SSB reported watching significantly more hours of TV, and participated in more sports teams.
Calloway E. et al 2016 Cross-sectional	Adolescents ages 12 to 17 (n=1487) United States	FLASHE survey (self reported by parents and children) SSB	To assess the relationship between risk of household food insecurity and intake frequency for parents and their adolescent children.	Adolescents at risk of household food insecurity consumed more SSB more frequently than adolescents not at risk.

Clarke A. et al, 2014 Cross-sectional	Adolescents ages 11 to 19 (n=581) United States	Semi-Quantitative food frequency questionnaire Added sugar	This study investigated the relationship between sleeping patterns (sleep duration and bedtime) and food group choices in adolescents.	Females who sleep 8-9 hrs per night consumed less added sugar (p=0.01) when compared to those who sleep >9 hours or <8 hours. Bedtime was not significantly associated with food intake among females. Male subjects who went to bed before 9 pm had a greater intake of fruits (p=0.0012) and a lower intake of starchy vegetables, snacks and added fat (p<0.01).
Craig L.C.A et al 2010 Cross-sectional	Children ages 5 to 11 and Adolescents ages 12 to 17 (n=1233) Scotland (UK)	Food Frequency Questionnaire (Survey of Sugar Intake Among Children) Desserts	To identify dietary patterns in school-aged children and investigate associations with SES, obesity, and physical activity.	Unhealthy dietary patterns high in desserts were associated with lower SES and lower education of food provider. Inactivity was positively associated with a diet high in desserts in girls 5-11.
Deierlein A. et al 2014 Cross-sectional	Female Children ages 6 to 8 (n=1010) United States	24-hour dietary recall SSB, high sugar foods	To describe availability and frequency of use of local snack-food outlets and determine whether reported use of these outlets was associated with dietary intakes.	Girls with access to only one type of outlet reported consuming food/beverage items less frequently than girls with access to two or three types of outlets (1 to 3 times/week consumed 0.27 (95 % CI 0.13, 0.40) servings of SSB more daily than girls who reported no use. Girls who reported using outlets >3 times/week consumed 449.61 (95 % CI 134.93, 764.29) kJ, 0.43 (95 % CI 0.29, 0.58) servings of SSB and 0.38 (95 % CI 0.12, 0.65) servings of snack foods/sweets more daily than those who reported no use.
Demissi Z. et al 2015	Adolescents grades 9 to 12 (n=11458)	Questionnaire (self reported, National Youth	To examine behavioural and environmental factors that may be related to dietary behaviours among	High fast food intake was associated with higher odds of SSB intake.

Cross-sectional	United States	Physical Activity and Nutrition Study) SSB	US high school students.	
Fernandez M. et al 2008 Cross-sectional	Adolescents aged 11 (n=10215) United States	Questionnaire (self reported) SSB	To quantify the association among soft drink availability, school-based purchases, and overall consumption for elementary school children in the United States.	26% of children who have access to soft drinks at school consume them. Those who consume more soft drinks at school, such as low-income and black non-Hispanic children, are more likely to consume more soft drinks overall. Controlling for covariates, limiting availability of soft drinks at school is associated with a 4% decrease (odds ratio 1.38) in the rate of any consumption overall.
Fernandez-Alvira J.M. et al 2013 Cross-sectional	Children ages 2 to 9 (n=14 426) Italy, Estonia, Cyprus, Belgium, Sweden, Hungary, Germany, Spain	Food Frequency Questionnaire SSB, high sugar foods	To assess the relationship between parental education and the consumption of obesity-related foods in European children.	Children of low and medium parental education level had higher odds of more frequently eating high sugar foods.
Ferreira N.L. et al 2015 Cross-sectional	Adolescents ages 13 to 15 (n=108 726) Brazil	Questionnaire (self reported) SSB, sweets	To analyze the consumption of high-sugar foods by Brazilian schoolchildren and to identify associated factors.	Higher consumption of sweets and/or SSB was associated with being female, higher maternal education, not living with mother and father, not eating meals with parents, eating while watching TV, and longer TV time.
Fink S.A. et al 2014 Cross-sectional	Children and Adolescents ages 0 to 17(n=1 992) United States	Questionnaire (parent reported) SSB	To examine the relationship between diet quality and frequency of family meals throughout childhood and adolescence.	Participating in > 5 family meals/week was associated with less sugar sweetened beverage intake among younger (OR 2.04; CI 1.06–3.93) and older children (OR 2.12; 95% CI 1.27–3.55).

