7-15-2020 2:00 PM

The Impact of School Nutrition Policy on Diet Quality of Children and Youth in Canada

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

Abstract

Improving diet quality is an important public policy initiative targeted to enhance population health worldwide. In this regard, school nutrition policy is an important means to promote healthy diet among children and youth. In Canada, six provinces implemented mandatory school nutrition policies at different times between 2005 and 2011. We investigated the impact of mandatory school nutrition policy on diet quality of Canadian children and youth using a quasi-experimental study design. Using 24-hour dietary recall data from the 2004 Canadian Community Health Survey (CCHS) Cycle 2.2 and 2015 CCHS-Nutrition, we constructed the Diet Quality Index (DQI). We used multivariable difference-in-differences regression models to quantify the effect of school nutrition policy on diet quality. We conducted stratified analyses by sex, school grade, and household income to gain additional insights into the effect of nutrition policy. We found that the effect of mandatory school nutrition policy on diet quality, measured by DQI, increased by 4.34 points (95% CI: 1.83 - 6.85) per child during school-hours in provinces with mandatory nutrition policy compared to control provinces. Although the confidence intervals overlap, the effect was higher among males (6.51 points, 95% CI: 2.93 - 10.09) compared to females (2.14 points, 95% CI: -1.25 - 5.52), and the effect among children in elementary schools was higher (4.82 points, 95% CI: 1.97 - 7.67) compared to those in high schools (3.37 points, 95% CI: -1.22 - 7.95). Our findings suggest that other jurisdictions may consider implementing mandatory school nutrition policy.

Keywords

School Nutrition Policy; Diet Quality; difference-in-differences; Children; Youth; Canada

Summary for Lay Audience

Numerous studies show that children and youth are not meeting the recommendations of Canada's Food Guide. Studies of food consumption among Canadian children report that more than half ate less than the minimum recommended daily servings of fruits and vegetables, milk products, and grain products. Because poor diet is associated with the incidence of many preventable chronic conditions, nutrition has been identified as a focus point for initiatives aimed at improving the health of children. One such initiative targeted directly at children and youth are school nutrition policies. This thesis evaluated the effect of mandatory school nutrition policies on diet quality of Canadian children and youth using data from the Canadian Community Health Surveys collected by Statistics Canada. Using 24-hour diet recall data, diet quality scores (on a scale of 0 to 100) were calculated. Mandatory provincial school nutrition policy increased diet quality of children during school-hours compared to provinces with voluntary school nutrition policy. Males and elementary school students had greater improvements in diet quality during school hours. The findings suggest that other provinces may consider implementing mandatory school nutrition policies.

Co-Authorship Statement

A shorter version of the thesis was submitted to Preventive Medicine for consideration for publication, following peer-review a revision is now requested. Victoria Gaudin conducted the literature review, statistical analysis, drafted the thesis and subsequent draft manuscript. Dr. Sisira Sarma contributed to the study design, analysis plan and converted the draft to manuscript for journal submission. Dr. Saverio Stranges and Dr. Piotr Wilk further polished the manuscript.

Acknowledgments

I would like to express my sincere gratitude to my supervisor, Dr. Sisira Sarma, for his invaluable guidance throughout my graduate studies and completion of this thesis. A special thanks also goes to my committee members, Dr. Saverio Stranges and Dr. Piotr Wilk for providing their advice and expertise. I would also like to thank my examiners, Dr. Amardeep Thind, Dr. Jamie Seabrook and Dr. Shauna Burke for their comments and feedback which have improved the thesis presentation.

Thank you to Jacob for your unwavering love and support throughout this journey. To my parents, thank you for always supporting and encouraging me through everything I do. I could not have done this without you.

I would like to thank funding from the University of Western Ontario (Western Graduate Research Scholarship) and monthly stipend through the "Research to prevent adult obesity" project funded through the Estate of Margaret May Dodge. The data used for this research was supported by funds to the Canadian Research Data Centre Network (CRDCN) from the Social Sciences and Humanities Research Council (SSHRC), the Canadian Institute for Health Research (CIHR), the Canadian Foundation for Innovation (CFI), and Statistics Canada. Although the research and analysis are based on data from Statistics Canada, the opinions expressed in this study are solely the authors and do not represent the views of Statistics Canada.

Finally, I would like to dedicate this thesis to my grandmother Wilma, who passed away during my graduate studies. I know you would be proud of my achievement, and I wish I could share it with you.

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List of Abbreviations

AMPM:	Automated Multiple-Pass Methods
ANOVA:	Analysis of Variances
BMI:	Body Mass Index
CCHS:	Canadian Community Health Survey
CFG:	Canada's Food Guide
DRI:	Dietary Reference Intake
DQI:	Diet Quality Index
DQI-I:	Diet Quality Index-International
FV:	Fruit and Vegetable
HEI:	Healthy Eating Index
LNDF:	Low-Nutrient Dense Foods
MUFA:	Monounsaturated Fatty Acids
PUFA:	Polyunsaturated Fatty Acids
SES:	Socioeconomic Status
SFA:	Saturated Fatty Acids
SSB:	Sugar Sweetened Beverages

Chapter 1

1 Introduction

Nutrition and physical activity are lifestyle behaviours that have important implications for improving population health worldwide.[1] One related public policy initiative targeted at children and youth is the school nutrition environment. This is because the food environment that children experience at school may not only affect eating healthy foods at school but may also contribute to habit formation to influence the foods children choose to consume at home.

The 2007 Canada's Food Guide (CFG) recommended the following daily servings for children and youth, depending on age and sex: 5 to 10 servings of fruits and vegetables (FV), 4 to 8 servings of grains, 2 to 4 servings of milk and alternatives, and 1 to 3 serving(s) of meat and alternatives (see Table 1.1 for details). Current evidence indicates that children and youth in Canada failed to meet the recommendations of CFG. One Canadian study reported that 76.4% of children ate less than the minimum recommended daily servings of FV, 58.4% ate less than the minimum recommended daily servings of milk products and 57.3% ate less than the minimum recommended daily servings of grain products.[2] In attempts to improve the diet quality of Canadian children, some provinces have implemented mandatory school nutrition policies to improve the food environment within schools.

1.1 School Nutrition Policy in Canada

In Canada, health and education are under the jurisdiction of provinces and territories. Consequently, different provinces have developed their own school nutrition policies, leading to variations in policies and strategies.[3] Specifically, five provinces have implemented mandatory school nutrition policies (British Columbia, Quebec, New Brunswick, Nova Scotia and Ontario), one province (Prince Edward Island) has nutrition policies that are mandatory for schools, though not legislated provincially, and the rest of provinces have no mandatory policy with the exception of some general nutrition guidelines.[4] Note that six provinces implemented their policies at different times from 2005 to 2011, providing the opportunity for this quasi-experimental study to evaluate the impact of school nutrition policy on diet quality in Canada.

Table 1.2 provides an overview of mandatory school nutrition policy or guidelines across Canadian provinces. In 2005, New Brunswick was the first province to implement a mandatory school nutrition policy, followed by Prince Edward Island. Nova Scotia implemented a policy in 2007, and British Columbia and Quebec's policies were both implemented in 2008. Ontario is the most recent province to implement a mandatory school nutrition policy in 2011. The rest of the provinces provide nutrition guidelines to schools, but do not have a mandatory policy. The provinces with mandatory policies generally outline what types of food and beverage can be sold or served in public schools.

British Columbia has a mandatory school nutrition policy (The Guidelines for Food and Beverage Sales in B.C. Schools).[5] The policy defines the minimum nutrition standards for foods sold in schools. Freshly made foods are scored as one of two categories: "sell (100% of choices)" or "don't sell (0% of choices)." Prepackaged foods are scored as one of three categories: "sell most (at least 50% of choices)," "sell sometimes (up to 50% of choices)," or "do not sell (should not be sold to students)." Optional policies include restricting the marketing of unhealthy food and beverages, limiting the sale of sugar substitutes, and supporting healthy eating in the classroom.

Alberta does not have a mandatory school nutrition policy. Recommendations are provided for childcare facilities, school facilities, recreational facilities and environments, and overall for any environment where children may be present. Guidelines are provided for foods to choose most often, choose sometimes, and choose least often from each food group.

Saskatchewan does not have a mandatory school nutrition policy. The province provides guidelines for foods to choose most often and choose sometimes for each food group and for mixed dishes.

Manitoba does not have a mandatory school nutrition policy. Guidelines/checklists are provided for the school food environment, breakfast/snack/lunch programs, foods sold in cafeterias, canteen/vending machines, sporting events, and special lunch days. The province provides nutrition criteria for processed/packaged products and convenience items and information on fibre, sodium, sugar, sugar substitutes, trans fat, and whole grains and what to look for in ingredient lists (e.g., different names for sugar).

Ontario has a mandatory school nutrition policy (Policy/Program Memorandum No. 150).[6] All foods and beverages sold in schools must comply with policy requirements and nutrition standards. Nutrition criteria are divided into "sell most," "sell less," and "not permitted for sale" categories. Foods in the sell most category must make up at least 80% of foods sold and sell less must be less than 20%. Foods in the "not permitted for sale" category are not allowed at all. Guidelines for how to categorize foods are provided to schools. Schools are allowed up to 10 days a year for special events where foods sold do not need to meet nutrition standards.

Quebec has a mandatory school nutrition policy (Framework Policy on Healthy Eating and Active Living).[7] The policy framework consists of two orientations for healthy eating: 1) offers a variety of foods and prioritizes foods with high nutritional value, and 2) eliminates foods of low nutritional value from schools. It provides nutrition guidelines for schools to implement for foods sold in schools and requires elimination of SSB, french fries, foods with sugar as the first ingredient, and frying foods. Foods sold at school events and fundraisers also need to meet nutritional guidelines.

New Brunswick has a mandatory school nutrition policy (Policy 711).[8] Foods are grouped into "higher nutritional value" and "lower nutritional value" and guidelines are provided on how to determine which category a food falls into. The policy mandates that only foods in the "higher nutritional value" group may be sold. Lunch meals must include at least vegetables, fruits, whole grain products, milk/alternatives and meat/alternatives. Foods sold at fundraisers must still fall into the "higher nutritional value" category.

Nova Scotia has a mandatory school nutrition policy (The Food and Beverage Standards for Nova Scotia Public Schools).[9] Foods are categorized as "maximum nutrition," "moderate nutrition," or "minimum nutrition." Foods in these categories can be sold every day, no more than two times a week, and once or twice a month for special events, respectively. The province also provides guidelines on how to group foods, as well as information on the rationale behind why consumption of certain nutrients is encouraged (e.g., fibre) or limited (e.g., trans fat).

Prince Edward Island has a mandatory school nutrition policy (Public Schools Branch Nutrition Policy).[10] Foods are categorized into "foods to serve most often," "foods to serve sometimes," "foods to serve least often," and "healthier vending machine and canteen foods." Foods available

for breakfast and lunch should come from “foods to serve most often” or “foods to serve sometimes.” Foods from the “foods to serve least often” should rarely be sold. Foods sold in vending machines must meet nutritional standards; Sugar Sweetened Beverages (SSB) and other low-nutritional beverages are not to be sold. The policy also states that pricing should encourage students to purchase healthier foods and schools should use a comprehensive approach to nutrition education.

Newfoundland and Labrador does not have a mandatory school nutrition policy. The province encourages a focus on the four food groups. Foods are grouped as “serve most” and “serve moderately” and guidelines are provided specific to each food group. At least 50% of items sold should come from the serve most category according to the guidelines. Guidelines are also provided on foods to limit and serving sizes.

1.2 Diet Quality of Canadian Children

The literature suggests that Canadian children are not meeting the 2007 CFG recommendations. In Nova Scotia, a study of dietary intake among grade 7 and 11 students found that over 50% of girls in grades 7 and 11 reported intakes that did not meet the minimum CFG recommendations for grain products, FV, and milk and alternatives.[11] Over 2/3 of boys in grades 7 and 11 reported intakes that did not meet the minimum recommendations for FV or grain products. Overall, more than 80% of boys and girls did not meet CFG recommendations for FV servings. In Ontario, children aged 4-8 failed to meet 1/3 of the daily recommended servings of FV.[12] In children aged 9-13, the mean daily lunch servings failed to meet 1/3 of the daily recommended servings of FV, grain products, and milk and alternatives. Another study in Ontario evaluated CFG food group consumption of students in grades 6 and grade 9.[13] In grade 6, only 5% of males and 7% of females met the minimum serving recommendations for all food groups from CFG. This number decreased even more in grade 9, with only 0.4% of males and 2% of females meeting the minimum serving recommendations for all food groups. A study across Canada found that only 10% of grade 6-12 students in Canada met daily FV recommendations.[14] It is clear from the literature that there is room to improve the diet quality of Canadian children.

To date, a few studies have examined the impact of provincial school nutrition policy on various measures of dietary intake. One Canadian study evaluated the effect of junk food bans in schools on students' body mass index (BMI) using Canadian Community Health Survey (CCHS) data.[15] Although this study found that the effect of junk food bans in schools reduced BMI, the mechanisms by which BMI decreased was unclear. Other studies have assessed the impact of school nutrition policies or interventions on consumption of different food groups and diet quality.[16–20] After implementation of the provincial nutrition policy in Nova Scotia, diet quality of students had improved – increased consumption of FV, decreased consumption of soda and sugar-sweetened beverages, and increased Diet Quality Index (DQI) scores.[17,19] Following the implementation of school nutrition policy in Prince Edward Island, students were more likely to have met the recommended servings of FV.[20]

A number of systematic reviews with meta-analyses consistently reported higher FV consumption following the implementation of school nutrition policies outside of Canada.[21–27] A systematic review of the effectiveness of school-based nutrition policies in Europe found that 76% and 77% of studies looking at children (aged 6-12 years) and adolescents (aged 13-18), respectively, reported improvements in dietary behaviour.[22] However, the measure of dietary behaviour varied across included studies, with some only looking at FV consumption, and others looking at overall diet quality.

Given the amount of time children spend at schools, there is an opportunity to change the eating habits of children and youth through nutrition policies in schools. Overall, the studies looking at school nutrition policy, specifically in the Canadian context, have reported increased consumption of FV after implementation of provincial policies. In addition, a few studies of school nutrition policy found increases in DQI scores following implementation of policy in Nova Scotia. However, these studies did not have a control group. Although one study included a Canada-wide analysis of the effects of school nutrition policies, the outcome was BMI, but not diet quality. The three studies mentioned above evaluated specific provincial school nutrition policies used a Food Frequency Questionnaire to measure dietary intake.[17,19,20] The use of food frequency questionnaires may miss the inclusion of food items that are important to the population of interest.[28] Compared to food frequency questionnaires, the use of a 24-hour dietary recall captures all items that an individual consumed.

1.3 Gaps in the Literature Regarding the Effects of School Nutrition Policy on Diet Quality

There are a few gaps in the literature concerning the link between school nutrition policy and diet quality. One is the lack of nationwide study looking at school nutrition policy in Canada. Another is the lack of a control group in previous studies. While there have been studies examining the effects or impacts of school nutrition policies and specific school nutrition programs, none have conducted a Canada-wide examination of the effect of these policies on dietary behaviours of children and youth. Numerous studies have measured the effects of school nutrition policies and programs on food group consumption, especially FV, and nutrient intake, but measuring overall diet quality rather than consumption of certain dietary components is ideal to capture a more holistic view of diet and eating behaviour. The use of a control group is important for teasing apart the effects due to the school nutrition policy from social and environmental factors affecting diet quality in the population. There have been a number of changes in Canadian society over the time period of this study (2004 to 2015), such as food prices, a rise in media campaigns and the general awareness that comes with it, and an increase in the number of fast food restaurants,[29] that have been shown to impact the eating behaviour of children.

1.4 Study Rationale

In general, most of the literature in this area focuses on components of diet quality (e.g., nutrient intake, food group consumption), but a few studies have tried to capture changes in overall diet quality resulting from changes in the school food environment. Given that mandatory school nutrition policies in Canada are aimed at improving the diet quality of children, a study is required to examine whether this goal is actually being achieved. The key distinction between the provinces with and without mandatory school nutrition policy is the level of compliance with the guidelines for schools. All 10 provinces provide specifications for foods that can/should be available in the school, but the difference is whether these guidelines are mandated at the provincial level rather than being voluntary. This thesis contributes to the literature on school nutrition policies and diet quality by going beyond simply measuring changes in food group and nutrient consumption to capture changes in overall diet quality scores among children before and after implementation of policies across Canada.

Although a recent study described the differences in school-hour dietary intakes between 2004 and 2015 using CCHS data using the Healthy Eating Index (HEI) and sub-scores for FV, milk and alternatives and meat and alternatives, it did not investigate the role of school nutrition policy.[30] We used DQI as the primary measure of diet quality because DQI provides a comprehensive measure of diet quality by looking at four aspects of diet quality (variety, adequacy, moderation, and overall balance) instead of two (adequacy, moderation) by the HEI. By using a difference-in-differences approach, this study investigates the impact of mandatory school nutrition policy on diet quality of Canadian children and youth.

1.5 Study Objectives

The primary objective of this study was to estimate the change in diet quality from 2004 to 2015, as measured by DQI, that occurred among Canadian school-going children resulting from the implementation of mandatory school nutrition policies in some provinces, relative to provinces with voluntary school nutrition policy. The secondary objective was to estimate the change in diet quality measured by HEI, and conduct stratified analyses by sex, school grade and household income on HEI and DQI.

Based on the existing literature, the main hypothesis of this study was that after implementation of mandatory school nutrition policy, the diet quality of school-going children will improve.

1.6 Tables

Table 1.1. Dietary recommendations from 2007 Canada's Food Guide

Sex	Age group	Food groups (servings/day)				Sodium intake (mg/day)		Calcium intake (mg/day)	Iron intake (mg/day)	Vitamin C (mg/day)	Fibre (g/day)
		Fruits and vegetables	Grains	Milk and alternatives	Meat and alternatives	AI	TUL	AI	AI	RDA	AI
Children	4-8	5	4	2	1	1200	1900	1000	10	25	25
	9-13	6	6	3-4	1-2	1500	2200	1300	8	45	26(f) 31(m)
Female	14-18	7	6	3-4	2	1500	2300	1300	15	65	26
Male	14-18	8	7	3-4	3	1500	2300	1300	11	75	38
Female	19-50	7-8	6-7	2	2	1500	2300	1000	18	75	25
Male	19-50	8-10	8	2	3	1500	2300	1000	8	90	38
Female	51-70	7	6	3	2	1300	2300	1200	18	75	21
Male	51-70	7	7	3	3	1300	2300	1000	8	90	30
Female	71+	7	6	3	2	1200	2300	1200	8	75	21
Male	71+	7	7	3	3	1200	2300	1200	8	90	30

* AI = Adequate Intake, TUL = Tolerable Upper Limit, RDA = Recommended Dietary Allowances

Table 1.2. Provincial school nutrition policy

Province	Implemented Mandatory School Nutrition Policy (Y/N)	Year	Policy specifics
British Columbia[5]	Y	2008	• Defines minimum nutrition standard for foods sold in schools • Freshly made foods scored as either "sell (100% of choices)" or "don't sell (0% of choices)" • Prepackaged foods scored as either "sell most (at least 50% of choices)," "sell sometimes (up to 50% of choices)," "do not sell (should not be sold to students)" • Includes optional policies: restricting the marketing of unhealthy food and beverages, limiting the sale of sugar substitutes, and supporting healthy eating in the classroom
Alberta[31]	N		• Provides recommendations for childcare facilities, school facilities, recreational facilities and environments, and overall for any environment where children may be present • Provides guidelines for foods to choose most often, choose sometimes, and choose least often from each food group
Saskatchewan[32]	N		• Provides guidelines for foods to choose most often and choose sometimes for each food group and for mixed dishes
Manitoba[33]	N		• Provides guidelines/checklists for school food environment, breakfast/snack/lunch programs, foods sold in cafeteria, canteen/vending machines, sporting events, special lunch days • Provides nutrition criteria for processed/packaged products and convenience items • Provides information on fibre, sodium, sugar, sugar substitutes, trans fat, and

			whole grains and what to look for in ingredient lists (e.g., different names for sugar)
Ontario[6]	Y	2011	• Requires that all food and beverages sold in schools comply with policy requirements and nutrition standards • Nutrition criteria divided into "sell most," "sell less," and "not permitted for sale" categories • Foods in sell most category must make up at least 80% of foods sold and sell less must be less than 20% • Foods in "not permitted for sale" category are not allowed at all • Guidelines for how to categorize foods is provided to schools • Schools are allowed up to 10 days a year where foods sold don't need to meet nutrition standards for special events
Quebec[7]	Y	2008	• Policy framework consists of two orientations for healthy eating: 1) offer a variety of foods and prioritize foods with high nutritional value; 2) eliminate foods of low nutrition value from schools • Provides nutritional guidelines for schools to implement for foods sold/provided in schools • Requires elimination of sugar-sweetened beverage, French fries, foods with sugar as the first ingredient, and frying of foods • Foods sold at school events, fundraisers, etc. need to meet nutritional guidelines
New Brunswick[8,34,35]	Y	2005	• Groups foods into "higher nutritional value" and "lower nutritional value" and provides guidelines on how to determine which category a food falls into • Mandates that only foods in the "higher nutritional value" group may be sold • Provides nutritional guidelines for selling "a la carte" items

			• Lunch meals must include at least: vegetables, fruit, whole grain products, milk/alternatives and meat/alternatives • Foods sold at fundraisers must still fall into "higher nutritional value" category
Nova Scotia[9]	Y	2007	• Categorizes foods as "maximum nutrition," "moderate nutrition," and "minimum nutrition" • Maximum, moderate, and minimum nutrition foods can be sold every day, no more than two times a week, and once or twice a month for special events, respectively • Provides guidelines on how to group foods, as well as information on the rationale behind why consumption certain nutrients are encouraged (e.g. fibre) or limited (e.g. trans fat) • Breakfast programs must meet the nutrition policy standards
Prince Edward Island[10,36]	Y	2005	• Foods categorized into "foods to serve most often," "foods to serve sometimes," "foods to serve least often," and "healthier vending machine and canteen foods" • Foods available for breakfast and lunch should come from "foods to serve most often" or "foods to serve sometimes" • Foods from the "foods to serve least often" should rarely be sold • Foods sold in vending machines must meet nutritional standards, sugar-sweetened beverages and other low-nutritional beverages are not to be sold • Pricing should encourage students to purchase healthier foods • Schools should use a comprehensive approach to nutrition education
Newfoundland and Labrador[37]	N		• Encourages a focus on the four food groups • Groups foods as "serve most" and "serve moderately" and provides guidelines specific to each food group • At least 50% of items sold should come from the serve most category

			• Provides guidelines on foods to limit and serving sizes

Chapter 2

2 Literature Review

This chapter provides a detailed overview of diet quality among children, current knowledge from studies of school nutrition policies and programs, and factors that affect diet quality.

2.1 Search Strategy

EMBASE, Medline, CINAHL and Web of Science databases were searched using the combination of headings and keywords for food, consumption, school and policy below. Grey literature search of Scopus, BIOSIS Previews and ProQuest Dissertations and Theses Global was completed using the following keywords: (“food*” OR “nutrition*”) AND (“consum*”) AND (“school*”) AND (“polic*”). Appendix A1 provides the search strategy used for each database.

Inclusion criteria for articles were: published between 1990 and 2019, evaluate the effect of school nutrition policies or interventions on school-aged children (6 to 18 years), measure food consumption or nutrient intake in some way and written in English language. Reference lists of included articles were reviewed for additional relevant articles, and Google Scholar was used to check forward citations and to search articles not captured in the original search. From the search, 46 articles were identified: five systematic reviews, two discussion papers and thirty-nine studies or trials. Appendix A2 contains information regarding the screening process for articles.

2.2 Factors that Affect Diet Quality

The following section discusses factors identified in the literature as having an effect on diet quality of individuals.

2.2.1 Age

It has been reported that diet quality declines with age. Parents can have an influence on diet quality of their children as they age. Parents make choices regarding food for the family, and model eating behaviours to their children.[38] With younger children, parents may be more inclined to ensure that they are eating a balanced diet. Younger children are also less likely to prepare their own foods compared to older children, and do not have as much freedom or

financial ability to purchase foods outside of the home. Consequently, as children age into late childhood and adolescence, there tends to be an increase in consumption of foods outside the home environment, including fast food.[39] Thus, lower diet quality in older children/youth may be a result of more freedom in dietary choices. In addition, changes in meal patterns in adolescence may also partially explain the decline in diet quality among older children. For example, adolescents are more likely to skip breakfast and consume fewer meals with their family.[39]

A study by Hiza et al. (2012) found that diet quality was higher for American children aged 2 to 5 years old than children aged 6 to 17 years old.[40] A study of diet quality during school hours in Canada reported that diet quality scores decreased with age,[41] further indicating that older children may have poor dietary behaviours.

2.2.2 Sex

Sex differences in terms of dietary behaviours have been documented in the literature. Typically, females are reported to have better diet quality and greater consumption of FV compared to males. While the reason for this difference is not entirely clear, one potential explanation is the concern with weight and body image that often emerges among female teenagers.[38] As a result, females may feel pressured to consume a more healthy diet, resulting in the observed diet differences between males and females.

A study of Americans found that females had higher diet quality scores than males for all age groups.[40] For children specifically, females had higher scores for consumption of fruit, whole fruit, and vegetables.[40] A study of grades 7 to 12 students in British Columbia, Canada reported that females had significantly better diet quality than males.[42] In addition, it was reported that males had significantly lower odds of being a moderate to higher consumer of SSB.[42]

2.2.3 Race/Ethnicity

There are a number of factors that can influence diet quality among ethnic groups. These factors can be grouped into seven clusters: social and cultural environment (e.g., cultural identity), food beliefs and perceptions (e.g., perception of healthy foods), psychosocial (e.g., taste preferences), accessibility of food (e.g., food prices), social and material resources (e.g., income), migration context (e.g., region of origin), and the body (e.g., consciousness).[43]

Previous studies have found racial differences in diet quality among children. A study of three-year-old children found that compared to White children, Black and Hispanic children consumed more SSB and fast food.[44] Black and Hispanic children also consumed less bad fats, snacks, and low-fat dairy products. Another study reported that in comparison to non-Hispanic White children, non-Hispanic Black children had lower diet quality scores, while Hispanic children had higher diet quality scores.[45]

2.2.4 Immigration

The relationship between immigration and diet quality can be explained by the healthy immigrant effect. The healthy immigrant effect states that immigrants to a country are healthier on average compared to individuals born in the host country.[46] In the context of this study, this suggests that immigrants to Canada would have better diet quality than native born Canadians. However, the phenomenon known as diet acculturation also plays a role. Diet acculturation refers to the process by which a group of individuals (i.e., immigrants, in this case) adopt the dietary behaviours and eating patterns of a host country.[47] Taken together, these phenomena indicate that immigrants to Canada will initially have better diet quality, on average, compared to native born Canadians, but over time will adopt the typical dietary behaviours of those born in Canada.

A literature review by Tarraf et al. (2017) explored the relationship between immigration and food insecurity in a Canadian context.[48] The immigrant population had an overall higher risk of calcium, iron and protein deficiencies.[48] Additionally, included studies found that immigrants' traditional diets were of higher nutritional value than the standard Canadian diet, and that as the length of stay in Canada increased, so did the intake of fat and sodium by immigrants. Therefore, whether or not an individual is an immigrant and how long they have been in Canada may affect their diet quality.

2.2.5 Parental Education

Education has been shown to be positively associated with healthy habits among children, including better diet quality. The Grossman's health capital model can be used to explain how education increases health. This model posits that all individuals have an initial stock of health

capital that depreciates over time, but can be augmented by making investments in health.[49] In the context of this model, a higher level of education results in an individual producing health more efficiently through better use of health inputs as well as allocating more time towards healthy activities.[49] In other words, more educated individuals receive a higher marginal benefit of improved health for the same marginal input compared to an individual with a lower level of education.

Education is consistently associated with diet quality such that individuals with lower levels of education tend to have lower diet quality.[50] One study found that adults with a college diploma had significantly higher diet quality scores compared to adults with less than high school.[40] A recent meta-analysis found that higher education level was associated with consumption of FV.[51] A review of the effects of social and family factors on diet quality reported that parents with higher levels of education make healthier food choices,[52] which may have an impact on the diet quality of their children. This review showed that children or parents with higher education levels consumed more servings of FV and also had a greater likelihood of meeting the recommended daily servings of dairy products. The review also found that higher education level of mothers was associated with lower added sugar intake in preschoolers, and a lower percentage of energy from fat among adolescents. Conversely, households with less than high school education had more exclusive use of whole milk, compared to households with a college education who used more reduced-fat milk exclusively. The percentage households with some completed postsecondary education surrounding a school has also been found to be associated with better diet quality among students.[42]

2.2.6 Household Income

The relationship between income and diet quality is rather straightforward. Income greatly affects the types of foods that an individual can purchase, and therefore, diet quality.[40,51–53] For example, fresh FV typically cost more, so individuals with higher income are able to afford healthy foods. Low-income households may have to rely on packaged products that may be of lower nutritional value, canned vegetables, refined grains rather than whole grains, and fast food. Compared to high-income households, low-income households have to make a decision between food cost and nutritional value. The literature on income and diet quality consistently reports that high-income households have better diet quality than low-income households.[40,51–53]

Lower income households purchase foods of lower nutrition quality compared to high income households.[53] A study of Americans reported that with increasing income, diet quality generally increased for adults, except for sodium intake.[40] From a review of the association between social class and diet quality, Darmon and Drewnowski (2008) reported some consistencies across studies looking at the effect of socioeconomic status (SES) on food consumption.[51] Higher SES was found to be associated with consumption of whole grains, while lower SES was associated with consumption of refined grains. Higher SES groups also consumed more servings of FV, as well as a greater variety of FV than lower SES groups. Individuals of higher SES had a greater preference for skim or low-fat milk, and consumed more lean meats. The association between SES and micronutrient intake and total energy intake were both inconsistent across the included studies. Another review also found that individuals of lower SES tend to consume fewer FV and have lower intake of many micronutrients than individuals of high SES.[52] Additionally, high SES households were more likely to meet the recommended daily servings of dairy products.[52]

2.2.7 Urban vs. Rural Environment

The effect of living in an urban vs. rural environment on diet quality may differ depending on the location where the individual is living. For example, certain urban areas may be in a “food desert”, which is an area of typically lower income with poor access to supermarkets and healthy foods.[54] On the other hand, income may moderate the relationship such that certain urban areas have a higher average household income and therefore better diet quality compared to a rural area in the same general location.

The type of neighbourhood environment in which an individual resides may affect the types of foods they consume, and therefore, their overall diet quality. A study conducted in Quebec found that living in a rural environment was associated with having poorer diet quality.[55] Similarly, a study in British Columbia found that grade 7 to 12 students from schools in suburban and rural settings had higher odds of being overweight and obese.[42] Conversely, a study of diet quality among adolescents in Australia found that students living in rural regions had higher diet quality scores, consumed less SSB and fast food, and a higher proportion reported eating breakfast.[56]

2.2.8 School Food Environment

The food environment within schools plays an important role in dietary behaviours and nutrition among students.[38,42,57,58] This explains the goal of school nutrition policies in changing school food environments to improve diet quality among children. In addition, the type of environment surrounding schools can also have an effect on diet quality.[42,58,59]

Focusing on the within-school food environment, the availability of SSB, healthful food environments, and marketing can affect the health of children through SSB consumption and obesity. In Quebec, a study found that overall healthful schools were associated with less material deprivation and were in areas with significantly less social deprivation compared to overall unhealthful schools.[57] In addition, an unhealthful food environment inside the school and overall unhealthful schools were associated with a significantly greater percentage of central adiposity in children. Another study from British Columbia using mixed-effects linear and logistic regressions reported that students at schools with SSB readily available had higher odds of having obesity,[42] further corroborating that unhealthful food environments within schools can have negative implications for obesity rates among children. In Alberta, the availability of sweetened coffees/teas in vending machines was significantly associated with higher SSB consumption.[58]

Food and beverage marketing within schools is another component of the school environment that can influence students' food choices. Velazquez et al. (2017) reviewed evidence of the impact of food and beverage marketing in schools in Canada, US, Ireland and Poland.[38] They found three different methodologies that were commonly used in studies measuring food and beverage marketing in schools: direct observations, self-report surveys and interviews (in-person or telephone). The most common forms of direct advertising in schools were posters/signs and vending machines. Food coupons as indirect advertising were more common in elementary than middle or high schools. From the included studies, 21% to 80% of schools had a contract with a food or beverage company. Approximately half of the schools had policy regarding the restriction or regulation of food and beverage marketing at school. Approximately 60% of advertisements in schools were for unhealthy foods. Some studies found that advertisements were more common in middle schools. There was some evidence of an association between

advertising in schools and purchase or consumption of the advertised item. Studies found that most of the advertisements in schools is for items that are not recommended by dietary guidelines.[38]

There are also a number of factors in the surrounding environment outside of the schools that can influence diet quality and food consumption among students. One factor is the percentage of households with postsecondary education surrounding the school. In one study, a higher percentage of postsecondary education surrounding a school was associated with significantly lower consumption of SSB among students (OR = 0.89).[42] In addition, students attending schools with higher rates of households with postsecondary education in the surrounding neighbourhood had significantly higher scores on the Food Consumption Index, by 0.12 points, indicating better diet quality. Another external factor affecting the environment around schools is the presence of restaurants, especially fast food establishments. Access to restaurants within 1km of a school has shown to be associated with significantly higher SSB consumption among children.[58] A qualitative study using semi-structured interviews in Ontario also identified having fast-food restaurants in close proximity to schools as a challenge to implementation of school nutrition policy.[59]

The above studies have shown that the school food environment can have an effect on the types of foods consumed by children. Certain aspects of the environment surrounding schools identified in these above studies, such as the percentage of postsecondary education surrounding schools, the geographical location (suburban, rural) and proximity of fast food restaurants to schools, cannot be changed by school nutrition policy. However, what can be and is targeted by school nutrition policy is the environment *within* the school. Studies have identified availability of SSB within the school as being associated with higher consumption of SSB, and an increased chance of a child having obesity. SSB availability is generally restricted by the school nutrition policies. One study compared differences in the school food environment between Alberta (no mandatory policy) and Ontario (has a mandatory policy) and found that students in Alberta consumed more SSB than students in Ontario, and there was also a higher percentage of SSB available in Alberta schools.[58] Since this study was conducted after implementation of the

mandatory school nutrition policy in Ontario, this indicates that policies may be effective for targeting changes in the school food environment.

2.3 Effects of School Nutrition Policies and Programs

This section summarizes studies evaluating the impact of school nutrition policies, school-based nutrition programs and the school food environment in Canada, as well as reviews that have evaluated studies in this area outside of Canada.

Health and education are under the jurisdiction of provinces and territories in Canada, leading to variations in the policies and strategies implemented by provinces.[3] The Pan-Canadian Joint Consortium for School Health was introduced in 2005 as a partnership between provincial and territorial (excluding Quebec) health and education ministries.[3] While school food is under the jurisdiction of provincial governments, all provinces do have some form of a health promotion strategy. Although provinces have renewed their nutrition guidelines since 2005, they differ. Specifically, some provincial school nutrition policies require districts to develop their own policies, so guidelines vary across districts within provinces, in addition to across provinces.

Currently, five provinces have mandatory school nutrition policies or standards: British Columbia,[60] Quebec,[61] New Brunswick,[62] Nova Scotia[63] and Ontario.[64] Prince Edward Island has nutrition policies that are mandatory for schools, but they are not legislated at the provincial level.[65] Alberta has strong nutrition guidelines for schools, but they are not mandatory at this time.[66] Newfoundland,[67] Manitoba[68] and Saskatchewan[69] also provide nutrition guidelines to schools, but are not mandatory.

2.3.1 Macronutrient and Micronutrient Intakes

Change in intake of certain micronutrients, vitamins, and macronutrients have been reported as a result of school nutrition policy. While school nutrition policies in Canada do not necessarily target specific micronutrients, increased consumption of certain nutrients (e.g., fibre) and decreased consumption of other nutrients (e.g., sodium) can contribute to a healthy diet.

A few studies have assessed the effects of school nutrition policies/programs on macronutrient intake. The three types of macronutrients commonly studied are protein, fat, and carbohydrates. A study of the mandatory school nutrition policy in Nova Scotia, Canada assessed changes in diet before and after implementation.[17] They found that the percentage of total energy intake that came from carbohydrates and protein increased, while the percentage from fat decreased.[17] A systematic review of school food environment policies globally found that the percentage of energy intake from fat at school decreased by 1.49%.[24] After implementation of the Texas Public School Nutrition Policy, students had higher intake of protein and a decreased percentage of energy intake from fat.[21]

Changes in micronutrient intakes from modifications to the school food environment are mixed in the literature. Micronutrients include minerals and vitamins. The minerals measured across the included studies (two Canadian, three international) are sodium, fibre, zinc, calcium, and iron. As a result of school nutrition policies or programs, two studies reported decreased consumption of sodium,[17,24] while one reported increased consumption.[21] A majority of studies reported increases in fibre intake; three reported increases[21,23,70] and one reported a decrease.[17] Only one study measured changes in zinc consumption and found a decrease in intake.[17] Two out of three studies found an increase[21,70] in calcium intake, the other reported a decrease[17]. One study reported an increase in iron intake.[70]

The vitamins measured across the included studies were vitamin A, folate (vitamin B9), vitamin C, and vitamin D. For both vitamin A and vitamin C, two studies reported increased intake,[21,70] and one study reported a decrease in intake.[17] One study found an increase in folate (vitamin B9) intake,[70] while another found a decrease.[17] Only one study measured vitamin D consumption, with a reported increase following implementation of a school nutrition program.[70]

Overall, previous literature consistently reports that energy intake from fat decreases as a result of policies targeting the school food environment.[17,21,24] Decreasing energy density, which is the number of calories per gram, is often targeted among children for improved diet quality and reducing obesity. Fat has a higher energy density (9 calories/gram) compared to protein and carbohydrates (4 calories/gram each), so decreasing fat intake is an effective way to decrease

overall energy density, as reported in previous studies.[17,21,24] Changes in all micronutrients were inconsistent across studies, except for zinc and iron, which were only measured in one study each. Macronutrients and micronutrients are one aspect of diet quality but increases or decreases in intake need to be examined with the context of a starting point, because either an excess or too little of these nutrients can negatively impact health.

Macro and micronutrients are a component of overall diet quality. The HEI and DQI both provide points for consumption of certain nutrients. The DQI scores consumption of fibre, protein, iron, calcium, vitamin C, total fat and saturated fat,[71] while the HEI scores consumption of total protein foods, seafood and plant proteins, and fatty acid ratios.[72] Previous literature indicates that energy intake from fat decreased as a result of changes to the school nutrition environment,[17,21,24] which may contribute to better overall diet quality. Although the literature is inconsistent when examining the changes in micronutrient intake,[17,21,23,24,70] these may also contribute to better diet quality as scored by the DQI and HEI.

2.3.2 Policy Implementation and Compliance

Without proper implementation and high compliance of policies, the policy goals may not be realized to the desired extent. Limited studies have assessed implementation and compliance rates of mandatory school nutrition policies in Canada.

In British Columbia, the Food and Beverage Sales in Schools guidelines were implemented in 2008. A study was conducted of how this policy affected the food environment in schools by comparing data between 2007 and 2011/2012 using multilevel mixed effects linear and logistic regression models.[73] Surveys of implementation were completed by school principals. In the 2011-12 school year, the highest reported guideline implementation was for vending machines, with 66% of schools reporting implementation. Guidelines for snack bars, cafeterias, fundraising activities and special events were implemented in 45%, 36%, 10% and 8% of schools, respectively. Twenty-two percent of elementary schools reported implementation of guidelines for fundraising activities and 15% for special activities. In 2011-12, elementary schools had significantly higher odds of having FV available and significantly lower odds of having 100% fruit juice available compared to 2007. Middle and high schools had significantly lower odds of

having SSB, regular baked goods, chocolates and candy, regular salty snacks and French fries available. In 2011-12, most principals reported that their school was serving whole wheat crust and buns with pizza, hot dogs and hamburgers. Staff and parent support for healthy eating policies increased in elementary, middle and high schools over the 5-year time period. Student support for healthy eating policies increased in elementary schools. A limitation of this study was that principals completed the surveys and may have been biased. This study suggests that schools in British Columbia did not have complete implementation of the mandated school nutrition policy. While there was a reduction in the availability of SSB and unhealthy snacks in high schools, less than half of schools implemented the guidelines for snacks bars, cafeterias, fundraising activities and special events.[73]

Assessing barriers to implementation is important to identify areas for improvement in policies. Qualitative analysis of factors that affect implementation of nutrition policies in Ontario schools were assessed using semi-structured interviews.[59] The authors found that the cost of healthy food was a concern, especially in schools with a larger proportion of low-income students. Another concern that arose was revenue loss in cafeterias from the higher price of healthy food and reduced sales.[59] Some respondents felt that the nutrition policies were too restrictive and they were concerned about stigma surrounding students who could not afford to purchase food at school or did not have enough food to eat. A recent systematic review assessed the published results of Canadian nutritional programs in elementary schools.[74] The included studies identified barriers to implementation of interventions as inconsistent delivery of interventions, lack of parental involvement, and limited financial and human support. Specifically, inconsistent and lack of repetition of educational components, passive involvement from parents, a lack of affordable healthy foods, and staffing issues were mentioned as areas to target for improvement in program and policy implementation. Both of these studies identified the cost of healthy foods as a concern and barrier to implementation of school nutrition policies.

There is limited literature on compliance rates following implementation of mandatory school nutrition policies in Canada. Research in British Columbia indicated that compliance rates were not 100% following implementation of the provincial policy, and compliance rates also varied for the different policy components, as indicated by principal reports.[73] Barriers to

implementation have also been identified in the literature, highlighting the need for more financial and staffing support, parental involvement and support, and consistency in delivering the policy.[59,74] This showcases the need for research on actual compliance rates and barriers to implementation across schools in provinces with mandatory policies. While compliance rates may not be 100% across the provinces with mandatory school nutrition policy, having these policies in place is still better than no policy or voluntary guidelines for schools.

2.3.3 Knowledge and Attitudes

Improving knowledge and attitudes towards healthy dietary behaviours is another goal of many school nutrition programs. Changing the way that children think about and perceive food may help to create longer lasting effects. Previous literature indicates that some school nutrition programs have increased children's attitudes, knowledge, and willingness to try different healthier foods, particularly FV.