Fismen A.S. et al 2012 Cross-sectional	Adolescents grades 6,8 and 10 (n=6 447) Norway	Questionnaire (self reported) SSB, high sugar foods	To evaluate if material capital and cultural capital individually and independently contribute to the prediction of eating habits.	Cultural capital was significantly associated to consumption of fruit (OR 1.85), vegetables (OR 2.38) sweets (OR .45), sugary soft drinks (OR .26), breakfast (OR 2.13) and dinner (OR 1.54).
Gebremariam M.K. et al 2017 Cross-sectional	Children ages 10 to 12 (n=7 886) Belguim, Greece, Hungary, Netherlands, Norway, Slovenia, Spain, Switzerland	Questionnaire (self reported, ENERGY Survey) SSB	To explore if children who spend more time on screen-based sedentary activities drink more SSB.	In 6/8 countries there was a significantly positive association between TV viewing and SSB independent of individual and home environmental factors. Parental education moderated the effect of TV in other 2 countries. No significant association between computer use and SSB in 6/8 countries.
Han E. 2013 Cross-sectional	Children ages 2 to 11 (n=8627), Adolescents ages 12 to 19 (n=8922) United States	24-hour dietary recall SSB	To assess consumption patterns and individual level characteristics of SSB intake.	Low-income children had a higher odds of heavy total SSB consumption (OR 1.93) and higher energy intake from total SSBs and fruit drinks (by 23 and 27 kcal/day) than high-income children. Adolescents with low- vs. high-educated parents had higher odds of heavy total SSB consumption (OR 1.28) and higher energy intake from total SSBs and soda (by 27 and 21 kcal/day).
Hearst M.O. et al 2011 Cross-sectional	Adolescents ages 11 to 17(n=634) United States	Questionnaire (self reported) SSB	To assess the relationship between adolescent perception of time to walk to neighbourhood food retail outlets and purchasing of sugar-sweetened beverages (SSB), fast and convenience food items, and to test for differences by urban v. suburban environment.	Greater perceived time to food outlets was associated with less frequent purchasing of SSB, convenience store foods and fast-food items. Multivariate models showed that a perceived shorter walking time (i.e. 1-5 v. 3+ min) was significantly associated with more SSB purchasing. SSB purchases were also significantly associated with the number of food outlets within a 10 min walk (B= 0.05, P= 0.02)

Hebden L. et al 2013 Cross-sectional	Children and Adolescents ages 4 to 16 (n=8 058) Australia	Questionnaire (self reported) SSB	To examine associations between SSB availability at school and in the home, and consumption among Australian school students.	Students in years K–10 (ages 4–16 years) who usually purchased sugar-sweetened soft drinks or sports drinks from their school canteen were almost three times as likely to be high consumers (aOR 2.90; 95% CI 2.26, 3.73). Students in years 6–10 (ages 9–16 years) were almost five times as likely to be high consumers if soft drinks were usually available in their home (aOR 4.63; 95% CI 3.48, 6.17), and almost ten times as likely to be high consumers if soft drinks were usually consumed with meals at home (aOR 9.83; 95% CI 6.06, 15.96)
Hilsen M. et al 2011 Cross-sectional	Adolescents grades 9 and 10 (n=2 870) Norway	Questionnaire (self reported) SSB	To explore mediators of gender and educational differences in sugar sweetened soft drinks consumption.	Girls (β = -1.06) and pupils planning higher education (β = -0.69) reported lower frequency of SSB. The strongest mediators were accessibility and modelling for future educational plans differences (explaining alone respectively 69 % and 44 %) and attitudes and preferences for gender differences (explaining alone respectively 57 % and 51 %).
Jensen J.D. et al 2012 Cross-sectional	Children ages 10 to 12 (n=7234) Belgium, Greece, Hungary, Netherlands, Norway, Slovenia, Spain	Questionnaire (self and parent reported) SSB	To explore the association of micro-level economic factors and incentives with sports activities and intake of soft drinks and fruit juice in 10-12 year old school children across Europe, and to explore price sensitivity in children's soft drink consumption and correlates of this price sensitivity	Economic factors were found to be associated with children's sugary drink consumption, explaining 27% and 12% of the variation in the children's soft drink and juice consumption, respectively. Children's pocket money was a strong correlate (β =21.034) of soft drink consumption. The majority of the responding children reported to expect that significantly higher prices of soft drinks would lead them to buy less soft drinks with their own pocket money, but a