One aspect of creating long-term healthy habits is improving the nutritional knowledge of children through education on the importance of a balanced diet. In Ontario, after implementation of the Northern Fruit and Vegetable Pilot Programme (NFVPP), a non-blinded randomized controlled trial, all three intervention groups had high scores on knowledge.[18] Outcome data were only collected on grades 5 – 8 students due to the literacy level required to complete the endpoint survey, so the study may have missed out on important data from younger students. A recent systematic review of Canadian elementary school nutrition programs found that children's nutritional knowledge improved, and there was a positive association between interventions that were longer than a year in duration and nutritional knowledge.[74] Another systematic review of school-based nutrition promotion programs, in an international context, found that most of the included studies reported significant improvements in diet and nutrition knowledge following the intervention.[23]

In addition to improving dietary knowledge, working to improve attitudes and preferences of children towards healthier foods, and willingness-to-try healthier foods, can support improvement in dietary and nutrition behaviours. In Northern Ontario, after implementation of a FV intervention program, all three groups had high scores on attitude, liking, intention,

willingness and peer-influence scales that were used.[18] From baseline to endpoint, preferences for some FV shifted from 'never tried it' to 'liked it.'[18] In British Columbia, the effect of a school intervention on consumption of FV among students was assessed.[16] Repeated measures Analysis of Variance (ANOVA) was used to determine main and interaction effects over time between intervention schools and usual practice schools. They found that the percentage of FV that students tried increased at the intervention schools. This study was conducted before implementation of the mandatory school nutrition policy in British Columbia. A recent systematic review in Canada found that children's dietary behaviours improved through increased preferences, attitudes and willingness towards nutrient-dense foods, such as FV.[74] An international systematic review reported that in addition to knowledge, included studies showed that attitudes improved due to intervention.[23] In particular, more students felt that nutrition was important and were more willing to try vegetables.

In summary, the literature consistently shows improvements in dietary knowledge, attitudes, and willingness to try as a result of policies and programs in schools. In both Canadian and international contexts, increased preferences, attitudes, and willingness towards healthy foods, such as FV have been reported.[18,23,74] In addition, the percentage of FV tried, and nutrition knowledge improved in some studies.[16,18,23,74] In particular there seems to especially be increases in attitudes and willingness to try different FV,[18,23,74] which may improve dietary behaviours and habits among children. School nutrition policies are important not just for potentially improving nutrition at schools, but also formation of healthy eating habits that may last for life.

2.3.4 Food Group Consumption

Numerous studies have investigated the effects of school nutrition programs and policies on consumption of food groups from the 2007 CFG (FV, milk and alternatives, meat and alternatives, and grain products). In particular, most studies focus on changes in FV consumption, likely because there is an emphasis on improving FV consumption among children and youth. Food group consumption was the most studied outcome from the studies included in this literature review.

Consuming FV is beneficial for a number of reasons. FV contain dietary fibre, which can reduce the risk of cardiovascular disease and obesity.[75] In addition, they contain a variety of vitamins, minerals, and phytochemicals.[75] For these reasons, increasing daily servings of FV is frequently targeted to improve dietary health. Following implementation of the school nutrition policy in Prince Edward Island, students were more likely to consume more servings of FV.[20] In Nova Scotia, students in schools with the Annapolis Valley Health Promoting Schools Project consumed significantly more FV than students at schools without the program.[76] Two studies in Quebec assessed the effects of different school-based nutrition programs and found significant increases in FV consumption after the programs, and both used control groups. One study found that the intervention group consumed an average of 3.1 more servings of FV compared to the control group during and after the 8-week program.[77] The other study found that students in the intervention group had significantly higher consumption of FV during the intervention period compared to the control group.[78] However, by 10 weeks after the end of the program, there was no longer a significant difference in consumption of FV. A program in Northern Ontario was assessed that provided free FV snacks to students attending participating schools. After accounting for clustering effects, the difference in FV consumption at school was statistically significant, with intervention groups consuming 0.49 servings/day more than control groups.[18] In 2004, students participating in an Ontario snack program had significantly higher intake of FV compared to controls.[70] In Alberta, students attending Alberta Project Promoting Active Living and Healthy Eating schools, a school nutrition program, consumed significantly more FV than students at other schools in Alberta.[79] After implementation of a school-nutrition program intervention in British Columbia, FV consumption increased by 0.18 servings at intervention schools, which was significantly different from the usual practice schools.[16] Finally, moving to a Canada-wide context, a recent systematic review evaluated studies of school nutrition programs in elementary schools.[74] More than half of the studies reported greater consumption of FV among children following the intervention.

A number of studies outside of Canada have also reported increased consumption of FV following the implementation of school-based nutrition policy. From examination of the Texas Public School Nutrition Policy on dietary intake among middle-school students, the authors found that after implementation of this policy, students consumed more vegetable products in

their lunches.[80] Micha et al. (2018) completed a systematic review and meta-analysis of studies evaluating the impact of school policies affecting the food environment within schools internationally.[24] From studies looking at the impact of policies of direct provision of healthful foods and beverages, fruit intake increased by 0.27 servings/day after pooling and vegetable intake increased by 0.04 servings/day. Combined FV intake increased by 0.28 servings/day. From studies looking at the impact of school meal standards, fruit intake increased by 0.76 servings/day. Another international systematic review and meta-analysis quantified the pooled estimate of FV consumption excluding and including fruit juice for interventions as 0.25 portions/day ($P < 0.01$) and 0.32 portions/day ($P < 0.01$) higher in intervention groups than control.[25] The pooled estimate of fruit consumption only excluding and including fruit juice for interventions were both 0.24 portions/day ($P < 0.01$) higher in the intervention groups than the control group.[25] A third international systematic review of school-based nutrition promotion programs found that included studies reported increases in milk and FV consumption.[23] Finally, a systematic review of the effectiveness of school-based nutrition policies in Europe only found that multicomponent nutrition interventions showed increased FV consumption in subgroups, and some reported a long-term effect.[22]

While most studies have reported increases in FV consumption over time, a few other studies found decreases or no change in intake. A study from Prince Edward Island assessing food consumption groups at school lunch between 2007 and 2012 found that school sources of low-fat FV decreased during the time period.[81] In Nova Scotia, one study found no change in FV consumption following the implementation of the province's school nutrition policy, however no control group was used.[17] After implementation of a school-nutrition intervention targeting FV intake in Ontario, there was no significant difference in the frequency of FV consumption between groups.[82]

The majority of studies assessed changes in FV consumption, but some also measured changes in grain, milk, and meat consumption. In Prince Edward Island, the number of servings of low-fat whole grain products increased from 2007 to 2012.[81] School sources of high-fat non-whole grains increased, and home sources of high-fat whole grains also increased from 2007 to 2012. After implementation of the school nutrition policy in Nova Scotia, daily servings of grains,

meat, and milk significantly increased among students.[17] In Quebec, students consumed significantly more servings of milk following two school-based nutrition programs.[77,78] Students also consumed more milk products after implementation of the Texas Public School Nutrition Policy.[80]

Food group consumption is one important component of diet quality, and a widely used outcome measure in studies of school nutrition policies. However, studies of overall diet quality are limited in the literature and need to be assessed. The majority of previous literature indicates that FV consumption increased following implementation of school nutrition policies or programs, however three studies reported a decrease or no change in FV consumption.[17,81,82] Some studies also report increases in consumption of dairy, meat and grain products.[17,21,77,78,81] However, it is important to interpret changes in food group consumption in the context of baseline measures, because too much of an increase in dairy and meat consumption may not contribute to better diet quality. The DQI provides points for overall food group variety, and for meeting serving recommendations for fruits, vegetables, and grains.[71] In other words, the DQI is a non-linear combination of different components of food groups capturing overall diet quality.

2.3.5 Unhealthy Snacks and Sugar Sweetened Beverages

A common goal of programs and policies targeting the school food environment is a reduction in consumption of unhealthy snacks (e.g., chips and candy) and SSB. In the context of school nutrition policies, the availability and sale of these foods is usually restricted in schools.

Reducing the consumption of SSB is frequently targeted among children due to the evidence that SSB increases the risk of overweight/obesity.[83] A study of dietary behaviour before (2003) and after (2011) the implementation of school nutrition policies in Nova Scotia, Canada found that students consumed less SSB (-0.20 SSB per day) in 2011.[17] No control group was used, so the effects that are due to the policy change are not separated from those that occurred due to overall societal changes. In British Columbia, the percent of households with postsecondary education surrounding the school neighbourhood, sex, school guidelines and availability of SSB at school were all significantly associated with SSB consumption.[42] This indicates that school nutrition policies restricting the availability of SSB can help to reduce SSB consumption among students.

A study of the school nutrition policy in Texas found that after implementation, daily consumption of SSB among middle-school students decreased by 3.94 ounces, on average.[21] A systematic review of school-based nutrition promotion programs found that intake of SSB decreased across some of the studies.[23]

Consumption of unhealthy snacks, such as potato chips, is also targeted for reduction. An international systematic review and meta-analysis evaluated the impact of school policies affecting the food environment within schools.[24] Studies looking at the impact of policies of direct provision of healthful foods and beverages showed that unhealthy snack intake decreased by 0.17 servings/day overall, and 0.05 servings/day at school. Another systematic review of school-based nutrition promotion programs found that included studies reported increases in healthier snacks and decreases in low-nutrient dense foods.[23] A series of studies examined the effects of the Texas Public School Nutrition Policy on dietary intake, dietary energy density, and food selection among middle-school students. The authors found that after implementation of this policy in Texas, consumption of chips decreased by 0.17 servings.[21]

Most of the studies found that consumption of SSB decreased following the implementation of a school nutrition policy or program/intervention.[17,21] One study found that school guidelines and the availability of SSB within schools is associated with SSB consumption,[42] showcasing the importance of school nutrition policy for targeting SSB. In addition to SSB, consumption of unhealthy snacks, such as potato chips, decreased from school nutrition policy in Canada and internationally.[21,23,24] Decreased consumption of SSB and low-nutrient dense foods can contribute to better diet quality. The DQI provides points for a low percentage of energy intake coming from empty calorie foods (e.g., SSB, chips and chocolate)[71] and the HEI partially scores diet quality on a low percentage of total daily energy intake coming from added sugars.[72]

2.3.6 Diet Quality

A few studies have attempted to directly measure changes in overall diet quality as a result of changes in the school food environment through policies or programs. Most of the studies measuring diet quality in Canada were conducted in Nova Scotia.

Two studies in Nova Scotia evaluated change in diet quality, measured by the DQI, after implementation of the province's school nutrition policy. One study found that students in 2003 had a significantly lower Diet Quality Index – International (DQI-I) score than students who attended a school in 2011 with limited implementation of health education by 2.15 points.[19] This suggests that diet quality improved from 2003 to 2011 following implementation of a provincial policy, even for students attending schools with limited implementation of Health Promoting School policy components. Similarly, the second study measured differences in diet quality between 2003 and 2011 (before and after implementation of the provincial school nutrition policy). Random effects regression models were used to assess the policy effect, and mean DQI scores increased by 1.80 points following policy implementation.[17] Both studies indicated that diet quality improved in the province from 2003 to 2011, but no control group was used so it is uncertain whether the changes were solely due to the policy.

Another study conducted in Nova Scotia examined the effectiveness of a school nutrition program called Annapolis Valley Health Promoting Schools Project.[84] Using multilevel regression methods, they found that students in schools with the Annapolis Valley Health Promoting Schools Project had significantly better diet quality (OR = 1.29), measured by the DQI, than students at schools without the program.[84]

In Europe, a systematic review of the effectiveness of school-based nutrition policies found that 76% and 77% of studies looking at children (aged 6-12 years) and adolescents (aged 13-18), respectively, reported improvements in dietary behaviour.[22] The measurement of dietary behaviour varied across studies, but majority of the studies used a 24-hour dietary recall, food diary, or food frequency questionnaire.

Ther literature assessing the impact of school nutrition policies on diet quality in Canada is limited. It appears that school nutrition programs and policies can improve diet quality among children, however more evidence is needed. As discussed in this chapter, only a few studies in Canada have evaluated the effects of mandatory school nutrition policies. Only two studies attempted to measure the change in diet quality as a result of mandatory school nutrition policy in Nova Scotia.[17,19] Therefore, research is needed on the impacts of these policies across Canada.

Thus far, most studies in this area measured changes in consumption of FV. Although FV consumption is one important component of diet quality, changes in FV consumption alone is not sufficient to capture overall diet quality. The DQI used in our study measures overall diet quality.[71]

Chapter 3

3 Methods

3.1 Data Source

Data from the 2004 Canadian Community Health Survey (CCHS) Cycle 2.2 and 2015 CCHS – Nutrition survey were used. Both cross-sectional surveys are nationally representative and collected detailed 24-hour dietary recall data along with information on socio-economic factors.[85] Children under the age of 11 completed the survey by proxy or with the assistance of a parent or guardian.[85] The 2004 CCHS had a response rate of 76.5% (n = 35,107), while in 2015 the response rate was 61.6% (n = 20,487).[85]

3.2 Study Population

Individuals aged 6 to 18 were included in our main analysis to capture students who were attending school at the time of survey completion. For individuals aged 6 at the time of the interview, only those who completed the dietary recall during or after September were included to ensure they were attending school at the time. Likewise, for individuals aged 18 at the time of the interview, only those who completed the dietary recall before or during June were included. Observations with missing data were excluded from our analyses.

3.3 Measurement Instruments

We used diet quality index (DQI) as our measure of diet quality because DQI provides a comprehensive measure of diet quality by capturing four components of diet (variety, adequacy, moderation and overall balance).[86] We employed a difference-in-differences approach rather than the standard multivariable regression or before-after analysis commonly used which may produce misleading conclusions, to tease out the effect of mandatory school nutrition policy on diet quality. Additionally, we account for the different school environments by investigating the differences of policy effects by sex, school grade, and household income.

3.4 24-Hour Dietary Recall

The 24-hour dietary recall data were collected face-to-face using a computer-assisted personal interview, based on the United States Department of Agriculture Automated Multiple-Pass Method (AMPM).[85] The AMPM is designed to guide interviewers in getting accurate recall of foods consumed by the respondents. The 24-hour dietary data collection consisted of five steps: (1) quick list, (2) forgotten foods, (3) time and occasion, (4) detail cycle, and (5) final review.[85] Step 1 involved the respondent listing all foods consumed in the 24-hour period before the interview day. In step 2, respondents were asked probing questions about commonly forgotten foods missed in step 1. In step 3, respondents reported the time that each food was consumed and the type of meal (breakfast, lunch, dinner, or snack). Step 4 involved obtaining specific details about the foods consumed, such as type of bread and amounts consumed using pictures of different sized eating and drinking wares. Finally, step 5 collected information on any food or drinks forgotten earlier in the interview. The 2015 CCHS made minor modifications to the AMPM method by updating food categories and adding some food-specific limits that seemed too small or too large, but the main structure of the AMPM process remained unchanged between cycles. For the main analysis, time of day that a food was consumed was used to determine whether that food was consumed during or outside of school-hours. Since school-hours differ across jurisdictions in Canada, following a previous study a standard of 9:00 to 14:00 was used as school-hours.[41]

3.5 Diet Quality

The DQI[71] and HEI[72] are two popular diet quality indices used in the literature. Although both indices capture adequacy and moderation components, the DQI is more comprehensive as it consists of four components (variety, adequacy, moderation, and overall balance) that contribute to a healthy diet.[71] In comparison, the HEI contains only two components for scoring: adequacy and moderation.[72] Both the DQI and HEI award points for consuming the recommended daily servings from each food group of the 2007 CFG, and for consuming less sodium, saturated fats, and empty calorie/added sugar foods.[71,72] The DQI captures overall food group variety, within-group variety from protein, macronutrient ratio (carbohydrates-protein-fat) and fatty acid ratios, while the HEI only looks at adequacy and moderation.[71,72]

With regards to scoring, the HEI provides points for each item on a continuous scale of 0 to 5 or 0 to 10, depending on the item (Table 3.2). The DQI on the other hand awards a certain number of points for meeting a recommendation or being in a certain percentage range of the recommendation (Table 3.1). The HEI weights 60% of points to adequacy, and 40% to moderation.[72] On the other hand, the DQI weights 20% of points to variety, 40% to adequacy, 30% to moderation, and 10% to overall balance.[86] However, the DQI captures some components of diet quality that the HEI does not. The DQI provides points for consuming foods from all 4 food groups, and maximum points are also awarded for consuming protein from at least 3 different sources.[86] Another component measured by the DQI, but not by HEI, is the overall macronutrient ratio for foods consumed. Maximum points are awarded for falling within a healthy range for the ratio of carbohydrates, proteins, and fats from foods consumed.[86] Finally, the DQI also includes scoring for sufficient consumption of important micronutrients, specifically fibre, iron, calcium, and vitamin C; also, for not exceeding recommendations for the percentage of daily energy intake from fat and limiting intake of cholesterol.[86] Since DQI measures variety and overall balance of diet, we have chosen it as our preferred measure of diet quality. However, HEI was used for secondary analysis to assess how differences in measuring diet quality affect the results, due to differences in scoring and weighting between the two indices.

3.6 Construction of Diet Quality Index and Health Eating Index Scores

The DQI scores were calculated for each respondent using the 24-hour dietary recall data. Scoring criteria presented in Table 3.1 were adopted from Tur et al. (2005).[86] Points are achieved by eating a variety of foods, an adequate amount of food from each group and vitamin/mineral recommendations, eating less fat, cholesterol, sodium and empty calorie foods, and having a balanced intake of macronutrients and fatty acids. DQI scores range from 0 to 100, with higher scores indicating better diet quality.[86] For CCHS respondents who completed the dietary on a weekday while school was in session, three DQI scores were calculated: school-hour DQI, for foods consumed during school-hours; non-school DQI, for foods consumed outside of school-hours; and whole-day DQI, for foods consumed any time throughout the day. Scoring for school-hour DQI was scaled by one-third, and scoring for non-school DQI was scaled by two-thirds,

based on the typical percentage of daily energy intake consumed during and outside of school-hours reported in a previous study.[41] For the dietary recall on the weekend or on a weekday when school was not in session, national statutory holidays, between June 21 to September 7, and December 25 to January 7, two DQI scores were calculated: non-school hour DQI and whole-day DQI. It is important to note that since not all respondents have a school-hour DQI score, the scores for school-hour and non-school hour DQI do not add up to the overall DQI score.

Similar to the DQI, an HEI score was calculated for each respondent based on the criteria presented in Table 3.2, which were adapted to meet the recommendations of the 2007 CFG.[87] HEI scores range from 0 to 100, with higher scores indicating better diet quality.[72] Like DQI, three HEI scores were calculated: school-hour HEI, non-school hour HEI, and whole-day HEI.

3.7 Construction of Explanatory Variables

The explanatory variables included were age, province of residence, intervention group, school grade, sex, highest level of education in the household, geographic location (rural/urban), immigrant status, race/cultural background, and household income. Age, sex, and province of residence were collected as part of the CCHS data collection. Intervention group was based on province of residence and was coded as 1 if the respondent lived in a province that implemented a mandatory school nutrition policy (British Columbia, Ontario, Quebec, Prince Edward Island, Nova Scotia, or New Brunswick), and 0 otherwise. Survey year was used to code the post-intervention dummy variable, with 2004 being coded as 0 and 2015 being coded as 1. Urban and rural classification as part of the CCHS dataset was derived by Statistics Canada based on postal codes.

For school grade, respondents were grouped into either high school or elementary school based on their year of birth and year of survey completion. For respondents of the 2004 CCHS, the high school group consisted of youth born in or before 1990. The elementary school group consisted of children born after 1990 (aged 13 or 14 at the time of survey completion). For respondents of the 2015 CCHS, the high school group consisted of youth born in or before 2001 (aged 13 or 14 at the time of survey completion). The elementary school group consisted of children born after 2001. Year of birth was chosen to distinguish the two groups rather than age,

as year of birth generally dictates when an individual begins school. Individuals in high school were coded as 1, and those in elementary school were coded as 0.

For race/cultural background, respondents were asked, “people living in Canada come from many different cultural and racial backgrounds. Are you:” and provided with a list of choices, including the option to provide “other”. Based on this, we derived a variable for respondents who identified as white, with individuals who identified being coded as 1 and 0 otherwise.

For education, respondents were asked for each member of their household that has completed high school, “what is the highest degree, certificate, or diploma [respondent name] has obtained?” and provided a list of options. Since only the highest education in the household was provided as a variable in the CCHS dataset, this was used to determine if anyone in the household completed post-secondary education. For the purposes of this study, completion of post-secondary education was defined as a degree or diploma awarded, at least a trade certificate/diploma or higher.

Income was derived by Statistics Canada by calculating an adjusted ratio of each household’s total income to the low-income cut-off for their household and community size. The distribution of these ratios was then categorized into deciles consisting of approximately equal percentages of respondents, with decile 1 being the lowest 10% of adjusted income ratios and decile 10 being the highest 10% of adjusted income ratios. For the purposes of this study, we converted the income deciles into quintiles.

3.8 Statistical Analyses

Multivariable difference-in-differences regression analyses were conducted to test differences in diet quality in provinces that implemented mandatory school nutrition policies relative to the control provinces. The following DID equation was used: $Y_{ipt} = \beta_0 + (\beta_1 * Treatment) + (\beta_2 * Period) + (\beta_3 * Treatment * Period) + X_{ipt} + \varepsilon_{ipt.}$

In the above equation, Y_{ipy} represents the diet quality for individual i in province p in year t; β_0 is the intercept (the mean value of the outcome in the control group at baseline); β_1 is a dummy variable taking a value of one if province p has a mandatory school nutrition policy, otherwise zero; β_2 is a dummy variable for the period equal to one if the year t is after implementation of

the nutrition policy, zero otherwise; β_3 is a dummy variable for the interaction of treatment and period representing DID estimate; X_{ipy} is a vector of control variables (age, age-squared, sex, elementary vs. high school grade, highest education status in the household (post-secondary degree awarded or not), immigrant status, white, province, geographic location (rural or urban) and household income quintiles); and ε_{ipy} is the error term. Since the policies were all implemented between 2005 and 2011, 2004 represents the pre-intervention period and 2015 represents the post-intervention period.

To account for clustering within provinces, wild cluster bootstrapping[88] was used to adjust confidence intervals and p-values. Wild cluster bootstrapping was used rather than normal clustered standard errors due to the clustering of a large number of individuals within a small number of clusters (ten provinces). Under normal clustered standard errors, the small number of clusters would result in standard errors being biased downwards and thus, over-rejection of the null hypothesis would occur.[88] The wild cluster bootstrapping was clustered by province and used equal Rademacher weights over 100 iterations.

All analyses were weighted using the survey sampling weights provided by Statistics Canada to make results representative of the population of children and youth aged 6 to 18 in Canada.[85] Analyses were completed using Stata 15.

3.9 Stratified Analyses

Stratified analyses by sex, school grade, and income group were conducted as a priori hypothesis based on previous literature. Elementary school and high school students were grouped based on their age at the time of completing the survey, as described previously. The low-income group was defined as individuals in the bottom two income quintiles, and the high-income group was defined as individuals in the top three income quintiles.

3.10 Tables

Table 3.1. Scoring criteria for Diet Quality Index

Component	Score ranges	Points	Scoring criteria
Variety	**0-20**		
Overall food group variety	0-15	15	≥ 1 serving from each food group/d
		12	Any 1 food group missing/d
		9	Any 2 food groups missing/d
		6	Any 3 food groups missing/d
		3	≥ 4 food groups missing/d
		0	None from any food group
Within-group variety from protein source	0-5	5	≥ 3 different sources/d
		3	2 different sources/d
		1	From 1 source/d
		0	None
Adequacy	**0-40**		
Vegetable group	0-5	5	> 100% recommendations
		3	50-100% recommendations
		1	< 50% recommendations
		0	0% recommendations
Fruit group	0-5	5	> 100% recommendations
		3	50-100% recommendations
		1	< 50% recommendations
		0	0% recommendations
Grain group	0-5	5	> 100% recommendations
		3	50-100% recommendations
		1	< 50% recommendations
		0	0% recommendations
Fibre	0-5	5	> 100% recommendations
		3	50-100% recommendations
		1	< 50% recommendations
		0	0% recommendations
Protein	0-5	5	> 100% recommendations
		3	50-100% recommendations
		1	< 50% recommendations
		0	0% recommendations
Iron	0-5	5	> 100% recommendations
		3	50-100% recommendations
		1	< 50% recommendations
		0	0% recommendations
Calcium	0-5	5	> 100% recommendations
		3	50-100% recommendations
		1	< 50% recommendations
		0	0% recommendations

Vitamin C	0-5	5	> 100% recommendations
		3	50-100% recommendations
		1	< 50% recommendations
		0	0% recommendations
Moderation	**0-30**		
Total fat	0-6	6	≤ 20% of total energy/d
		3	> 20-30% of total energy/d
		0	> 30% of total energy/d
Saturated fat	0-6	6	≤ 7% of total energy/d
		3	> 7-10% of total energy/d
		0	> 10% of total energy/d
Cholesterol	0-6	6	≤ 300 mg/d
		3	> 300-400 mg/d
		0	> 400 mg/d
Sodium	0-6	6	≤ 2400 mg/d
		3	> 2400-3400 mg/d
		0	> 3400 mg/d
Empty calorie food	0-6	6	< 3% of total energy/d
		3	> 3-10% of total energy/d
		0	> 10% of total energy/d
Overall balance	**0-10**		
Macronutrient ratio (carbohydrate-protein-fat)	0-6	6	55-65:10-15:15-25
		4	52-68:9-16:13-27
		2	50-70:8-17:12-30
		0	Otherwise
Fatty acid ratio	0-4	4	P/S = 1-1.5; M/S = 1-1.5
		2	P/S = 0.8-1.7; M/S = 0.8-1.7
		0	Otherwise

* M/S = Ratio of MUFA to SFA intakes, P/S = Ratio of PUFA to SFA intakes

Table 3.2. Scoring criteria for 2015 Canadian Healthy Eating Index

Component	Maximum points	Criteria for max score	Criteria for min score
Adequacy Sub-score	**60**		
Total fruits and vegetables	10	4-10 servings	No servings
Whole fruits	5	0.84-2.1 servings (21% of fruits and vegetables)	No servings
Greens and beans	5	0.42-1.05 servings (10.5% of fruits and vegetables)	No servings
Whole grains	10	1.5-4 servings (50% of grains)	No servings
Dairy	10	2-4 servings	No servings
Total protein foods	5	1-3 servings	No servings
Seafood and plant proteins	5	0.32-0.96 servings (32% of meats and alternatives)	No servings
Fatty acids	10	(PUFA+MUFA)/SFA ≥ 2.5	(PUFA+MUFA)/SFA ≤1.2
Moderation sub-score	**40**		
Refined grains	10	<50% of grains refined	≥50% of grains refined
Sodium	10	AI to UL	2x UL
Added sugars	10	≤6.5% of energy	≥26% of energy
Saturated fats	10	≤8% of energy	≥16% of energy

* PUFA = Polyunsaturated Fatty Acids, MUFA = Monounsaturated Fatty Acids, SFA = Saturated Fatty Acids, AI = Adequate Intake, TUL = Tolerable Upper Limit

Chapter 4

4 Results

4.1 Included Sample and Missing Data

Table 4.1 presents the number of respondents in the original dataset and the number that were included in the final sample. 8186 respondents from the 2004 CCHS and 3956 respondents from the 2015 CCHS were included in the final sample, giving an overall sample size of 12,142. Table 4.2 presents the number of responses missing for variables included in analyses.

4.2 Sample Characteristics

Table 4.3 presents the characteristics of the study population in 2004 and 2015. The average age of this group was 11.44 years (SD: 3.33) in 2004 and 11.70 years (SD: 3.38) in 2015. In 2004, 48.70% of the study population were female, compared to 49.65% in 2015. In 2004, 74.35% of the study population had a household member who had been awarded a post-secondary degree (at least "trades certificate or diploma awarded"), compared to 83.43% in 2015. In 2004, 18.95% of the study population resided in a rural area, compared to 18.97% in 2015. In 2004, 6.64% of the study population were immigrants, compared to 11.98% in 2015. In 2004, 82.65% of the study population identified as white, compared to 71.04% in 2015. The percentage of the study population residing in each province remained similar between 2004 and 2015.

4.3 Diet Quality

The mean diet quality scores across the study population in 2004 and 2015 are reported in Table 4.4. The mean whole-day DQI score increased from 55.00 to 55.75 points ($p = 0.033$). However, the mean school-hour DQI score increased from 50.41 to 54.14 points ($p = 0.000$), while the mean non-school-hour DQI score decreased from 54.58 to 54.43 points ($p = 0.038$).

Table 4.5 presents the mean diet quality scores across the intervention and control groups in 2004 and 2015. In the intervention group, the mean whole-day DQI score increased from 55.29 to 56.14 points ($p = 0.041$). The mean school-hour DQI score increased from 50.43 to 55.02 points ($p = 0.000$), while the decrease in mean non-school-hour DQI scores was statistically non-significant (54.90 vs. 54.66 points. $p = 0.573$). In the control group, the mean whole-day DQI

score did not differ (53.77 vs. 54.30 points, $p = 0.411$). The mean school-hour DQI scores (50.31 vs. 50.95 points, $p = 0.589$) and non-school-hour DQI scores (52.33 vs. 53.53 points, $p = 0.626$) also did not differ.

4.4 Difference-in-Differences

4.4.1 Overall

Table 4.6 presents the estimated effect of nutrition policy on DQI scores overall, during school-hours, and outside of school-hours in the study population. Whole-day DQI scores did not change ($\beta = 0.82$, 95% CI: -0.585 to 2.231, $p = 0.252$). DQI scores during school-hours increased by 4.34 points (95% CI: 1.832 to 6.848, $p = 0.001$), but the decrease in DQI scores outside of school-hours was statistically non-significant ($\beta = -0.06$, 95% CI: -0.71 to 0.65, $p = 0.932$).

Table 4.7 presents the estimated impact of nutrition policy on whole-day HEI, school-hour HEI, and non-school-hour HEI in the study population. Whole-day HEI scores did not change ($\beta = 0.08$, 95% CI: -1.714 to 1.869, $p = 0.933$). HEI scores during school-hours ($\beta = 2.41$, 95% CI: -0.153 to 4.977, $p = 0.065$) and outside of school-hours did not change ($\beta = -0.09$, 95% CI: -1.809 to 1.620, $p = 0.914$).

4.4.2 Stratified Analysis by Sex

Table 4.8 presents the estimated change in DQI scores overall, during school-hours, and outside of school-hours by sex. Among males, whole-day DQI scores did not change ($\beta = 1.16$, 95% CI: -0.793 to 3.114, $p = 0.244$), but DQI scores during school-hours increased by 6.51 points (95% CI: 2.931 to 10.088, $p = 0.000$). DQI scores outside of school-hours did not change ($\beta = 0.26$, 95% CI: -1.759 to 2.278, $p = 0.801$). Among females, whole-day DQI scores did not change ($\beta = 0.28$, 95% CI: -1.704 to 2.272, $p = 0.780$). DQI scores during school-hours ($\beta = 2.14$, 95% CI: -1.253 to 5.523, $p = 0.217$) and outside of school-hours ($\beta = -0.56$, 95% CI: -2.494 to 1.372, $p = 0.569$) also did not change.

Table 4.9 presents the estimated impact of nutrition policy on whole-day HEI scores, during school-hours HEI, and outside of school-hours HEI by sex. Among males, whole-day HEI scores did not change ($\beta = 0.74$, 95% CI: -1.751 to 3.221, $p = 0.562$). HEI scores during school-hours

increased by 5.21 points (95% CI: 1.719 to 8.706, $p = 0.003$), but HEI scores outside of school-hours did not change (β = -0.06, 95% CI: -2.441 to 2.312, $p = 0.958$). Among females, whole-day HEI scores did not change (β = -0.80, 95% CI: -3.321 to 1.730, $p = 0.537$). HEI scores during school-hours and non-school-hours decreased but statistically non-significant by 0.53 points (95% CI: -4.126 to 3.060, $p = 0.771$) and 0.45 points (95% CI: -2.858 to 1.963, $p = 0.716$).

4.4.3 Stratified Analysis by School Grade

Table 4.10 presents the estimated change in DQI scores overall, during school-hours, and outside of school-hours by school grade. Among elementary school students, whole-day DQI scores did not change (β = 0.55, 95% CI: -1.275 to 2.375, $p = 0.554$). DQI scores during school-hours increased by 4.82 points (95% CI: 1.972 to 7.665, $p = 0.001$). DQI scores outside of school-hours did not change (β = -0.52, 95% CI: -2.352 to 1.313, $p = 0.578$). Among high school students, the effect of nutrition policy on DQI was statistically no-significant outside of school-hours or during school-hours.

Table 4.11 presents the estimated change in HEI scores overall, during school-hours, and outside of school-hours by school grade. Among elementary school students, whole-day HEI scores did not change (β = 0.46, 95% CI: -1.874 to 2.793, $p = 0.700$) in the intervention group from 2004 to 2015. HEI scores during school-hours (β = 2.95, 95% CI: -0.217 to 6.115, $p = 0.068$) and outside of school-hours did not change (β = 0.02, 95% CI: -2.192 to 2.229, $p = 0.987$). Among high school students, whole-day HEI scores did not change (β = -0.75, 95% CI: -3.501 to 1.999, $p = 0.592$) in the intervention group from 2004 to 2015. HEI scores during school-hours (β = 1.42, 95% CI: -2.743 to 5.590, $p = 0.503$) and outside of school-hours did not change (β = -0.39 95% CI: -3.072 to 2.283, $p = 0.773$).

4.4.4 Stratified Analysis by Income

Table 4.12 presents the estimated change in DQI scores overall, during school-hours, and outside of school-hours by income group. Among the low-income group, whole-day DQI scores did not change (β = 1.66, 95% CI: -0.66 to 3.98, $p = 0.161$). DQI scores during school-hours increased by 5.08 points (95% CI: 0.89 to 9.27, $p = 0.017$). DQI scores outside of school-hours did not change (β = 0.14, 95% CI: -2.18 to 2.46, $p = 0.907$). Among the high-income group, whole-day DQI scores did not change (β = 0.05, 95% CI: -1.68 to 1.78, $p = 0.952$). DQI scores during school-

hours increased by 3.72 points (95% CI: 0.75 to 6.69, $p = 0.014$). DQI scores outside of school-hours did not change ($\beta = -0.48$, 95% CI: -2.22 to 1.27, $p = 0.594$).

Table 4.13 presents the estimated change in HEI scores overall, during school-hours, and outside of school-hours by income group. Among the low-income group, whole-day HEI scores did not change ($\beta = 0.30$, 95% CI: -2.48 to 3.09, $p = 0.831$). HEI scores during school-hours ($\beta = 2.18$, 95% CI: -2.17 to 6.54, $p = 0.326$) and outside of school-hours did not change ($\beta = -0.14$, 95% CI: -2.83 to 2.55, $p = 0.918$). Among the high-income group, whole-day HEI scores did not change ($\beta = -0.22$, 95% CI: -2.55 to 2.11, $p = 0.854$). HEI scores during school-hours ($\beta = 2.60$, 95% CI: -0.38 to 5.57, $p = 0.087$) and outside of school-hours did not change ($\beta = -0.16$, 95% CI: -2.40 to 2.090, $p = 0.892$).

When comparing the changes in DQI and HEI scores across the overall population and subgroups, the general trends were qualitatively similar. However, there were some differences in the magnitude of the effects and significance levels. While there was a significant increase in DQI scores during school-hours, school-hour HEI scores did not reach statistical significance. When looking at school-hour scores by sex, both DQI and HEI scores increased by 6.51 points (95% CI: 2.931 to 10.088, $p = 0.000$) and 5.21 points (95% CI: 1.71 to 8.70, $p = 0.003$), respectively during school-hours among males. In the school grade subgroup analysis, school-hour DQI scores increased among elementary school students, while school-hour HEI scores did not. DQI scores during school-hours increased among both low- and high-income households, while HEI scores during schools-hours only increased among high-income households.

4.5 Tables

Table 4.1. Respondents included in the final sample

	Included in sample		
Year	Yes (%)	No (%)	Total
2004	8186 (84.30)	1524 (15.70)	9710
2015	3956 (93.59)	271 (6.41)	4227
Total	12142	1795	13937

Table 4.2. Number missing for included variables

	Original Sample Size: 13937	
	2004: 9710	**2015: 4227**
Age	0	0
Sex	0	0
Province of residence	0	0
Rural/Urban	0	0
Some post-secondary education completed and Immigrant	139	16
Identify as white	8	262
Income	1004	0
Final Sample Size	**8186**	**3956**
Total Sample Size	**12142**	

Table 4.3. Study population characteristics

Variable	2004		2015	
	Mean or %	*SD*	Mean or %	*SD*
Age	11.44	3.33	11.70	3.38
Age^2	141.91	77.30	148.33	79.54
Intervention (%)	80.73	—	79.25	—
Female (%)	48.70	—	49.65	—
High School (%)	35.96	—	40.17	—
Some post-secondary completed in household (%)	74.35	—	83.43	—
Rural (%)	18.95	—	18.97	—
Immigrant (%)	6.64	—	11.98	—
White (%)	82.65	—	71.04	—
Province of residence				
NL (%)	1.49	—	1.31	—
PEI (%)	0.46	—	0.44	—
NS (%)	2.91	—	2.55	—
NB (%)	2.27	—	2.09	—
QC (%)	21.99	—	23.25	—
ON (%)	40.71	—	39.00	—
MB (%)	3.81	—	3.52	—
SK (%)	2.95	—	3.03	—
AB (%)	11.02	—	12.89	—
BC (%)	12.39	—	11.91	—
Income Quintile				
1 (%)	22.47	—	21.55	—
2 (%)	22.63	—	20.18	—
3 (%)	21.17	—	23.87	—
4 (%)	20.19	—	18.40	—
5 (%)	13.54	—	16.01	—

Table 4.4. Mean diet quality scores among children aged 6 to 18 in 2004 and 2015

Variable	2004		2015		
	Mean	*SD*	Mean	*SD*	*p*-value
HEI	50.63	13.34	52.48	13.16	0.000
School-hour HEI	42.65	14.79	50.17	12.35	0.000
Non-School-hour HEI	49.94	13.37	52.15	12.42	0.000
DQI	55.00	10.09	55.75	11.17	0.033
School-hour DQI	50.41	12.65	54.14	13.26	0.000
Non-School-hour DQI	54.58	10.16	54.43	11.35	0.678

Table 4.5. Mean diet quality scores in the intervention and control groups in 2004 and 2015

	Intervention Group					Control Group				
	Year					Year				
	2004		2015			2004		2015		
Variable	Mean	*SD*	Mean	*SD*	*p*-value	Mean	*SD*	Mean	*SD*	*p*-value
HEI	50.99	13.26	52.81	13.25	0.000	49.11	13.57	51.24	12.73	0.006
School-Hour HEI	42.73	14.73	50.71	12.37	0.000	42.31	15.05	48.19	12.11	0.000
Non-School-Hour HEI	50.32	13.33	52.46	12.51	0.000	48.36	13.43	50.96	12.01	0.001
DQI	55.29	10.06	56.14	11.05	0.041	53.77	10.14	54.30	11.51	0.411
School-Hour DQI	50.43	12.61	55.02	13.09	0.000	50.31	12.79	50.95	13.41	0.589
Non-School-Hour DQI	54.90	10.12	54.66	11.38	0.573	53.23	10.21	53.53	11.21	0.626

Table 4.6. Impact of school nutrition policy on whole day Diet Quality Index scores, school-hour Diet Quality Index scores, and non-school-hour Diet Quality Index scores among Canadian children and youth aged 6 to 18

	Whole Day DQI						School DQI						Non-School DQI					
	Conventional			DID			Conventional			DID			Conventional			DID		
Variable	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	65.18	0.000	60.70, 69.65	66.03	0.000	61.61, 70.44	58.89	0.000	51.32, 66.47	57.11	0.000	49.63, 64.59	62.05	0.000	57.67, 66.43	63.29	0.000	58.99, 67.00
Intervention	1.81	0.004	0.58, 3.05	0.59	0.223	-0.44, 1.61	0.33	0.706	-1.37, 2.03	-0.37	0.725	-2.46, 1.71	1.75	0.005	0.52, 2.97	0.65	0.223	-0.40, 1.71
Post				0.01	0.992	-1.19, 1.20				0.43	0.699	-1.76, 2.62				-0.28	0.639	-1.47, 1.34
DID				0.82	0.252	-0.59, 2.23				4.34	0.001	1.83, 6.84				-0.06	0.932	-0.71, 0.65
Age	-1.50	0.000	-2.30, -0.71	-1.50	0.000	-2.29, -0.71	-0.69	0.330	-2.09, 0.70	-0.61	0.373	-1.95, 0.73	-1.20	0.002	-1.95, -0.45	-1.20	0.02	-1.94, -0.45
Age^2	0.03	0.070	0.00, 0.07	0.03	0.071	-0.00, -0.07	0.01	0.825	-0.06, 0.07	0.00	0.947	-0.06, 0.65	0.02	0.207	-0.01, 0.06	0.02	0.206	0.012, 0.05
Female	-0.11	0.742	-0.78, 0.55	-0.12	0.024	-0.78, 0.54	0.77	0.166	-0.32, 1.86	0.83	0.130	-0.24, 1.89	-0.03	0.925	-0.71, 0.65	-0.03	0.932	-0.70, 0.64
High School	-0.74	0.304	-2.14, 0.67	-0.75	0.295	-2.14, 0.65	-3.18	0.008	-5.52, -0.84	-3.11	0.007	-5.36, -0.86	0.16	0.812	-1.19, 1.52	0.17	0.802	-1.17, 1.52
Some post-secondary completed in household	1.37	0.001	0.54, 2.20	1.28	0.003	0.44, 2.10	1.07	0.110	-0.24, 2.38	0.48	0.456	-0.77, 1.73	1.46	0.001	0.63, 2.29	1.50	0.000	0.67, 2.32
Rural	-0.75	0.113	-1.68, 0.18	-0.078	0.096	-1.71, 1.40	0.64	0.355	-0.72, 2.01	0.46	0.481	-0.82, 1.75	-1.22	0.013	-2.19, -0.25	-1.21	0.014	-2.16, -0.24
White	-0.79	0.132	-1.83, 0.24	-0.66	0.210	-1.68, 0.37	-1.04	0.221	-2.70, 0.62	-0.36	0.667	-1.97, 1.26	-0.83	0.137	-1.92, 0.26	-0.89	0.109	-1.97, 0.19
Immigrant	1.13	0.108	-0.25, 2.51	1.13	0.108	-0.24, 2.51	-0.26	0.856	-3.09, 2.57	-0.40	0.778	-3.17, 2.37	1.15	0.094	-0.20, 2.50	-1.17	0.090	-0.18, 2.51
Province of residence																		
NL	0.00	0.997	-1.61, 1.62	-0.02	0.984	-1.63, 1.59	-1.72	0.116	-3.86, 0.42	-1.83	0.091	-3.95, 0.28	0.45	0.586	-1.16, 2.06	0.45	0.581	-1.15, 2.06