				majority of parents did not expect higher soft drink prices to reduce their children's soft drink consumption.
Johnson D.B. et al 2009 Cross-sectional	Adolescents grades 6 to 8 (n=9 151) United States	Questionnaire (self reported) SSB	To determine the associations between 1) exposure to sugar-sweetened beverages (SSB) in middle schools and student consumption of SSB during the school day; and 2) school district policies about SSB and exposure to SSB in schools.	SSB exposure was a significant predictor of SSB consumption (β = .157, $p < .001$). District SSB policy was a significant predictor of SSB exposure (β = -9.50, $p < .0002$).
Jones A.C. et al 2015 1 year of longitudinal study	Adolescents grades 9 to 12 (n=23 680) Canada	COMPASS questionnaire (self reported) SSB	To examine lunch sources during the school week among students and the associations with FV and SSB consumption	Greater frequency of a fast food or restaurant lunch was associated with more frequent SSB consumption
Kenney E.L. et al 2017 Cross-sectional	Adolescents ages 15 to 17 (n=24 800) United States	Youth Risk Behavior Survey (self reported) SSB	To quantify the relationships between TV and other screen devices and obesity risk factors.	Watching ≥ 5 hours of TV, or other screen devices per day was associated with daily SSB.
Kjeldsen J.S. et al 2014 Cross-sectional	Children ages 8 to 11 (n=676) Denmark	Food diary (web based) SSB, added sugar	To evaluate whether sleep duration and sleep problems are independently associated with dietary risk factors.	Independent of confounders, sleep duration are negatively associated with added sugar (β=-1.5) and SSB (β=-1.07). Variability is sleep duration was also associated with SSB.
Larson N. et al 2015 Cross-sectional	Adolescents grades 9 to 12 (n=2 374) United States	Food Frequency Questionnaire (completed by students and parents)	To examine differences in the family/home food environments of adolescents and associations with measures of their dietary intake and weight status.	Serving more healthy foods at meals was positively associated with fruit/vegetable consumption ($p<0.001$) and inversely associated with sugar-sweetened beverage consumption ($p<0.001$). Parental encouragement for healthy eating was

		SSB		associated with lower intake of SSB only among youth representing the White, African American, Asian, and mixed/other ethnic/racial groups and was unrelated to intake among East African, Hispanic, and Native American youth
Laska N.L. et al 2010 Cross-sectional	Adolescents ages 10 to 17 (n=334) United States	24 hour dietary recall (Identifying Determinants of Eating and Activity Study) SSB	To examine neighbourhood food environment, adolescent nutrition, and weight status.	Adjusting for gender, age, and SES, SSB intake was associated with residential proximity to restaurants, convenience stores, grocery stores and other retail facilities with 800 and/or 1600 m. School food environment had few associations with adolescent outcomes.
Lebel A. et al 2016 Cross-sectional	Children ages 5 to 12 (n=8 612) Canada	Questionnaire (parent reported) SSB	To explore the associations between the characteristics of a school's vicinity and the risk of SSB consumption in elementary students.	Students going to a school with the lowest urban density environment had a significantly lower risk of SSB consumption as compared to other school environments.
Lee S.I. et al 2014 Cross-sectional	Children in grade 3 (n=3 435) South Korea	Questionnaire (self reported) SSB, high sugar foods	This study aims to examine if the eating habits and eating behaviors of children are different according to the frequency of family dinners.	Unhealthy eating behaviors (e.g., eating fatty foods, salty foods, sweets, etc.) were not significantly different by the frequency of family dinners.
Levy D.T. et al 2011 Literature Review	"Youth" English language countries	SSB	This paper reviews the literature on school nutrition policies and price interventions directed at youth SSB consumption.	School nutrition and price policies reduce SSB consumption and that reduced SSB consumption is associated with a reduction in energy intake that can influence BMI.
Lippevelde W.V. et al 2013 Cross-sectional	Children ages 11 to 12 (n=7 915) Belgium, Greece, Hungary,	Questionnaire (self and parent reported)	To investigate associations of family-related factors with children’s fruit drink/ juice and soft drink consumption	Three of the 11 family- related factors (modeling, availability, and family consumption) were positively associated with children’s fruit drink/juice and soft drink intake. Additionally, three family-