PEI	-0.39	0.558	-1.71, 0.92	-0.42	0.535	-1.73, 0.90	0.59	0.565	-1.43, 2.61	0.45	0.661	-1.56, 2.46	-0.87	0.257	-2.37, 0.63	-0.86	0.266	-2.36, 0.65
NS	-1.84	0.003	-3.04, -0.64	-1.85	0.02	-3.04, -0.64	-1.40	0.166	-3.39, 0.58	-1.33	0.173	-3.25, 0.58	-1.40	0.021	-2.58, -0.21	-1.39	0.021	-2.57, -0.20
NB	-1.85	0.005	-3.12, -0.57	-1.86	0.04	-3.13, -0.58	-0.63	0.520	-2.54, 1.28	-0.69	0.480	-2.59, 1.22	-1.67	0.018	-3.06, -0.29	-1.67	0.018	-3.05, -0.28
QC	1.40	0.004	0.45, 2.36	1.36	0.05	0.40, 2.32	2.43	0.002	0.89, 3.98	2.17	0.004	0.67, 3.66	1.27	0.010	0.30, 2.25	1.29	0.010	0.30, 2.27
MB	0.37	0.651	-1.23, 1.96	0.36	0.659	-1.23, 1.95	-1.30	0.251	-3.52, 0.92	-1.39	0.219	-3.60, 0.82	0.44	0.589	-1.15, 2.02	0.45	0.580	-1.13, 2.03
SK	0.84	0.243	-0.57, 2.25	0.84	0.244	-0.57, 2.24	-1.29	0.267	-3.58, 0.99	-1.36	0.236	-3.62, 0.89	1.10	0.117	-0.28, 2.48	1.12	0.111	-0.25, 2.49
BC	0.60	0.238	-0.40, 1.60	0.59	0.245	-0.40, 1.59	-0.31	0.711	-1.96, 1.33	-0.25	0.764	-1.87, 1.37	0.84	0.117	-0.21, 1.89	0.84	0.116	-0.20, 1.89
Income																		
Quintile 2	0.05	0.933	-1.04, 1.13	0.06	0.911	-1.02, 1.15	0.28	0.746	-1.44, 2.01	0.24	0.780	-1.43, 1.91	0.39	0.484	-0.70, 1.48	0.39	0.485	-0.70, 1.47
Quintile 3	0.91	0.091	-0.15, 1.97	0.67	0.107	-0.18, 1.92	0.94	0.291	-0.81, 2.69	0.69	0.422	-0.99, 2.37	1.01	0.067	-0.07, 2.09	1.03	0.061	-0.04, 2.11
Quintile 4	1.24	0.033	0.10, 2.38	1.25	0.032	0.10, 2.38	0.13	0.881	-1.63, 1.90	0.21	0.815	-1.51, 1.93	1.56	0.010	0.37, 2.74	1.56	0.010	0.37, 2.73
Quintile 5	1.24	0.038	0.07, 2.40	1.12	0.042	0.04, 2.38	1.08	0.298	-0.96, 3.12	1.00	0.319	-0.96, 2.97	1.53	0.012	0.34, 2.72	1.55	0.011	0.36, 2.74

Table 4.7. Changes in whole day Healthy Eating Index scores, school-hour Healthy Eating Index scores, and non-school-hour Healthy Eating Index scores among Canadian children and youth aged 6 to 18

	Whole Day HEI						School HEI						Non-School HEI					
	Conventional			DID			Conventional			DID			Conventional			DID		
Variable	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	62.28	0.000	56.71, 67.85	61.71	0.000	58.19, 67.24	53.09	0.000	45.18, 61.00	50.09	0.000	42.43, 57.74	60.59	0.000	55.39, 65.80	59.81	0.000	54.66, 64.96
Intervention	1.78	0.013	0.38, 3.18	1.75	0.050	0.28, 3.23	-0.50	0.554	-2.13, 1.14	-1.52	0.127	-3.47, 0.43	2.14	0.002	0.79, 3.49	2.20	0.003	0.77, 3.63
Post				1.23	0.107	-0.27, 2.73				5.59	0.000	3.39, 7.78				1.70	0.021	0.26, 3.13
DID				0.08	0.933	-1.71, 1.87				2.41	0.065	-0.15, 4.98				-0.09	0.914	-1.81, 1.62
Age	-1.75	0.000	-2.73, -0.78	-1.75	0.000	-2.73, -0.78	-1.05	0.151	-2.49, 0.38	-0.92	0.183	-2.28, 0.43	-1.53	0.001	-2.45, -0.61	-1.53	0.01	-2.44, 0.61
Age^2	0.05	0.021	0.01, 0.10	0.05	0.021	0.01, 0.10	0.04	0.308	-0.03, 0.10	0.03	0.393	-0.04, 0.09	0.04	0.041	0.00, 0.09	0.04	0.042	0.00, 0.08
Female	0.83	0.056	-0.02, 1.68	0.82	0.059	-0.03, 1.67	0.90	0.128	-0.26, 2.07	0.93	0.104	-0.19, 2.05	0.44	0.282	-0.37, 1.25	0.43	0.300	-0.38, 1.23
High School	-1.08	0.219	-2.80, 0.64	-1.11	0.203	-2.83, 0.60	-3.22	0.013	-5.77, -0.68	-3.22	0.008	-5.62, -0.82	-0.42	0.618	-2.07, 1.23	-0.46	0.581	-2.10, 1.18
Some post-secondary completed in household	2.78	0.000	1.80, 3.75	2.61	0.000	1.64, 3.59	1.85	0.010	0.44, 3.27	0.82	0.236	-0.53, 2.17	2.78	0.000	1.83, 3.73	2.58	0.000	1.63, 3.52
Rural	-0.97	0.127	-2.21, 0.27	-1.02	0.108	-2.27, 0.22	0.67	0.381	-0.83, 2.17	0.35	0.640	1.10, 1.79	-1.25	0.041	-2.45, -0.05	-1.32	0.032	-2.51, -0.11
White	-3.68	0.000	-4.85, -2.51	-3.44	0.000	-4.62, -2.25	-2.59	0.005	-4.38, -0.79	-1.34	0.130	-3.06, 0.39	-3.63	0.000	-4.73, -2.53	-3.34	0.000	-4.44, -2.22
Immigrant	1.00	0.271	-0.78, 2.78	0.93	0.303	-0.84, 2.71	-0.78	0.555	-3.38, 1.82	-1.30	0.316	-3.83, 1.24	1.70	0.036	0.11, 3.29	1.61	0.047	0.01, 3.20
Province of residence-																		
NL	-0.40	0.673	-2.27, 1.46	-0.43	0.654	-2.23, 1.44	-2.38	0.043	-4.68, -0.08	-2.42	0.028	-4.56, -0.26	0.78	0.399	-1.03, 2.58	0.75	0.412	-1.03, 2.53
PEI	-0.55	0.498	-2.15, 1.04	-0.60	0.464	-2.22, 1.01	1.66	0.165	-0.68, 3.99	1.37	0.238	-0.90, 3.63	-0.98	0.245	-2.65, 0.68	-1.05	0.218	-2.71, 0.61

NS	-1.08	0.139	-2.50, 0.35	-1.10	0.132	-2.52, 0.33	1.36	0.237	-0.90, 3.62	1.44	0.187	-0.70, 3.57	-1.16	0.124	-2.63, 0.32	-1.19	0.114	-2.65, 0.28
NB	-1.18	0.139	-2.75, 0.38	-1.21	0.130	-2.78, 0.36	1.13	0.295	-0.99, 3.25	0.99	0.357	-1.12, 3.10	-1.35	0.096	-2.93, 0.24	-1.39	0.087	-2.97, 0.20
QC	0.45	0.485	-0.82, 1.72	0.38	0.561	-0.90, 1.66	2.99	0.001	1.30, 4.67	2.51	0.02	0.89, 4.13	0.08	0.895	-1.12, 1.28	-0.01	0.989	-1.21, 1.20
MB	0.83	0.363	-0.96, 2.61	0.78	0.394	-1.01, 2.57	-0.56	0.648	-2.95, 1.83	-0.58	0.642	-3.09, 1.85	0.83	0.331	-0.84, 2.49	0.76	0.370	-0.90, 2.42
SK	0.91	0.286	-0.76, 2.57	0.83	0.331	-0.84, 2.49	-0.34	0.756	-2.50, 1.82	-0.74	0.495	-2.87, 1.39	0.94	0.250	-0.66, 2.55	0.83	0.309	-0.77, 2.44
BC	2.08	0.004	0.67, 3.49	2.07	0.004	0.66, 3.48	1.79	0.060	-0.08, 3.65	1.87	0.046	0.03, 3.70	1.18	0.066	-0.08, 2.43	1.16	0.071	-1.55, 0.94
Income																		
Quintile 2	0.14	0.834	-1.17, 1.45	0.14	0.830	-1.17, 1.46	1.03	0.274	-0.81, 2.87	0.82	0.362	-0.95, 2.60	-0.31	0.630	-1.56, 0.94	-0.31	0.631	-1.55, 0.94
Quintile 3	1.05	0.129	-0.31, 2.40	0.95	0.169	-0.40, 2.30	1.70	0.081	-0.21, 3.62	0.35	0.225	-0.68, 2.93	0.43	0.513	-0.85, 1.71	0.31	0.641	0.97, 1.58
Quintile 4	1.29	0.079	-0.15, 2.74	1.27	0.084	-1.17, 2.72	1.06	0.291	-0.91, 3.04	-1.34	0.264	-0.81, 2.97	0.88	0.207	-0.49, 2.24	0.85	0.222	-0.51, 2.21
Quintile 5	1.68	0.022	0.24, 3.13	1.58	0.033	0.13, 3.03	2.12	0.048	0.02, 4.21	-1.30	0.117	-0.39, 3.58	1.27	0.072	-0.11, 2.66	1.14	0.109	-0.25, 2.53

Table 4.8. Impact of school nutrition policy on whole day Diet Quality Index scores, school-hour Diet Quality Index scores, and non-school-hour Diet Quality Index scores among Canadian children and youth aged 6 to 18 by sex

a) Males

Variable	Whole Day DQI			School-Hour DQI			Non-School-Hour DQI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	68.37	0.000	62.59, 74.14	60.87	0.000	51.47, 70.27	63.95	0.000	58.05, 69.84
Intervention	1.24	0.149	-0.44, 2.92	-2.10	0.122	-4.76, 0.56	1.11	0.205	-0.61, 2.85
Post-Intervention	0.04	0.956	-1.60, 1.69	-0.53	0.747	-3.78, 2.71	0.07	0.931	-1.62, 1.77
DID	1.16	0.244	-0.79, 3.11	6.50	0.000	2.93, 10.08	0.25	0.801	-1.75, 2.27
Age	-2.19	0.000	-3.20, -1.17	-0.98	0.252	-2.66, 0.69	-1.61	0.002	-2.62, -0.59
Age^2	0.05	0.011	0.01, 0.10	0.02	0.661	-0.06, 0.09	0.03	0.140	-0.01, 0.08
High School	0.27	0.758	-1.45, 1.99	-2.80	0.055	-5.67, 0.05	1.23	0.165	-0.51, 2.99
Some post-secondary completed in household	0.35	0.016	0.26, 2.51	0.47	0.591	-1.25, 2.19	1.59	0.009	0.40, 2.78
Rural	-0.15	0.814	-1.41, 1.10	0.20	0.804	-1.43, 1.85	-0.94	0.164	-2.28, 0.38
White	-0.33	0.633	-1.70, 1.03	-0.49	0.635	-2.52, 1.53	-0.62	0.399	-2.07, 0.82
Immigrant	1.36	0.101	-0.26, 2.99	-1.73	0.360	-5.45, 1.98	1.66	0.035	0.11, 3.22
Province of residence									
NL	0.35	0.766	-1.96, 2.66	-1.08	0.445	-3.88, 1.70	0.57	0.631	-1.77, 2.93

PEI	-1.65	0.061	-3.39, 0.07	-0.47	0.720	-3.08, 2.13	1.45	0.165	-3.50, 0.59
NS	-2.56	0.003	-4.25, -0.86	-4.03	0.000	-6.16, 1.90	-1.19	0.169	-2.90, 0.51
NB	-2.18	0.018	-3.99, -0.37	-2.17	0.122	-4.93, 0.58	-1.35	0.198	-3.43, 0.71
QC	1.71	0.009	0.43, 3.00	0.66	0.495	-1.24, 2.56	2.00	0.003	0.68, 3.32
MB	0.16	0.868	-1.81, 2.15	-3.04	0.027	-5.75, -0.34	0.07	0.942	-2.02, 2.18
SK	0.69	0.488	-1.26, 2.64	-2.64	0.111	-5.88, 0.60	1.01	0.330	-1.02, 3.04
BC	1.18	0.098	-0.21, 2.58	-0.08	0.931	-1.96, 1.79	1.50	0.055	-0.03, 3.05
Income									
Quintile 2	-0.58	0.422	-2.00, 0.83	0.10	0.924	-2.10, 2.31	0.06	0.927	-1.39, 1.53
Quintile 3	1.50	0.034	0.11, 2.89	1.65	0.122	-0.44, 3.74	2.01	0.009	0.49, 3.53
Quintile 4	1.86	0.014	0.37, 3.36	0.72	0.511	-1.44, 2.90	2.25	0.006	0.63, 3.87
Quintile 5	1.01	0.218	-0.60, 2.63	1.26	0.327	-1.25, 3.78	1.78	0.039	0.09, 3.47

b) Females

Variable	Whole Day DQI			School-Hour DQI			Non-School-Hour DQI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	61.95	0.000	55.42, 68.48	56.83	0.000	45.50, 68.16	60.34	0.000	54.09, 66.60
Intervention	1.71	0.064	-0.09, 3.52	-1.21	0.382	-3.93, 1.50	2.58	0.003	0.89, 4.27
Post-Intervention	0.08	0.920	-1.61, 1.78	1.29	0.375	-1.57, 4.17	-0.52	0.517	-2.12, 1.06

DID	0.28	0.780	-1.70, 2.27	2.13	0.217	-1.25, 5.52	-0.56	0.569	-2.49, 1.37
Age	-0.84	0.170	-2.05, 0.36	-0.24	0.817	-2.28, 1.80	-0.80	0.148	-1.89, 0.28
Age^2	0.01	0.701	-0.05, 0.06	-0.01	0.784	-0.10, 0.08	0.01	0.664	-0.03, 0.06
High School	-1.91	0.087	-4.10, 0.27	-3.36	0.041	-6.59, -0.13	-1.08	0.569	-3.13, 0.96
Some post-secondary completed in household	1.06	0.069	-0.08, 2.22	0.35	0.692	-1.40, 2.11	1.27	0.023	0.17, 2.37
Rural	-1.42	0.032	-2.73, -0.12	0.73	0.470	-1.25, 2.73	-1.46	0.033	-2.80, -0.11
White	-1.01	0.189	-2.53, 0.50	-0.20	0.875	-2.71, 2.31	-1.18	0.147	-2.79, 0.42
Immigrant	0.84	0.454	-1.37, 3.06	0.86	0.662	-3.01, 4.74	0.67	0.546	-1.52, 2.87
Province of residence									
NL	-0.27	0.817	-2.57, 2.03	-2.36	0.142	-5.52, 0.79	0.45	0.682	-1.72, 2.64
PEI	0.88	0.382	-1.09, 2.85	1.29	0.412	-1.79, 4.37	-0.18	0.873	-2.41, 2.04
NS	-1.03	0.230	-2.71, 0.65	1.40	0.375	-1.69, 4.49	-1.48	0.078	-3.13, 0.16
NB	1.56	0.080	-3.32, 0.18	0.68	0.614	-1.97, 3.34	-2.01	0.026	-3.78, -0.24
QC	1.02	0.154	-0.38, 2.43	3.69	0.001	1.42, 5.96	0.56	0.439	-0.87, 2.01
MB	0.61	0.631	-1.89, 3.12	0.60	0.732	-2.86, 4.08	0.86	0.467	-1.47, 3.20
SK	1.09	0.291	-0.93, 3.12	0.04	0.977	-3.02, 3.11	1.34	0.148	-0.47, 3.17
BC	-0.05	0.934	-1.47, 1.35	-0.64	0.635	-3.32, 2.02	0.12	0.864	-1.29, 1.54
Income									

Quintile 2	0.76	0.355	-0.85, 2.37	0.53	0.657	-1.81, 2.87	-0.75	0.351	-0.82, 2.33
Quintile 3	0.12	0.878	-1.43, 1.67	-0.16	0.898	-2.67, 2.34	-0.04	0.957	-1.54, 1.46
Quintile 4	0.56	0.507	-1.10, 2.23	0.45	0.721	2.96, 2.04	0.86	0.315	-0.82, 2.55
Quintile 5	1.44	0.089	-0.21, 3.10	0.72	0.627	-2.20, 3.66	1.37	0.102	-0.27, 3.03

Table 4.9. Changes in whole day Healthy Eating Index scores, school-hour Healthy Eating Index scores, and non-school-hour Healthy Eating Index scores among Canadian children and youth aged 6 to 18 by sex

a) Males

Variable	Whole Day HEI			School-Hour HEI			Non-School-Hour HEI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	64.52	0.000	56.76, 72.27	49.10	0.000	38.57, 59.63	65.90	0.000	58.90, 72.90
Intervention	0.89	0.386	-1.13, 2.92	-1.17	0.398	-3.90, 1.54	1.29	0.209	-0.72, 3.31
Post-Intervention	0.96	0.358	-1.09, 3.03	3.78	0.015	0.72, 6.83	1.80	0.073	-0.16, 3.77
DID	0.73	0.562	-1.75, 3.22	5.21	0.003	1.71, 8.70	-0.06	0.958	-2.44, 2.31
Age	-2.36	0.001	-3.71, -1.00	-0.89	0.336	-2.72, 0.92	-2.71	0.000	-3.93, -1.49
Age^2	0.07	0.011	0.01, 0.14	0.032	0.458	-0.05, 0.11	0.09	0.001	0.03, 0.14
High School	-1.63	0.162	-3.91, 0.65	-4.33	0.007	-7.49, -1.17	-0.81	0.464	-3.00, 1.36
Some post-secondary completed in household	2.71	0.000	-2.93, 2.20	1.11	0.266	-0.85, 3.09	2.67	0.000	1.32, 4.02
Rural	-0.79	0.362	-2.51, 0.91	-0.86	0.375	-2.77, 1.04	-0.42	0.618	-2.08, 1.23
White	-2.26	0.008	-3.94, -0.57	-1.066	0.363	-3.36, 1.23	2.27	0.004	-3.81, -0.73
Immigrant	2.35	0.039	0.11, 4.59	-0.89	0.596	-4.18, 2.40	2.55	0.019	0.42, 4.69
Province of residence									
NL	-0.36	0.780	-2.93, 2.20	-0.56	0.694	-3.35, 2.23	0.51	0.696	-2.07, 3.10

PEI	-1.83	0.097	-4.00, 0.33	1.04	0.522	-2.15, 4.25	-1.75	0.092	-3.78, 0.28
NS	-1.75	0.066	-3.62, 0.11	-0.01	0.991	-2.45, 2.43	-1.25	0.209	-3.20, 0.70
NB	0.06	0.951	-2.15, 2.29	0.01	0.991	-2.84, 2.88	0.17	0.875	-2.03, 2.38
QC	0.48	0.588	-1.26, 2.23	1.67	0.127	-0.47, 3.83	0.49	0.549	1.13, 2.12
MB	0.11	0.928	-2.45, 2.69	-1.43	0.312	-0.422, 1.35	0.28	0.817	-2.12, 2.68
SK	1.05	0.366	-1.22, 3.33	0.25	0.865	-2.73, 3.25	1.26	0.275	-1.00, 3.54
BC	3.11	0.001	1.21, 5.00	2.94	0.021	0.44, 5.44	1.98	0.028	0.20, 3.75
Income									
Quintile 2	-0.46	0.616	-2.30, 1.36	-0.63	0.602	-3.03, 1.76	-1.05	0.240	-2.80, 0.70
Quintile 3	0.85	0.409	-1.17, 2.87	1.39	0.273	-1.10, 3.90	0.51	0.595	-1.38, 2.41
Quintile 4	1.67	0.116	-0.41, 3.75	1.43	0.264	-1.08, 3.94	1.06	0.297	-0.89, 3.02
Quintile 5	0.92	0.415	-1.29, 3.13	1.18	0.397	-1.54, 3.91	0.90	0.407	-1.22, 3.03

b) Females

Variable	Whole Day HEI			School-Hour HEI			Non-School-Hour HEI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	59.27	0.000	51.40, 67.13	51.75	0.000	40.92, 62.59	53.94	0.000	46.42, 61.45
Intervention	2.75	0.011	0.63, 4.88	-1.57	0.265	-4.33, 1.19	3.38	0.001	1.42, 5.35
Post-Intervention	1.63	0.128	-0.47, 3.74	7.45	0.000	4.42, 10.48	1.79	0.081	-0.22, 3.80
DID	-0.79	0.537	-3.32, 1.73	-0.53	0.771	-4.12, 3.06	-0.44	0.716	-2.85, 1.96

Age	-1.06	0.136	-2.46, 0.33	-0.94	0.347	-2.90, 1.02	-0.32	0.637	-1.69, 1.03
Age^2	0.23	0.485	-0.04, 0.08	0.02	0.604	-0.067, 0.116	-0.01	0.875	-0.06, 0.05
High School	-0.55	0.667	-3.09, 1.98	-2.40	0.174	-5.88, 1.06	-0.04	0.972	-2.48, 2.39
Some post-secondary completed in household	2.40	0.000	1.07, 3.74	0.36	0.692	-1.44, 2.17	2.32	0.000	1.04, 3.60
Rural	-1.27	0.159	-3.05, 0.49	1.47	0.176	-0.66, 3.60	-2.22	0.010	-3.91, -0.52
White	-4.71	0.000	-6.34, -3.07	-1.65	0.198	-4.18, 0.87	-4.49	0.000	-6.04, 2.95
Immigrant	-0.40	0.763	-3.01, 2.21	-1.17	0.532	-4.85, 2.50	0.69	0.550	-1.58, 2.97
Province of residence									
NL	-0.31	0.821	-3.02, 2.39	-4.09	0.012	-7.26, -0.91	1.27	0.304	-1.16, 3.71
PEI	0.79	0.511	-1.58, 3.17	1.81	0.276	-1.45, 5.08	-0.19	0.888	-2.85, 2.47
NS	-0.33	0.763	-2.49, 1.83	3.06	0.083	-0.39, 6.52	-1.05	0.350	-3.26, 1.15
NB	-2.53	0.020	-4.65, -0.40	1.92	0.225	1.18, 5.04	-3.05	0.05	-5.19, -0.92
QC	0.29	0.754	-1.57, 2.17	3.41	0.005	1.00, 5.82	-0.46	0.607	-2.25, 1.31
MB	1.55	0.213	-0.89, 4.00	1.01	0.602	-2.80, 4.83	1.43	0.204	-0.77, 3.64
SK	0.73	0.545	-1.64, 3.11	-1.56	0.299	-4.52, 1.39	0.66	0.545	-1.48, 2.81
BC	0.96	0.357	-1.09, 3.02	0.68	0.593	-1.82, 3.19	0.24	0.788	-1.53, 2.02
Income									
Quintile 2	0.75	0.420	-1.07, 2.58	2.31	0.070	-0.18, 4.82	0.46	0.608	-1.29, 2.22

Quintile 3	1.05	0.245	-0.72, 2.84	0.94	0.461	-1.57, 3.47	0.09	0.913	-1.61, 1.80
Quintile 4	0.83	0.402	-1.11, 2.79	0.52	0.701	-2.14, 3.19	0.65	0.489	-1.20, 2.51
Quintile 5	2.28	0.019	0.37, 4.18	1.91	0.179	-0.87, 4.68	1.49	0.106	-0.31, 3.29

Table 4.10. Impact of school nutrition policy on whole Diet Quality Index scores, school-hour Diet Quality Index scores, and non-school-hour Diet Quality Index scores among Canadian children and youth aged 6 to 18 by school grade

a) Elementary School

Variable	Whole Day DQI			School-Hour DQI			Non-School-Hour DQI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	65.59	0.000	57.19, 73.98	55.36	0.000	41.97, 68.75	66.08	0.000	57.57, 74.59
Intervention	2.06	0.013	0.44, 3.69	-2.19	0.065	-4.53, 0.14	2.30	0.006	0.66, 3.94
Post-Intervention	0.68	0.389	-0.87, 2.25	0.64	0.598	-1.75, 3.05	0.22	0.776	-1.30, 1.75
DID	0.55	0.554	-1.27, 2.37	4.82	0.001	1.97, 7.66	-0.51	0.578	-2.35, 1.31
Age	-1.79	0.051	-3.58, 0.01	0.40	0.784	-2.49, 3.30	-2.33	0.012	-4.13, -0.52
Age^2	0.05	0.301	-0.04, 0.14	-0.05	0.504	-0.20, 0.10	0.08	0.088	0.012, 0.17
Female	0.31	0.448	-0.49, 1.11	1.06	0.101	-0.20, 2.33	0.35	0.399	-0.47, 1.19
Some post-secondary completed in household	0.86	0.114	-0.20, 1.92	0.01	0.992	-1.47, 1.48	1.05	0.057	-0.03, 2.13
Rural	-1.25	0.022	-2.32, -0.18	0.20	0.802	-1.41, 1.83	-2.07	0.000	-3.20, -0.94
White	-0.58	0.353	-1.80, 0.64	-0.44	0.657	-2.38, 1.50	-0.32	0.629	-1.62, 0.98
Immigrant	1.21	0.151	-0.44, 2.87	-0.62	0.728	-4.12, 2.88	1.57	0.078	-0.17, 3.31
Province of residence									
NL	0.19	0.858	-1.96, 2.35	-3.05	0.040	-5.96, -0.13	0.99	0.373	-1.18, 3.17

PEI	-0.34	0.679	-0.19, 1.29	096	0.479	-1.70, 3.64	-0.80	0.424	-2.78, 1.17
NS	-0.91	0.230	-2.40, 0.57	-0.50	0.683	-2.90, 1.90	-0.54	0.460	-1.98, 0.90
NB	-1.50	0.068	-3.13, 0.11	0.44	0.712	-1.92, 2.82	-1.06	0.243	-2.84, 0.72
QC	1.36	0.019	0.22, 2.51	2.46	0.009	0.60, 4.32	1.46	0.017	0.26, 2.66
MB	1.40	0.202	-0.75, 3.55	-2.33	0.099	-5.11, 0.44	1.52	0.175	-0.67, 3.72
SK	1.66	0.086	-0.23, 3.57	-1.52	0.264	-4.21, 1.15	1.88	0.053	-0.02, 3.78
BC	0.99	0.117	-0.24, 2.24	-0.22	0.830	-2.28, 1.83	1.24	0.064	-0.07, 2.55
Income									
Quintile 2	0.20	0.760	-1.08, 1.49	-0.84	0.367	-2.67, 0.98	0.53	0.438	-0.82, 1.90
Quintile 3	0.92	0.147	-0.32, 2.16	-0.40	0.688	-2.37, 1.56	1.25	0.068	-0.09, 2.60
Quintile 4	1.14	0.091	-0.18, 2.46	-1.86	0.056	-3.77, 0.05	1.68	0.020	0.26, 3.10
Quintile 5	1.07	0.129	-0.31, 2.45	-0.13	0.912	-2.46, 2.20	1.99	0.09	0.50, 3.48

b) High School

Variable	Whole Day DQI			School-Hour DQI			Non-School-Hour DQI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	107.65	0.012	24.15, 191.15	210.41	0.001	85.02, 335.81	68.95	0.052	-0.46, 137.36
Intervention	0.44	0.643	-1.42, 2.31	-0.92	0.580	-4.22, 2.36	0.96	0.282	-0.79, 2.72
Post-Intervention	-0.99	0.284	-2.81, 0.82	0.34	0.871	-3.81, 4.50	-0.98	0.287	-2.78, 0.82

DID	1.16	0.291	-0.99, 3.33	3.36	0.150	-1.21, 7.95	0.50	0.645	-1.64, 2.64
Age	-7.01	0.214	-18.08, 4.05	-21.50	0.012	-38.23, -4.76	-1.75	0.706	-10.90, 7.38
Age^2	0.21	0.249	-0.15, 0.57	0.68	0.015	0.13, 1.24	0.03	0.801	-0.26, 0.33
Female	-0.81	0.163	-1.97, 0.33	0.59	0.514	-1.19, 7.95	0.96	0.229	-1.82, 2.64
Some post-secondary completed in household	1.93	0.004	0.62, 3.25	1.68	0.139	-0.55, 3.92	2.09	0.001	0.85, 3.34
Rural	0.01	0.993	-1.68, 1.69	1.03	0.322	-1.01, 3.08	0.17	0.835	-1.50, 1.86
White	-0.80	0.393	-2.69, 1.04	-0.35	0.799	-3.08, 2.37	-1.82	0.061	-3.72, 0.08
Immigrant	0.89	0.448	-1.42, 3.21	-0.55	0.790	-4.67, 3.55	0.43	0.695	-1.73, 2.60
Province of residence									
NL	-0.37	0.755	-2.74, 1.99	-0.27	0.858	-3.28, 2.73	-0.36	0.756	-2.69, 1.95
PEI	-0.77	0.486	-2.97, 1.41	-0.64	0.657	-3.46, 2.18	-1.19	0.303	-3.47, 1.08
NS	3.32	0.001	-5.27, -1.36	-2.48	0.113	-5.55, 0.58	-2.71	0.008	-4.71, -0.71
NB	-2.48	0.019	-4.56, -0.40	-2.61	0.096	-5.68, 0.46	-2.70	0.015	-4.86, -0.53
QC	1.28	0.137	-0.40, 2.98	1.41	0.253	-1.00, 3.82	-1.04	0.219	-0.62, 2.72
MB	-1.32	0.263	-3.63, 0.99	0.12	0.947	-3.64, 3.90	-1.25	0.246	-3.36, 0.86
SK	-0.61	0.552	-2.63, 1.40	-1.37	0.500	-5.38, 2.63	-0.24	0.798	-2.16, 1.66
BC	-0.04	0.962	-1.73, 1.65	-0.28	0.840	-3.01, 2.45	0.23	0.793	-1.50, 1.97
Income									

Quintile 2	-0.19	0.842	-2.14, 1.75	2.48	0.123	-0.67, 5.64	0.09	0.912	-1.67, 1.87
Quintile 3	0.76	0.423	-1.10, 2.63	2.67	0.078	-0.29, 5.63	0.65	0.464	-1.09, 2.40
Quintile 4	1.30	0.223	-0.79, 3.41	3.47	0.031	0.32, 6.61	1.24	0.236	-0.80, 3.29
Quintile 5	1.34	0.202	-0.72, 3.42	3.13	0.068	-0.22, 6.49	0.84	0.391	-1.08, 2.78

Table 4.11. Changes in whole day Healthy Eating Index scores, school-hour Healthy Eating Index scores, and non-school-hour Healthy Eating Index scores among Canadian children and youth aged 6 to 18 by school grade

a) Elementary School

Variable	Whole Day HEI			School-Hour HEI			Non-School-Hour HEI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	66.52	0.000	55.96, 77.08	43.00	0.000	28.98, 57.02	66.76	0.000	56.77, 76.74
Intervention	1.50	0.128	-0.43, 3.44	-2.30	0.063	-4.72, 0.12	2.49	0.010	0.59, 4.39
Post-Intervention	0.85	0.394	-1.10, 2.81	5.23	0.000	2.49, 7.96	1.42	0.133	-0.43, 3.27
DID	0.46	0.700	-1.87, 2.79	2.94	0.068	-0.21, 6.11	0.01	0.987	-2.19, 2.22
Age	-2.73	0.017	-4.97, -0.50	1.02	0.504	-1.98, 4.03	-3.09	0.004	-5.22, -0.97
Age^2	0.10	0.076	-0.01, 0.22	-0.07	0.339	-0.23, 0.08	0.12	0.025	0.01, 0.24
Female	0.57	0.297	-0.50, 1.64	0.76	0.263	-0.57, 2.09	0.08	0.876	-0.94, 1.10
Some post-secondary completed in household	2.06	0.002	0.78, 3.33	0.70	0.399	-0.93, 2.35	2.01	0.002	0.76, 3.26
Rural	-1.93	0.014	-3.46, -0.39	-0.41	0.647	-2.17, 1.34	-2.42	0.001	-3.900, -0.95
White	-3.54	0.000	-5.03, -2.04	-1.52	0.153	-3.61, 0.56	-3.22	0.000	-4.65, -1.79
Immigrant	0.83	0.506	-1.62, 3.28	-1.55	0.314	-4.59, 1.47	1.81	0.084	-0.24, 3.87
Province of residence									
NL	-0.11	0.931	-2.62, 2.39	-3.65	0.019	-6.72, -0.58	1.22	0.326	-1.21, 3.67

PEI	0.77	0.450	-1.24, 2.80	2.38	0.127	-0.67, 5.45	0.10	0.924	-2.06, 2.27
NS	-0.03	0.966	-1.81, 1.73	2.34	0.061	-0.11, 4.81	-0.38	0.667	-2.15, 1.38
NB	-0.20	0.847	-2.27, 1.86	2.06	0.101	-0.40, 4.52	-0.20	0.848	-2.33, 1.91
QC	0.84	0.295	-0.73, 2.42	3.83	0.000	1.92, 5.74	0.06	0.935	-1.44, 1.56
MB	1.39	0.254	-1.00, 3.80	-1.67	0.219	-4.34, 0.99	1.73	0.131	-0.51, 3.98
SK	1.47	0.197	-0.76, 3.71	-0.28	0.835	-2.99, 2.40	1.69	0.126	-0.47, 3.87
BC	3.00	0.002	1.11, 4.89	3.16	0.006	0.89, 5.42	1.49	0.079	-0.17, 3.15
Income									
Quintile 2	0.06	0.938	-1.57, 1.70	-0.45	0.637	-2.32, 1.42	-0.13	0.864	-1.72, 1.45
Quintile 3	1.33	0.144	-0.45, 3.13	0.19	0.858	-1.94, 2.33	0.67	0.442	-1.04, 2.39
Quintile 4	1.28	0.181	-0.60, 3.17	-0.92	0.421	-3.18, 1.32	1.11	0.220	-0.66, 2.88
Quintile 5	1.91	0.048	0.02, 3.80	1.14	0.355	-1.28, 3.57	1.65	0.081	-0.20, 3.52

b) High School

Variable	Whole Day HEI			School-Hour HEI			Non-School-Hour HEI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	124.26	0.008	32.81, 215.71	178.80	0.006	52.28, 305.32	74.93	0.084	-10.00, 159.88
Intervention	2.23	0.047	0.03, 4.44	-0.15	0.926	-3.31, 3.01	1.79	0.095	-0.31, 3.91
Post-Intervention	2.03	0.080	-0.24, 4.31	6.20	0.001	2.70, 9.70	2.26	0.048	0.01, 4.50

DID	-0.75	0.592	-3.50, 1.99	1.42	0.503	-2.74, 5.58	-0.39	0.773	-3.07, 2.28
Age	-10.18	0.098	-22.23, 1.86	-18.78	0.028	-35.56, -1.99	-3.48	0.543	-14.70, 7.74
Age^2	0.32	0.106	-0.06, 0.72	0.61	0.030	0.06, 1.16	0.10	0.580	-0.26, 0.47
Female	1.19	0.083	-0.15, 2.55	1.27	0.191	-0.63, 3.17	0.93	0.154	-0.35, 2.22
Some post-secondary completed in household	3.44	0.000	2.03, 4.85	1.24	0.269	-0.96, 3.46	3.39	0.000	2.02, 4.75
Rural	0.46	0.648	-1.53, 2.45	1.84	0.133	-0.55, 4.24	0.44	0.658	-1.51, 2.40
White	-3.25	0.001	-5.20, -1.30	-0.96	0.520	-3.89, 1.97	-3.45	0.000	-5.20, -1.71
Immigrant	0.89	0.486	-1.62, 3.42	-1.13	0.590	-5.25, 2.99	1.33	0.276	-1.06, 3.74
Province of residence									
NL	-0.92	0.505	-3.64, 1.79	-0.77	0.597	-3.64, 2.09	0.03	0.979	-2.51, 2.58
PEI	-3.04	0.020	-5.60, -0.48	-0.60	0.706	-3.73, 2.52	-3.11	0.014	-5.61, -0.61
NS	-2.73	0.023	-5.09, -0.37	0.11	0.953	-3.66, 3.88	-2.42	0.063	-4.99, 0.13
NB	-2.93	0.015	-5.29, -0.56	-1.11	0.564	-4.88, 2.66	-3.31	0.006	-5.66, -0.96
QC	-0.43	0.690	-2.59, 1.71	0.12	0.931	-2.64, 2.89	-0.13	0.897	-2.12, 1.86
MB	-0.33	0.802	-2.96, 2.29	1.33	0.571	-3.29, 5.96	-0.84	0.494	-3.25, 1.57
SK	-0.25	0.833	-2.63, 2.12	-1.70	0.316	-5.04, 1.63	-0.58	0.616	-2.88, 1.70
BC	0.57	0.583	-1.47, 2.62	-0.27	0.868	-3.48, 2.93	0.59	0.539	-1.29, 2.48
Income									

Quintile 2	0.20	0.850	-1.90, 2.31	3.39	0.057	-0.10, 6.88	-0.63	0.521	-2.57, 1.30
Quintile 3	0.41	0.674	-1.52, 2.36	2.99	0.059	-0.11, 6.10	-0.20	0.823	-2.00, 1.59
Quintile 4	1.16	0.290	-0.99, 3.33	4.13	0.012	0.90, 7.36	0.40	0.697	-1.64, 2.46
Quintile 5	1.07	0.337	-1.11, 3.26	2.84	0.087	-0.41, 6.10	0.35	0.729	-1.65, 2.36

Table 4.12. Impact of school nutrition policy on whole Diet Quality Index scores, school-hour Diet Quality Index scores, and non-school-hour Diet Quality Index scores among Canadian children and youth aged 6 to 18 by household income status

a) Low Household Income

Variable	Whole Day DQI			School-Hour DQI			Non-School-Hour DQI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	64.47	0.000	54.47, 71.46	57.41	0.000	45.21, 69.61	58.84	0.000	52.24, 65.45
Intervention	2.02	0.035	0.14, 3.90	-1.13	0.458	-4.12, 1.86	2.08	0.026	0.25, 3.91
Post-Intervention	-1.00	0.330	-3.01, 1.01	-0.29	0.879	-4.00, 3.42	-0.89	0.379	-2.88, 1.10
DID	1.66	0.161	-0.66, 3.98	5.08	0.017	0.89, 9.27	0.14	0.907	-2.18, 2.46
Age	-1.56	0.021	-2.88, -0.23	-0.47	0.698	-2.83, 1.90	-0.73	0.221	-1.89, 0.44
Age^2	0.04	0.198	-0.02, 0.10	-0.01	0.897	-0.12, 0.11	0.01	0.740	-0.04, 0.06
Female	0.88	0.096	-0.16, 1.91	1.88	0.025	0.24, 3.52	0.99	0.062	-0.05, 2.03
High School	-1.71	0.129	-3.93, 0.50	-4.16	0.041	-8.16, -0.16	-0.49	0.643	-2.57, 1.59
Some post-secondary completed in household	0.60	0.281	-0.49, 1.70	0.24	0.772	-1.37, 1.84	0.96	0.089	-0.15, 2.07
Rural	-1.11	0.197	-2.78, 0.57	0.16	0.880	-1.86, 2.17	-1.54	0.073	-3.22, 0.14
White	-0.37	0.599	-1.75, 1.01	0.80	0.465	-1.35, 2.96	-1.02	0.149	-2.41, 0.37
Immigrant	1.72	0.060	-0.07, 3.51	0.48	0.788	-3.02, 3.98	1.36	0.122	-0.37, 3.09
Province of residence									

NL	0.11	0.929	-2.29, 2.51	-4.15	0.015	-7.51, -0.79	0.91	0.450	-1.45, 3.27
PEI	-0.35	0.756	-2.56, 1.86	-0.22	0.893	-3.37, 2.94	0.09	0.941	-2.29, 2.47
NS	-1.35	0.184	-3.34, 0.64	-2.85	0.053	-5.75, 0.04	-0.55	0.588	-2.52, 1.43
NB	-3.01	0.006	-5.17, -0.85	-2.65	0.082	-5.63, 0.34	-2.59	0.040	-5.07, -0.12
QC	1.02	0.168	-0.43, 2.47	1.72	0.133	-0.52, 3.95	0.96	0.205	-0.53, 2.45
MB	0.22	0.880	-2.67, 3.12	-1.48	0.470	-5.51, 2.54	-0.57	0.704	-3.49, 2.36
SK	1.95	0.075	-0.20, 4.09	-1.77	0.353	-5.49, 1.96	2.33	0.028	0.25, 4.40
BC	1.31	0.096	-0.23, 2.86	-0.82	0.545	-3.46, 1.83	1.64	0.046	0.03, 3.24

b) High Household Income

Variable	Whole Day DQI			School-Hour DQI			Non-School-Hour DQI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	66.55	0.000	60.95, 72.16	59.90	0.000	50.71, 69.10	65.49	0.000	59.74, 71.23
Intervention	0.92	0.254	-0.66, 2.50	-2.26	0.060	-4.61, 0.09	1.59	0.050	0.00, 3.19
Post-Intervention	0.80	0.280	-0.65, 2.25	1.00	0.438	-1.52, 3.52	0.28	0.696	-1.14, 1.71
DID	0.05	0.952	-1.68, 1.78	3.72	0.014	0.75, 6.69	-0.48	0.594	-2.22, 1.27
Age	-1.48	0.002	-2.44, -0.53	-0.68	0.384	-2.21, 0.85	-1.57	0.001	-2.52, -0.61
Age^2	0.03	0.191	-0.01, 0.07	0.01	0.857	-0.06, 0.07	0.03	0.153	-0.01, 0.08
Female	-0.84	0.050	-1.68, 0.00	0.11	0.877	-1.25, 1.47	-0.79	0.078	-1.66, 0.09