	Netherlands, Norway, Slovenia, Spain, Switzerland	SSB		related factors (permissiveness, monitoring, and self-efficacy) were solely associated with soft drink intake.
Lipsky L.M. et al 2012 Cross-sectional	Adolescents ages 5 to 19 (n=12 642) United States	Questionnaire (self reported, Health Behaviour in School-aged Children Study) SSB and candy	To examine associations of TV viewing with eating behaviours in a representative sample of US adolescents.	TV viewing was positively related to intake of candy after adjustment for SES, computer use, and physical activity. TV snacking was positively associated with intake of candy and SSB. The relationship of TV viewing was moderately attenuated by TV snacking.
Liu J. et al 2012 Cross-sectional	Adolescents ages 12 to 19 (n=2 286) United States	24-hour dietary recall (NHANES survey) SSB	To examine how the acculturation process as measured by generation status and language use is associated with the diet of Mexican American adolescents.	Both second and third generation adolescents consumed more SSB than first generation.
Lopez N.V. et al 2011 Cross-sectional	Children ages 5 to 8 (n=541) United States	Questionnaire (self reported) SSB	To examine the relationship between children's sugary beverage consumption and a parenting model that includes household food rules, parent modeling of food rules, parent-mediated behaviors, and parent support.	Parent support and parent-mediated behaviors, including total screen time and eating at fast-food restaurants at least weekly, were associated with greater consumption of sugary beverages in children.
Mark S. et al 2012 Cross-sectional	Adolescents ages 9 to 18 (n=8 938) Canada	24-hour food recall (Canadian Community Health Survey) SSB	To examine the influence of income and the conjoint influence of income and food insecurity on several dietary indicators in a representative sample of Canadian youth.	Low-income food insecure girls had a higher intake of SSB
Masse L.C. et al 2014	Adolescents grades 7 to 12	Questionnaire (self reported)	To examine associations between the school food environment, students'	School availability of SSBs was positively associated with moderate (OR) = 1.15, 95%

Cross-sectional	(n=11 385) Canada	SSB	dietary intake, and obesity in British Columbia (BC), Canada	CI = 1.02-1.30) and high (OR = 1.43, 95% CI = 1.13-1.80) SSB intake as were less healthful school nutrition guidelines for moderate SSB consumers only (OR = 0.65, 95% CI = 0.48-0.88).
McKnight-Eily L. et al 2011 Cross-sectional	Adolescents ages 13 to 18 (n=12 154) United States	Questionnaire (self reported) SSB	To examine associations between insufficient sleep (<8 h on average school nights) and health risk behaviours.	Insufficient sleep was associated with higher odds of drinking SSB more than once daily.
Melbye E. et al 2016 Cross-sectional	Adolescents ages 13 to 15 (n=440) Norway	Questionnaire (self reported) SSB	To explore the process in which impulsivity might influence soft drink consumption in adolescents, addressing potential mediating effects of perceived parental regulation regarding unhealthy eating.	Results from our model analyses (both maternal and paternal models) indicated that all the six measured parental regulatory behaviors jointly acted as mediators on the association between adolescent impulsivity and SSB consumption. However, only perceived maternal and paternal legitimacy of regulation showed a unique contribution to the mediated effect.
Moreira P. et al 2010 Cross-sectional	Children ages 5 to 10 (n=1 976) Portugal	Food Frequency Questionnaire SSB	To describe the association between food patterns and gender, parental education, physical activity, sleeping and obesity.	TV viewing was a significant positive predictor of SSB consumption.
Park S. 2010 Cross-sectional	Adolescents ages 12 to 14 (n=4 322) United States	Questionnaire (self reported) SSB, high sugar foods	To examine the prevalence of students buying snacks or beverages from school vending machines instead of buying school lunch and predictors of this behavior.	More students chose snacks or beverages instead of lunch in schools where beverage vending machines were also available. The strongest risk factor for buying snacks or beverages from vending machines instead of buying school lunch was availability of beverage vending machines in schools (aOR 3.5; 95% CI, 2.2 to 5.7). Other statistically significant risk factors were