High School	0.06	0.947	-1.72, 1.85	-2.15	0.104	-4.75, 0.45	0.75	0.410	-1.03, 2.53
Some post-secondary completed in household	2.32	0.000	1.24, 3.39	0.98	0.295	-0.86, 2.83	2.43	0.000	1.37, 3.50
Rural	-0.60	0.277	-1.68, 0.48	0.59	0.490	-1.09, 2.28	-0.99	0.093	-2.14, 0.16
White	-0.89	0.242	-2.39, 0.61	-1.43	0.248	-3.84, 0.99	-0.60	0.501	-2.34, 1.14
Immigrant	0.03	0.974	-1.89, 1.96	-1.81	0.279	-5.09, 1.47	0.48	0.632	-1.48, 2.44
Province of residence									
NL	-0.41	0.710	-2.58, 1.76	-0.70	0.597	-3.31, 1.90	0.03	0.981	-2.17, 2.22
PEI	-0.51	0.534	-2.12, 1.10	0.90	0.490	-1.66, 3.47	-1.52	0.117	-3.42, 0.38
NS	-2.13	0.005	-3.63, -0.63	-0.29	0.817	-2.79, 2.20	-1.89	0.012	-3.38, -0.41
NB	-1.12	0.168	-2.70, 0.47	0.58	0.640	-1.87, 3.04	-1.10	0.184	-2.72, 0.52
QC	1.57	0.016	0.29, 2.84	2.43	0.015	0.48, 4.38	1.51	0.023	0.21, 2.81
MB	0.08	0.935	-1.80, 1.95	-1.61	0.206	-4.10, 0.88	0.84	0.382	-1.04, 2.72
SK	-0.08	0.933	-1.87, 1.72	-1.20	0.379	-3.87, 1.47	0.22	0.808	-1.57, 2.02
BC	0.02	0.980	-1.28, 1.31	0.21	0.835	-1.80, 2.23	0.19	0.782	-1.19, 1.58

Table 4.13. Changes in whole day Healthy Eating Index scores, school-hour Healthy Eating Index scores, and non-school-hour Healthy Eating Index scores among Canadian children and youth aged 6 to 18 by household income status

a) Low Income Household

Variable	Whole Day HEI			School-Hour HEI			Non-School-Hour HEI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	57.49	0.000	49.44, 65.54	43.93	0.000	32.42, 55.43	57.91	0.000	50.61, 65.21
Intervention	2.63	0.013	0.56, 4.70	-1.51	0.320	-4.48, 1.47	2.78	0.006	0.81, 4.76
Post-Intervention	0.18	0.878	-2.08, 2.44	5.43	0.006	1.56, 9.31	1.06	0.346	-1.15, 3.28
DID	0.30	0.831	-2.48, 3.09	2.18	0.326	-2.17, 6.54	-0.14	0.918	-2.83, 2.55
Age	-1.17	0.117	-2.64, 0.29	0.10	0.930	-2.10, 2.29	-1.33	0.051	-2.67, 0.00
Age^2	0.04	0.284	-0.03, 0.10	-0.02	0.783	-0.12, 0.09	0.04	0.189	-0.02, 0.010
Female	1.22	0.065	-0.07, 2.52	1.93	0.029	0.20, 3.66	1.18	0.059	-0.04, 2.40
High School	-2.09	0.116	-4.70, 0.52	-4.21	0.048	-8.38, -0.03	-1.06	0.409	-3.58, 1.46
Some post-secondary completed in household	2.26	0.001	0.99, 3.54	1.07	0.219	-0.63, 2.77	2.22	0.000	0.99, 3.45
Rural	-1.81	0.152	-4.27, 0.66	0.64	0.630	-1.96, 3.23	-2.18	0.063	-4.47, 0.12
White	-3.15	0.000	-4.63, -1.67	0.03	0.976	-2.01, 2.07	-3.48	0.000	-4.87, -2.08
Immigrant	1.78	0.117	-0.45, 4.00	-0.96	0.547	-4.08, 2.16	2.16	0.027	0.25, 4.07
Province of residence									

NL	-0.26	0.846	-2.94, 2.41	-4.72	0.007	-8.14, -1.31	0.27	0.838	-2.29, 2.83
PEI	-0.39	0.766	-2.93, 2.16	0.98	0.578	-2.47, 4.44	-0.98	0.458	-3.56, 1.61
NS	-1.68	0.184	-4.16, 0.80	0.89	0.582	-2.29, 4.08	-1.35	0.273	-3.76, 1.06
NB	-2.94	0.028	-5.56, -0.32	-0.34	0.854	-3.97, 3.29	-3.00	0.029	-5.68, -0.31
QC	-0.56	0.562	-2.45, 1.33	2.01	0.110	-0.45, 4.48	-0.46	0.609	-2.24, 1.31
MB	-1.10	0.454	-3.97, 1.78	-2.69	0.252	-7.28, 1.91	-1.27	0.325	-3.79, 1.26
SK	2.39	0.039	0.12, 4.67	0.01	0.995	-3.50, 3.52	1.91	0.085	-0.27, 4.10
BC	1.90	0.123	-0.51, 4.32	1.65	0.248	-1.15, 4.44	1.52	0.146	-0.53, 3.57

b) High Household Income

Variable	Whole Day HEI			School-Hour HEI			Non-School-Hour HEI		
	β	*p*-value	95% CI	*β*	*p*-value	95% CI	*β*	*p*-value	95% CI
Intercept	65.84	0.000	58.24, 73.44	56.45	0.000	46.05, 66.84	61.41	0.000	54.11, 68.70
Intervention	1.14	0.285	-0.95, 3.23	-1.71	0.185	-2.45, 0.82	1.88	0.076	-0.20, 3.95
Post-Intervention	1.98	0.051	-0.01, 3.97	5.72	0.000	3.29, 8.15	2.11	0.029	0.21, 4.00
DID	-0.22	0.854	-2.55, 2.11	2.60	0.087	-0.38, 5.57	-0.16	0.892	-2.40, 2.09
Age	-2.19	0.001	-3.47, -0.91	-1.57	0.070	-3.28, 0.13	-1.69	0.007	-2.92, -0.45
Age^2	0.07	0.031	0.001, 0.12	0.05	0.171	-0.02, 0.13	0.05	0.113	-0.01, 0.10
Female	0.55	0.328	-0.55, 1.65	0.22	0.756	-1.19, 1.64	-0.11	0.842	-1.17, 0.95

High School	-0.32	0.779	-2.60, 1.95	-2.28	0.118	-5.15, 0.58	0.08	0.945	-2.10, 2.25
Some post-secondary completed in household	3.26	0.000	1.88, 4.65	0.69	0.534	-1.47, 2.84	3.10	0.000	1.76, 4.43
Rural	-0.54	0.433	-1.90, 0.81	0.10	0.912	-1.63, 1.83	-0.81	0.243	-2.17, 0.55
White	-3.67	0.000	-5.59, -1.76	-2.79	0.050	-5.58, 0.00	-3.05	0.001	-4.85, -1.26
Immigrant	-1.02	0.477	-3.83, 1.79	-1.56	0.413	-5.31, 2.18	0.16	0.908	-2.57, 2.89
Province of residence									
NL	-0.65	0.629	-3.29, 1.99	-1.13	0.432	-3.95, 1.69	1.12	0.395	-1.46, 3.70
PEI	-0.84	0.425	-2.89, 1.22	1.54	0.319	-1.48, 4.56	-1.21	0.269	-3.36, 0.94
NS	-0.72	0.413	-2.89, 1.22	1.75	0.230	-1.10, 4.60	-1.04	0.269	-2.87, 0.80
NB	-0.08	0.938	-2.44, 1.00	1.68	0.201	-0.89, 4.24	-0.28	0.779	-2.25, 1.68
QC	1.03	0.250	-2.06, 1.90	2.79	0.008	0.73, 4.86	0.26	0.758	-1.40, 1.92
MB	1.65	0.168	-0.72, 2.77	0.52	0.715	-2.26, 3.30	1.85	0.114	-0.45, 4.15
SK	-0.37	0.762	-0.69, 3.99	-1.49	0.257	-4.07, 1.09	0.13	0.914	-2.23, 2.49
BC	2.09	0.013	-2.77, 2.03	2.03	0.094	-0.34, 4.41	0.81	0.316	-0.77, 2.38

Chapter 5

5 Discussion

This chapter provides a discussion of the study results and comparison to previous literature, implications, study strengths and limitations, conclusions and next steps.

5.1 Summary

The first objective of this study was to compare the diet quality scores between provinces with and without mandatory school nutrition policies. DQI scores during school-hours increased in the intervention provinces by an estimated 4.34 points per children on average relative to the control provinces. Consequently, we found that the diet quality during school-hours increased in the intervention provinces relative to the control ones, but no significant changes in diet quality were found outside of school-hours.

The second objective of this study was to conduct stratified analyses by sex, school grade, and household income on changes in diet quality as a result of mandatory school nutrition policies. HEI and DQI scores increased during school-hours among males in the intervention group by an estimated 5.2 and 6.5 points on average, respectively. This indicates that most of the improvements in diet quality occurred among male students. We found that DQI scores during school-hours increased among elementary school students in the intervention group by an estimated 4.82 points on average compared to the control group. When stratifying by income group, changes in DQI scores during school-hours remained significant for both the low- and high-income groups.

5.2 Comparison with Previous Literature

5.2.1 Objective 1

We found that diet quality during school-hours increased among Canadian children aged 6 to 18 from 2004 to 2015. In particular, diet quality scores during school-hours increased the most: DQI and HEI scores increased by an estimated 3.73 and 7.52 points, respectively. This finding is consistent with the report of Tugault-Lafleur et al. (2019) using the 2004 and 2015 CCHS data.[30]

They reported that mean HEI scores during school-hours increased from 51.3 to 58.0 points, an estimated increase of 6.7 points.[30] While they did not use DQI as a measure of diet quality, their estimated increase in HEI of 6.7 is close to ours of 7.52. The small discrepancy is likely due to differences in the study sample. Our study included all respondents aged 6 to 18, while Tugault-Lafleur et al. only included respondents aged 6 to 18 who completed the dietary recall on a weekday. Overall, our descriptive results confirm those of this study, corroborating that the average diet quality among school-going children and youth did increase during school-hours between 2004 and 2015.

When comparing changes in diet quality between provinces with and without mandatory school nutrition policy, we found that DQI increased on average by 4.34 points per children in the intervention provinces due to implementation of school nutrition policies. Previous literature has reported improvements in diet quality following implementation of school nutrition programs or policies. Three studies from Nova Scotia, Canada have found increases in diet quality, measured by the DQI. McIsaac et al. (2015) found that students in 2011 had a higher DQI scores than students in 2003 by 2.15 points,[19] suggesting improved diet quality resulting from implementation of school nutrition policy. Similarly, another study from Nova Scotia found that mean DQI scores increased by 1.80 points between 2003 and 2011.[17] This is smaller than the increase found in our study, but there are a number of differences in the study design and population that could explain this.

The third study conducted in Nova Scotia found that students in schools with a health-promoting school nutrition program had better diet quality (OR = 1.29) than students at schools without the program.[76] The intervention in this study was a school nutrition program rather than a provincial policy as in the other two, so only 7 schools were included in the intervention group. All three Nova Scotia studies have shown improved diet quality following implementation of school nutrition policy, which is also confirmed by our results. In addition, a systematic review of the effectiveness of school-based nutrition policies in Europe found that approximately 75% of studies looking at children and adolescents reported improvements in dietary behaviour.[22]

5.2.2 Objective 2

Stratified analysis by sex revealed that diet quality scores increased more markedly among males, though the confidence intervals overlap. This is consistent with one previous study,[89] but inconsistent with a few others.[40,90,91] Although sex differences in diet quality and consumption of different foods exist, the reported effects in the literature were heterogeneous.[89,91] A study of food consumption among school-going children in Canada found that in grade 6, only 5% of males and 7% of females met the minimum serving recommendations for all food groups based on 2007 CFG.[13] This number decreased even more in grade 9, with only 0.4% of males and 2% of females meeting the minimum servings recommendations. Among males, a statistically significant decline in the mean number of servings of FV from grade 6 to grade 9 was found. Among females, a statistically significant decline in the mean number of servings of grain products and milk and alternatives from grade 6 to grade 9 was found. Although we found male students having increased diet quality after implementation of school nutrition policies relative to female students in our point estimates, the confidence intervals overlap.

We found that DQI scores during school-hours increased among elementary school students in the intervention provinces by an estimated 4.82 points compared to the control provinces. Our results are consistent with previous research indicating that younger children have better diet quality than older children.[40,41] A previous study in Canada found that grade 6 students had significantly higher odds of meeting recommended FV servings compared to grade 8-12 students.[14] Overall, only 10% of grade 6-12 students in Canada met daily FV recommendations.[14] A study similar to ours also evaluated changes in school-HEI scores using the 2004 and 2015 CCHS and found that the magnitude of change for HEI scores during school-hours was approximately the same between elementary and high school students.[30] However, this study was not evaluating school nutrition policies and thus did not have a control group, nor did they statistically test differences in diet quality scores across time between younger and older children.

One possible explanation for why elementary schools had better dietary quality could be that children in elementary school are unable to leave the school property at lunch time to purchase foods at restaurants or other establishments. In other words, students in elementary school may have greater adherence to the school nutrition policies. Increasing age among children has been

linked to declines in diet quality based on a number of factors. Parents can have an influence on the diet quality of children as they age through choices regarding food for the family, and model their eating behaviours–whether good or bad–to children.[38] Parents may be more vigilant in ensuring that younger children are consuming a well-balanced diet. Relatedly, older children tend to have more freedom in preparing their own foods and in purchasing and eating foods outside of the home. This leads to an increase in consumption of foods outside of home, including fast-food consumption.[39] This indicates that lower diet quality in older children/youth may be a result of more freedom in dietary choices, which may also explain why high school students did not have as high of an increase in diet quality as a result of school nutrition policies.

Changes in diet quality during school-hours were statistically significant for both low- and high-income households in provinces with mandatory school nutrition policy. This indicates that household income does not differentially impact the effect of the school nutrition policy. This is good news as it suggests that economic disadvantage does not reduce the benefits of school nutrition policies, and conversely, that being economically advantaged does not necessarily result in better diet quality over others in the context of school nutrition policies. While the difference in average diet quality scores between students from low- and high-income households was not investigated in this study, previous literature indicates that individuals with lower income tend to have poorer diet quality than individuals with high-income.[53] Previous literature also indicates that lower-income households tend to purchase foods of lower nutrition quality, consume fewer FV and have lower intake of micronutrients.[51,53] Conversely, higher-income households typically have higher diet quality, and consume more FV and whole grains.[40,52] A potential explanation for the results of income stratified analysis could be that students continued to consume similar foods in schools regardless of the household income status.

5.3 Implications

The major finding of this study is that school nutrition policies improve diet quality of children during school-hours, but not outside of this timing. This indicates that these policies do not have external effects that translate to foods consumed at home or in other environments. While compliance rates may not be 100% across the provinces with a mandatory school nutrition

policy, having these policies in place is still better than no policy or a voluntary policy for schools. The use of a control group in this study was important to estimate the average change in diet quality of children that occurred in provinces with mandatory school nutrition policies compared to those without.

Beyond its immediate effect on diet and health, diet quality has been shown to be associated with academic performance,[92] and potentially obesity rates. Previous studies have shown inconclusive evidence on the effects of school nutrition policies and programs on obesity rates among children and youth in both Canada[15,17,19,79,84] and internationally.[26,27] Some studies used a control group, while others did not, which may be a source of this difference. While obesity rates may have risen in the population over time, students attending schools with school nutrition policies or other programs in place may have a lower increase compared to children attending schools with no policies. Therefore, effective school nutrition policies may increase success in school and contribute to lifetime healthy habit formation.

The method used for the main analysis in this study is difference-in-differences. There are three key assumptions associated with this method. The first is known as parallel trends. Parallel trends means that in the absence of the intervention, the difference between the intervention and control group is constant over time. In other words, the difference in average diet quality between intervention and control groups would have remained the same if mandatory school nutrition policies were not implemented. Typically, this assumption is tested by observing the trends in multiple data points before and after a treatment/intervention is implemented. In this study there were only two data points available, one pre- and one post-intervention, so this assumption could not formally be tested. The second assumption is common shocks. This means that any events that occurred after an intervention should affect both groups equally. In the context of this study, any events that occurred after implementation of the mandatory school nutrition policies were assumed to affect both the intervention and control groups in a similar manner. The final assumption is that allocation to intervention was not determined by the outcome; in other words, the intervention and outcome were unrelated at baseline. This is a valid assumption for this study, as implementation of mandatory school nutrition policies in some provinces was not determined by the outcome of change in diet quality. The use of difference-in-

differences method to measure the average change in diet quality for children allowed us to tease apart the change in diet quality from policy, separate from external factors influencing diet quality, while also adjusting for other variables that previous literature has shown to be associated with diet quality. The use of a control group sets this study distinct from others examining changes in diet quality due to school nutrition policies in Canada.

The DQI was used as the main measure of diet quality in this study, with HEI being used as secondary analysis. Differences were found between the two indices in the magnitude and significance of average changes in diet quality. The use of HEI as secondary analysis allowed us to compare our results to those of a previous study that used the HEI and same CCHS datasets.

Since analysis was completed for this study, a new version of CFG has been released.[93] The new (insert year) CFG has moved away from food groups and recommended servings. Rather, the new guide promotes eating a variety of healthy foods each day, with emphasis on fruits and vegetables, different protein sources (including plant proteins), and choosing whole grains. In addition, compared to the 2007 CFG which promoted drinking milk every day, the new CFG recommends drinking water at every meal rather than milk. The recent changes to the CFG demonstrate the changes in thinking around healthy eating and what is considered to be a healthy diet.

It may be beneficial for future initiatives and policies to target high school students, for two reasons: (1) elementary school students already have better diet quality, which appears to decrease with age; and (2) high school students have more freedom and opportunity to purchase less healthy foods. Since diet quality has been reported to decline with age, there should be a focus on educating students on healthy dietary habits at a young age and encouraging the upkeep of these habits as they age.

5.4 Study Strengths

To our knowledge, this is the first study to examine the effect of school nutrition policy on diet quality in a Canadian context using difference-in-differences method. Previous studies have examined differences in diet quality or other measures of food consumptions before and after

implementation of Canadian school nutrition policy. However, changes across an entire study population before and after implementation of a policy may be due to overall changes in society and therefore may not be solely a result of policy. By comparing differences in diet quality before and after implementation of school nutrition policy between children exposed and not exposed to the policy, we were able to estimate the changes in diet quality that were most likely due to policy.

The data obtained from the CCHS provided a representative sample of Canadians, as well as detailed information on food consumption through the use of a 24-hour dietary recall and rich socio-economic data. In addition, the use of the DQI allowed us to measure diet quality of respondents using the food data contained within the CCHS. The DQI has benefits over the HEI because it captures more components of diet quality, including variety of food groups, macronutrient ratios, sufficient consumption of micronutrients, consuming a smaller percentage of daily energy intake from fat, and limiting cholesterol intake.

5.5 Study Limitations

While this study is the first to examine the effect of school nutrition policies on diet quality in Canada, there are limitations to be acknowledged.

Firstly, only two years of survey data were available for the analysis. Ideally, multiple years would have been ideal to observe the trend over time and test the parallel trends assumption. However, the use of a control group still removes the effect of any common trends that affect both groups and gives a better measure of the policy effect. In addition, having multiple days of food consumption collected for each respondent rather than just a 24-hour period would have allowed a more accurate measurement of diet quality. However, this was not available in the survey data used and would have been difficult to achieve with a large number of survey respondents. While the CCHS did collect a second day of dietary recall for some respondents, it was only a subsample of the respondents with very limited sample size.

Another potential limitation is that even though policies are implemented at the provincial level, there may be considerable variation between schools, school boards, or jurisdictions across the

province. For instance, some schools may have greater compliance with the policy guidelines compared to others. It is conceivable that variations in compliance rates may impact the measured effects of the mandatory provincial policy. The scope of this study also did not allow for assessment on a province-by-province basis. Furthermore, in the provinces that do not have mandatory school nutrition policies, we were not able to assess which school boards have nutrition guidelines implemented. The within-province variation is likely greater in provinces without mandatory policies because there is not a single set of guidelines mandated across the province. This means that different school boards will vary in whether they have guidelines implemented and the specific guidelines they choose to implement in their schools. This was not possible to evaluate using the data in this study, but within- and between-province variation would be important and worthwhile to assess in future studies evaluating school nutrition policy.

The 24-hour dietary recall collected as part of the CCHS Nutrition cycles was extremely valuable in making this study possible. Compared to other dietary measurement instruments, such as food frequency questionnaires, the 24-hour dietary recall captures all items that an individual consumed. This is an advantage because food frequency questionnaires may miss the inclusion of food items that are important to the population of interest, while the 24-hour dietary recall allows respondents to include any food items consumed.[28] However, there are some concerns associated with the use of a dietary recall for accurately estimating dietary intake. In particular, they are subject to biases, such as recall bias and social desirability bias.[94] This means that respondents may have difficulty remembering everything they ate in the past 24 hours when completing the interview. In addition, they may feel they have to change their answers to appear more socially desirable when completing the interview. For example, if a respondent consumed foods that they deem unhealthy but wish to appear that they ate more healthy foods, they may alter or remove certain items that they ate the previous day to appear healthier to the interviewer. This can similarly be applied to parents involved in the interview process. Since dietary recalls for children aged 11 and younger were completed with the assistance of a parent, the parents may also have influenced what the children were reported as eating the previous day to make themselves appear better.