				smoking, non-Hispanic black race/ethnicity, Hispanic ethnicity, and older age. Although healthier choices were available, the most common choices were the less healthy foods.
Park S. et al 2012 Cross-sectional	Adolescents grades 9 to 12 (n=16 188) United States	Questionnaire (self reported) SSB	To examine the association of demographic characteristics, weight status, self reported academic grades, and behavioral factors with sugar-sweetened soda intake among a nationally representative sample of US high school students	Factors significantly associated with sugar-sweetened soda intake at least one time per day included male sex (adjusted odds ratio [OR]1.47), Hispanic ethnicity (vs whites; OR 0.81), earning mostly B, C, and D/F grades (vs mostly As; OR1.26, 1.66, and 2.19, respectively), eating vegetables fewer than three times per day (OR 0.72), trying to lose weight (OR 0.72), sleeping 8 hours (OR 1.18), watching television 2 hours/day (OR 1.71), playing video or computer games or using a computer for other than school work 2 hours/day (OR 1.53), being physically active at least 60 minutes/day on 5 days during the 7 days before the survey (OR 1.19), and current cigarette use (OR 2.01).
Park S. et al 2012 Cross-sectional	Adolescents grade 9 to 12 (n=11 209) United States	Questionnaire (self reported, National Youth Physical Activity and Nutrition Study) SSB	To examine associations of demographic characteristics, weight status, availability of school vending machines, and behavioural factors with SSB intake.	Factors associated with greater odds for high SSB intake were male gender, being black, eating at a fast food restaurant in the past week, and watching TV for more than 2 hours a day.
Park S. et al 2015	Children aged 6 (n=1 350)	Questionnaire (parent reported)	To examine associations between mothers' child-feeding practices and children's SSB intake among 6-y-old	Adjusted ORs (aORs) of consuming SSBs ≥ times/d (vs. no SSB consumption) were significantly lower in children whose

Cross-sectional	United States	 SSB	children.	mothers reported setting limits on sweets/junk foods (aOR: 0.29; 95% CI: 0.15, 0.58 for underweight/normal-weight children; aOR: 0.16; 95% CI: 0.03, 0.79 for overweight/obese children). SSB intake was higher among underweight/normal-weight children whose mothers reported trying to keep the child from eating too much of their favorite foods (aOR: 2.03; 95% CI: 1.25, 3.29). Mothers' tendency to pressure their children to consume more food or to ‘‘clean the plate’’ was not associated with child's SSB intake.
Pearson N. et al 2011 Longitudinal	Adolescents ages 12 to 15 (n=9 842) Australia	Food Frequency Questionnaire (self reported) SSB	The aim of this study was to examine mediators of the longitudinal associations between television viewing (TV) and eating behaviours among Australian adolescents.	Adolescents who watched more than two hours of TV/day had higher intakes of energy-dense snacks and beverages, and lower intakes of fruit two years later. Furthermore, the associations between TV viewing and consumption of energy-dense snacks, energy-dense drinks and fruit were mediated by snacking while watching TV. Perceived value of TV viewing mediated the association between TV viewing and consumption of energy-dense snacks, beverages and fruit.
Pettigrew S. et al 2015 Cross-sectional	Children ages 8 to 14 (n=1 302) Australia	Questionnaire (parent reported) SSB	To investigate the relationship between a broad range of predictor variables and the frequency with which Australian children consume soft drinks.	Soft drink consumption frequency was primarily influenced by parents’ attitudes to soft drinks, children’s pestering behaviours, and perceived social norms relating to children’s consumption of these products.
Powell L.M. et al 2013	Children ages 2 to 11(n=4 717),	24-hour food recall	To examine the effect of fast-food and full service restaurant consumption on	Fast-food and full-service restaurant consumption, respectively, was associated

Cross-sectional	Adolescents ages 12 to 19(n=4 600) United States	(NHANES Survey) SSB and sugar	total energy intake, dietary indicators, and beverage consumption.	with higher intake of regular soda (73.77 g and 88.28 g for children and 163.67 g and 107.25 g for adolescents) and sugar-sweetened beverages generally. Fast-food consumption increased intake of sugar (5.71-16.24 g) for both age groups. Additional key findings were (1) adverse effects on diet were larger for lower-income children and adolescents and (2) among adolescents, increased soda intake was twice as large when fast food was consumed away from home than at home.
Rovner A.J. et al 2010 Cross-sectional	Adolescents grades 6 to 10 (n=5 930) United States	Food Frequency Questionnaire (self reported) SSB, high sugar foods	To examine the association between food sold in school vending machines and the dietary behaviors of students.	In younger grades, availability of fruit and/or vegetables and chocolate and/or sweets was positively related to the corresponding food intake, with vending machine content and school poverty index providing an explanation for 70.6% of between-school variation in fruit and/or vegetable consumption and 71.7% in sweets consumption. Among the older grades, there was no significant effect of food available in vending machines on reported consumption of those food
Ricmond T.K. et al 2013 Cross-sectional	Adolescents ages 11 to 14 (n=18 281) United States	Questionnaire (self reported) SSB	To determine if racial/ethnic differences in middle school student self-reported sugar- sweetened beverage (SSB) consumption is explained by differential distributions of food outlets surrounding their schools.	More SSB consumption was reported by students of all racial/ethnic minority groups compared to their White peers except Asians. The density of fast food restaurants and convenience stores was not associated with individual SSB consumption (β=0.001, p=0.875) nor did it mediate the association of race/ethnicity and SSB consumption.
Rossen L.M. et	Children ages 2 to	24-hour food	To examine differences in dietary	Children experiencing very low food

al 2016 Cross-sectional	15 (n=5 136) United States	recall (NHANES Survey) Added Sugar	intake by food security status among a nationally representative sample of children and adolescents.	security consumed significantly more added sugars compared to their propensity matched food secure counterparts.
Sampasa-Kanyinga H. et al 2015 Cross-sectional	Adolescents grades 7 to 12 mean 15 (n=9 858) Canada	Questionnaire (self reported, Ontario Student Drug Use and Health Survey) SSB	To investigate the associations between time spent on social networking sites and unhealthy eating behaviours and body weight.	Use of SNS was significantly associated with SSB in the past week in a dose response manner once adjustments for age, sex, ethnicity, SES, tobacco, alcohol, and cannabis use were made.
Santaliestra-Pası´as A.M. et al 2012 Cross-sectional	Adolescents ages 12 to 17 (n=2 202) Europe	24-hour food recall SSB	To examine the association between time spent on different sedentary behaviors and consumption of certain food and beverage groups in a sample of European adolescents.	Boys reporting more than 4 h/d of watching television, playing computer games, and using the Internet for recreation were more likely to consume sweetened beverages (weekends) ([OR], 1.83 [95%CI, 1.21- 2.75]; 1.99 [1.31-3.01]; and 1.73 [1.03-2.91], respectively), than those who spent less than 2 h/d. Girls spending more time per day watching television and playing computer or video games (weekdays) and playing computer games or surfing the Internet for recreation (weekends) were more likely to drink sweetened beverages (OR, 1.89 [95% CI, 1.21-2.94]; 1.57 [1.00-2.46]; 2.14 [1.16-3.97]; and 2.30 [1.24-4.28], respectively)
Shi L. 2010 Cross-sectional	Adolescents ages 12 to 17 (n=3 983) United States	Questionnaire (self reported, California Health Interview	To estimate the association between the availability of SSB from school vending machines and amount of SSB consumption.	Propensity score stratification shows that adolescents who had access to SSB through their school vending machines consumed 0.170 more drinks of SSB than those who did not (P<.05)

		Survey) SSB		
Vagstrand K. et al 2009 Cross-sectional	Adolescents aged 16 (n=474) Sweden	Questionnaire (self reported) SSB	The aim of the study was to investigate how soft drink and fruit juice consumption in teenagers is associated with lifestyle, other food choices, eating behaviour and maternal characteristics.	It was found that eating breakfast less than five times per week was independently associated with a high soft drink consumption in both girls and boys. A low intake of cooked meals and milk and a high intake of salty snacks were associated with soft drinks in boys only.
van Ansem W.J.C. et al 2014 1 year of longitudinal study	Children aged 11 (n=1 317) Netherlands	Questionnaire (self and parent reported) SSB	To examine the association between maternal education and unhealthy eating behaviour and explore environmental factors that might mediate this association in 11-year-old children.	Children of mothers with a low educational level were found to consume more SSB than those of mothers with a high educational level (β 0.63, P<0.01). The association between maternal educational level and children's SSB consumption was found to be mediated by parental intake of snacks and SSB and home availability of SSB. The home environment seems to be a promising setting for interventions on reducing socio-economic inequalities in children's SSB consumption
van de Gaar V.M. et al 2017 Cross-sectional	Children ages 6 to 13 (n=644) Netherlands	Questionnaire (parent reported) SSB	To evaluate associations between family and home-related factors and children's SSB consumption. We explored associations within ethnic background of the child.	Child's age, parents' subjective norm, parenting practices, and parental modelling were positively associated with the child's SSB intake. The availability of SSB at home and school and parental attitude were negatively associated with the child's SSB intake. The associations under study differed according to the child's ethnic background, with the explained variance of the full models ranging from 8.7% for children from Moroccan or Turkish ethnic background to

				44.4% for children with Dutch ethnic background.
van der Horst K. et al 2007 Cross-sectional	Adolescents ages 12 to 17 (n=383) Netherlands	Questionnaire (self reported) SSB	To investigate whether perceived parenting practices and parenting style dimensions (strictness and involvement) are associated with adolescents' consumption of sugar-sweetened beverages.	More restrictive parenting practices were associated with lower consumption of sugar-sweetened beverages (β -38.0 ml; 95% CI: -48.1, -28.0). This association was highly mediated (~55%) by attitude, self-efficacy and modeling from parents. Nevertheless, a significant direct effect remained (β -17.1 ml; 95% CI: -27.2, -6.90)
Williams J. et al 2013 Systematic Review	Children and Adolescents ages 5 to 18 International	SSB	This systematic review investigates associations between food outlets near schools and children's food purchases, consumption and body weight.	This review found very little evidence for an effect of the retail food environment surrounding schools on food purchases and consumption.
Zarnowiecki D. et al 2014 Cross-sectional	Children ages 9 to 13 (n=625 families) Australia	Semi-quantitative food frequency questionnaire SSB	This study investigated associations between diet and various SEP indicators among children aged 9–13 years.	Lower SEP was associated with higher intake of sweetened drinks, and more unhealthy behaviours. Mother's education appeared most frequently as a predictor of children's dietary intake, and postcode was the least frequent predictor of children's dietary intake.

Appendix B: Bureau of Nutritional Sciences Food Codes Included in Added Sugar Measure

Food Code	Description
05	Whole Grain and High Fibre Breakfast Cereals
06	Other Breakfast Cereals
07	Cookies, Biscuits and Granola Bars
08	Cakes, Pies, Danishes, and Other Pastries (Commercial)
09	Frozen Dairy Products
33C	Peanut Butter and Other Nut Spreads
41	Sugars, Syrups, and Preserves
43	Confectionary
44	Chocolate Bars
46	Non-Alcoholic Beverages (soft drinks, fruit drinks, malted milk and chocolate beverages, energy drinks, vitamin water, sport drinks)
49B	Alcoholic Coolers
50	Miscellaneous (sauces, salad dressings)
51	Tea and Coffee
54	Supplemented Bars, Shakes, and Meal Replacements
150	Sweet Baked Goods
170	Breakfast Combinations (with Eggs, Cheese, Ham etc. (English Muffins, Biscuits, Croissants, Pancakes, and French Toast))
202	Frozen Dairy Products (recipes)
205	Milk Desserts
229	Sweet Snacks, Sugar, Candies, etc. (recipes)
231	Beverages (recipes) (tea, coffee, milk based beverages (such as milkshakes, malted drinks, hot chocolate, instant breakfasts), fruit drinks, alcoholic beverages, liquid meal replacements, protein powder)

Curriculum Vitae

Name:	Ulaina Tariq
Post-secondary Education and Degrees:	Western University London, Ontario, Canada 2016-2018 MSc University of Waterloo Waterloo, Ontario, Canada 2010-2015 BSc
Honours and Awards:	Western Graduate Research Scholarship 2017-2018 Children's Health Research Institute Quality of Life Graduate Research Fellowship 2016-2017
Presentations:	Tariq U., Wilk P., Stranges S., and O'Connor C. Analysis of Added Sugar Intake of Canadian Children and Adolescents Using the Canadian Community Health Survey-Nutrition 2015. Poster Presentation at London Health Research Day. (London, Ontario; May 2018). Tariq U., Wilk P., Stranges S., and O'Connor C. Analysis of Added Sugar Intake of Canadian Children and Adolescents Using the Canadian Community Health Survey-Nutrition 2015. Oral Presentation at Canadian Obesity Network Student Meeting. (London, Ontario; June 2018)