A further potential limitation of this study is the way in which diet quality is measured. Since diet quality is not calculated as a variable in the CCHS, it had to be calculated based on the data obtained in the 24-hour dietary recalls. Two different scoring schemes were chosen, the DQI and HEI to construct diet quality. While both indices are validated measures, it is difficult to capture diet quality in a single score because there are many factors that influence it and it can be difficult to define. For example, the decision of the weight assigned to each component of a diet quality score can differ between scoring indices and impact the overall diet quality score obtained. Related to this, there may be differences in what is considered to be representative of good diet quality.

When considering diet quality during school-hours, high school students are able to leave school property and may be inclined to do so if only healthier options are available in school cafeterias. A limitation of this study is that data were not available on where foods consumed during school-hours were purchased or consumed (on or off school property) in the 2004 CCHS, so it is unknown how much was actually purchased within schools with mandatory nutrition policies compared to restaurants or other food sources located off school property. Regarding the creation of the outcome variables, although typical holidays were accounted for as being outside school-hours, there may have been additional days that children were not in school for various reasons that we cannot completely capture. Furthermore, the data did not distinguish whether students attended private or public schools. However, these two issues likely would not have a large impact on the results, as these issues would affect both the intervention and control group.

5.6 Conclusions

The objective of this study was to investigate the effect of mandatory school nutrition policy on the diet quality of children and youth in Canada. We found that mandatory school nutrition policy improves diet quality during school-hours, but it has no effect outside school-hours. When examining how this effect differed across students of different sexes and age, we found that diet quality increased most among males and students of elementary school age, although the confidence intervals overlap.

Our findings demonstrate that mandatory school nutrition policies are useful in improving the diet quality of children and youth in the school environment, especially children attending elementary schools. Our results suggest that jurisdictions without school nutrition policy should consider implementing mandatory school nutrition policies to improve the nutrition of children and youth during school-hours. School nutrition policies combined with other healthy lifestyle policies is likely required to create long lasting effects and overall improvement in the diet quality of not just children, but also other populations. These efforts to encourage healthy behaviours in children at a young age may prevent health problems and the development of chronic conditions later in life. By improving diet quality among children now, we can work to improve the health of future generations.

5.7 Next Steps

This study is a first step in examining the effects of nutrition policies targeting Canadian children and youth in schools. The effectiveness of school nutrition policies should continue to be evaluated and changes should be made as necessary. There is a need for policy evaluations to examine how school nutrition policies are implemented, whether they are actually being enforced, and how closely they are adhering to and meeting the objectives and goals with regard to desired outcomes. This will aid in increasing the effectiveness of the policies and address any concerns or barriers to implementing the policies in schools. Having access to more longitudinal data on diet quality is necessary to measure trends over time, ideally to see the patterns in each province before and after implementation of a policy and compared to provinces without a mandatory policy.

Further investigation into how sociodemographic differences affect how students are impacted by school nutrition policies would perhaps support changes in the policies to ensure the potential benefits are seen across all children. There should also be a focus on how to extend the effects of the policies externally to improve the health of Canadians, both children and adults, outside of schools.

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Appendices

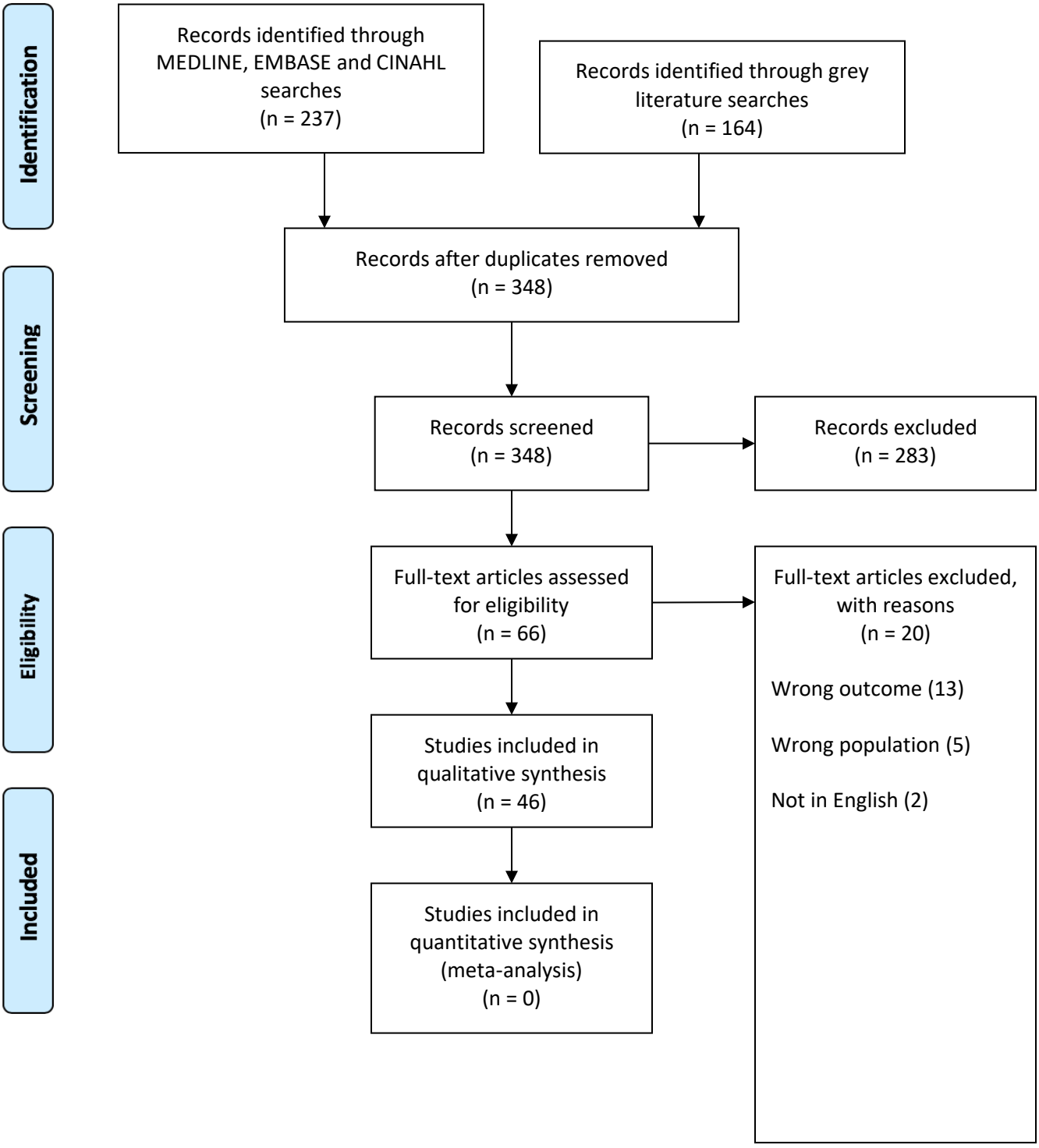
Appendix A1: Search Strategy

Concept	CINAHL	MEDLINE	EMBASE	Keywords
Food	(MH "Food+")	exp FOOD/	exp food intake/	Food* or nutrition*
Consumption				Consum*
School	(MH "School Policies") OR (MH "Nutrition Policy+")	exp SCHOOLS/	exp school/	School*
Policy		exp POLICY/	exp policy/	Polic*

Search Strategy Template

1. Food → subject heading
2. Food → keywords
3. **1 OR 2**
4. Consumption → subject heading
5. Consumption → keywords
6. **4 OR 5**
7. School → subject heading
8. School → keywords
9. **7 OR 8**
10. Policy → subject heading
11. Policy → keywords
12. **10 OR 11**
13. **3 AND 6 AND 9 AND 12**

Appendix A2: Search Results



Appendix A3: Summary of Included Articles

Author	Objective/Exposure/Outcome	Methods	Results	Comments
Martorell (2017)	• Objective: To better understand enabling frameworks, good practices, gaps and obstacles in provincial and federal policy interventions	• Discussion paper • Semi-structured interviews with individuals from British Columbia, Alberta, Nova Scotia, and New Brunswick • Informal scoping conversations and available documentation	• Pan-Canadian Joint Consortium for School Health (JCSH) introduced in 2005 → partnership between provincial and territorial health and education ministries except Quebec • School food is under jurisdiction of provincial/territorial governments • All provinces have some sort of health promotion strategy • All provinces have renewed their school nutrition guidelines since 2005, but they vary a lot • Some provincial policies require districts to develop their own policies, so can vary across provinces	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			• No federal funding for school food program and minimal provincial investment • Difficult to assess adherence to guidelines	
Vanderlee et al. (2017)	• Objective: Examine the state of food environment policy in Canada compared to internationally-established good practices in critical policy domains	• 6-step process • (1) Identified food policies in place in Canada • (2) Verified information with stakeholders and established a panel of experts • (3) Conducted online surveys to compare provincial/territorial policies in international best practices • (4) Rated federal policies compared to international best practices • (5) Refined policy support actions • (6) Prioritized important and	Alberta: • No additional tax on basic groceries • Good school nutrition policy (not mandatory) British Columbia: • Trans fat restriction in restaurants • No additional tax on basic groceries • Mandatory school nutrition policy Manitoba: • No additional tax on basic groceries • Mandatory school nutrition policy New Brunswick: • Mandatory school nutrition policy	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
		achievable actions for Canada	Newfoundland: • Support for implementing school nutrition policy Northwest Territories: • Policies and programs to support healthy food production • Guidelines for food served in schools Nova Scotia: • Little/no tax on basic groceries • Mandatory school nutrition policy • Policies to support healthy food in public sector Ontario: • Calorie labelling in chain restaurants • Mandatory school nutrition policy Prince Edward Island: • Wellness Strategy 2015-2017 to	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			improve food environment in schools and recreation centres Quebec: • Restricted marketing to children • No additional tax on basic groceries • QST on soft drinks, candy and potato chips Saskatchewan: • No additional tax on basic groceries • School nutrition guidelines (not mandatory) Yukon: • No additional tax on basic groceries • Wellness Plan for Yukon's Children and Families	
Leonard (2017)	Objective: To estimate the causal effect of banning the sale of junk food	• Longitudinal • CCHS • n = 153,000 • Canada	• An additional year of being exposed to a school junk food ban is associated with a	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	Exposure: School junk food bans Outcome: BMI	• Difference-in-differences regression	decrease in BMI of 0.04 to 0.05 • Students who have been exposed to a junk food ban at school for 5 or more years have a 0.35 lower BMI compared to those who haven't • Results were stronger for the 12-15 years age group • Results were usually stronger for females than males	
Tugault-Lafleur et al. (2017)	Objective: (i) examine differences between school-hour and non-school-hour dietary intakes, and (ii) assess demographic and socioeconomic correlates of school-hour diet quality among Canadian children Exposure: School-hour vs. non-school-hour Outcome: Dietary intakes (vitamin densities, HEI score)	• Cross-sectional • Canada • CCHS • n = 4,945 • Survey-weighted simple linear models • Simple linear regression models with Bonferroni adjustment • Case-wise deletion for missing data • Sampling weights applied	• Food and beverages consumed during school-hours accounted for 33.6% of total daily energy consumed • Cholesterol, vitamin A, vitamin D, vitamin B12, calcium, milk-product densities were all greatly significantly less during school-hours (greatest % difference)	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			• Age, household-level education, and province of residence were identified as demographic factors associated with differences in diet-quality among children during school-hours	
Fung et al. (2013)	Objective: To assess population-level trends in children's dietary intake and weight status before and after the implementation of a school nutrition policy in the province of Nova Scotia, Canada Exposure: Before (2003) and after (2011) implementation of school nutrition policy in Nova Scotia Outcome: Dietary behaviour and nutrient intake	• Longitudinal • n = 5215 (2003), n = 5508 (2011) • Canada • Children's Lifestyle and School-performance Study (CLASS) • Statistical analyses weighted for non-response bias • Rao-Scott-Chi-square or t-test for differences between pre- and post-policy • Random effects regression methods to account for clustering of students within	• % of total energy intake from carbohydrates and protein increased from 2003 to 2011 • % of total energy intake from fat decreased from 2003 to 2011 • Average sodium intake decreased from 2003 to 2011 • Average intake of vitamin C, folate, vitamin A, zinc and calcium decreased from 2003 to 2011 • Average intake of fibre decreased from 2003 to 2011	• No comparison group

Author	Objective/Exposure/Outcome	Methods	Results	Comments
		schools within school boards	• Students 33% more likely to pack a lunch in 2011 compared to 2003 • Students consumed 0.26 servings more of milk per day in 2011 • No change in FV consumption from 2003 to 2011 • 0.20 can decrease consumption of sugar-sweetened beverages	
He et al. (2009)	Objective: To measure the influence of a government of Ontario, Canada health promotion initiative, the Northern Fruit and Vegetable Pilot Programme (NFVPP) on elementary school-aged children's psychosocial variables regarding FV and FV consumption patterns Exposure: (i) Intervention I: Free Fruit and Vegetable Snack + Enhanced Nutrition Education; (ii) Intervention II: Free Fruit and Vegetable	• Cluster-randomised controlled trial • n = 1277 • List-wise deletion for missing data • 'Intent-to-treat' analysis • GLM Univariate procedure (for intervention effects) • Random effects modelling to account for clustering	• Statistically significant greater consumption of at school in Intervention I group vs. Control group (0.49 servings/day, $P<0.05$)	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	Snack-alone; and (iii) Control group Primary Outcome: Children's FV consumption Secondary Outcomes: Differences in children's awareness, knowledge, self-efficacy, preference, intention and willingness to increase FV consumption			
McIsaac et al. (2015)	Objective: To assess what health promotion policies and practices were adopted by schools in Nova Scotia and the extent that these policies and practices affected the diet quality, physical activity (PA) and weight status of students Exposure: Before (2003) and after (2011) implementation of school nutrition policy in Nova Scotia Outcomes: Changes in diet, physical activity and weight status	• Longitudinal • Canada • Children's Lifestyle and School-performance Study (CLASS) • n = 4,461 (2003), n = 5,140 (2011) • Schools classified as either limited implementation or moderate/intense implementation • Multilevel regression methods • Analyses adjusted for confounding • Analyses of dietary outcomes adjusted for energy intake	• More schools implemented health and physical activity and health promotion strategies than physical activity and healthy eating practices • Students had lower DQI-I scores in 2003 compared to limited implementation schools in 2011	• Possible response bias due to self-report • No comparison group

Author	Objective/Exposure/Outcome	Methods	Results	Comments
Mullaly et al. (2010)	Objective: Assess the nutritional benefits of the new policy by examining changes in student food consumption prior to and one year following implementation of the policy Exposure: Before (2001/2002) and after (2007) implementation of school nutrition policy in Nova Scotia	• Longitudinal • n = 971 (2001/02) • n = 562 (2007) • Administered food frequency questionnaire to elementary school students • Multilevel linear regression (to compare food consumption before and after implementation of the policy) • Analyses adjusted for confounders and difference in daily food servings from 2001 to 2007	• Proportion of low-nutrient density foods (LNDF) servings decreased • Proportion of milk and alternative (MA) servings increased • Students more likely to meet servings recommendations of in 2007	• No comparison group
Watts et al. (2014)	Objective: To examine school-level changes associated with the implementation of the Food and Beverage Sales in Schools (FBSS) and Daily Physical Activity (DPA) guidelines in British Columbia, Canada Exposure: Before (2007-08) and after (2011-12) implementation of provincial	• Longitudinal • n = 502 (2007/08) • n = 476 (2011/12) • Multilevel mixed effects linear and logistic regression to model temporal changes • Mixed effects modelling to account for clustering	• Vending machine guidelines had the greatest reported full implementation in middle/high schools (followed by snack bars, cafeterias, fundraising activities and special events) • In 2011-12 school year, elementary schools had higher	• Survey was completed by principals, may be biased (e.g. social desirability) • No comparison group

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	school nutrition and physical activity policies Outcomes: Healthy options available, minutes of physical exercise per week that students receive, change in PE delivery, stakeholder support for nutrition and physical activity policies	• Separate analysis for elementary and middle/high schools	odds of having available compared to 2007-08 • In 2011-12 school year, midde/high school had lower odds of having SSBs and unhealthy foods available compared to 2007-08	
McComber et al. (2015)	Objective: To assess food group consumption during school lunch over five years of school nutrition policy (SNP) implementation according to food source (home versus school)	• ANOVA	• Number of low-fat whole grain products (LFWG) servings increased from 2007 to 2012 • School sources of high-fat non-whole grains increased and home source of high-fat whole grains increased from 2007 to 2012 • School sources of low-fat decreased from 2007 to 2012	
Velazquez et al. (2017)	Objective: (1) identify and summarize approaches for assessing the food and beverage marketing environment in schools; (2) examine current evidence regarding the extent to which	• Review • 27 included studies • Searched MEDLINE, Web of Science, CINAHL, Embase, PsycINFO, and grey literature	• Three different methodologies used in studies measuring food and beverage marketing in schools: direct observations, self-	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	students in developed countries are exposed to food and beverage marketing at school; (3) determine whether exposure differs by student- and/or school-level characteristics; (4) assess whether exposure is associated with students' diet-related outcomes; and (5) identify gaps and future research directions as needed to inform emerging policies and practices designed to reduce the deleterious impacts of school-based food and beverage marketing	for documents published before 2016 • Used data extraction form to pull key information from articles	report surveys and interviews (in-person or telephone) • Posters/signs and vending machines were the most common forms of direct advertising • Food coupons as indirect advertising were more common in elementary schools than middle or high schools • 21-80% of schools had a contract with a food or beverage company • Approx. half of schools had policy regarding food or beverage marketing at school • Approx. 60% of advertisements in schools were for unhealthy foods • Some studies found that advertisements were more prevalent in middle schools	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			• Inconclusive whether low SES exposed to more advertising or not • Inconclusive difference in advertising by geographic location • Some evidence for association between advertising and purchase or consumption of that item • Most of advertising at school is for food items that aren't recommended by dietary guidelines	
Micha et al. (2018)	Objective: To systematically review and quantify the impact of school food environment policies on dietary habits, adiposity, and metabolic risk in children Exposure: Food environment policies targeting food/beverage availability across the school setting	• 91 interventions • Potential heterogeneity due to differences in educational and school systems across or within countries • Inclusion criteria: randomized or quasi-experimental intervention, assessed the impact	**Direct provision of healthful foods and beverages:** • After pooling, fruit intake increased by 0.27 servings/day • After pooling, vegetable intake increased by 0.04 servings/day • After pooling, combined FVintake	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	Outcome: The change in habitual consumption of the targeted food, beverage, or nutrient	of school food policy, and reported a quantitative change	increased by 0.28 servings/day • After pooling, no change in caloric intake **Competitive food and beverage standards:** • Inconclusive effect on sugar-sweetened beverages • Unhealthy snack intake decreased • No significant difference on caloric intake • In-school fat intake decrease, saturated fat intake did not change **School meal standards:** • Fruit intake increased by 0.76 servings/day • Non-significant increase in vegetable intake • No change in caloric intake • Sodium intake decreased	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
Evans et al. (2012)	Objective: To quantify the impact of school-based interventions on FV intake in children aged 5-12 y Exposure: Before vs. after school-based interventions Outcome: The difference in portions (total weight in g/80 g) of , separately and combined, consumed daily, excluding potatoes, between intervention and control groups	• Systematic review and meta-analysis • Random-effects models to determine pooled estimates in meta-analyses • Heterogeneity assessed • Funnel plots to assess publication bias	• Most interventions had both a school and home component • Unit of randomization in studies was normally the school • Pooled estimate of FV consumption (excluding fruit juice) for interventions was 0.25 portions/day ($P < 0.01$) higher in intervention groups than control • Pooled estimate of FV consumption (including fruit juice) for interventions was 0.32 portions/day ($P < 0.01$) higher in intervention groups than control • Pooled estimate of fruit consumption only (excluding fruit juice) for interventions was 0.24 portions/day (*P*	• Quality of studies is a concern • Inconsistent reporting in studies • Potential publication bias from funnel plots

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			< 0.01) higher in intervention groups than control • Pooled estimate of fruit consumption only (including fruit juice) for interventions was 0.24 portions/day (*P* < 0.01) higher in intervention groups than control • Pooled estimate of vegetable consumption only (including fruit juice) for interventions was 0.07 portions/day (*P* = 0.16) higher in intervention groups than control	
Veugelers et al. (2005)	Objective: Study the effects of schools programs in regard to prevent excess body weight Exposure: Nutrition program (with/without) Outcomes: overweight, obesity, FV consumption, fat intake, dietary quality,	• Cross-sectional • n = 5,200 students • Multilevel regression methods to examine effect of nutrition programs on outcomes • Analyses adjusted for confounders	• Students in schools with the AVHPSP program consumed significantly more and had significantly better diet quality • Students in schools with the AVHPSP program had significantly lower	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	participation in physical and sedentary activities	• Dietary analyses adjusted for energy intake • Schools with nutrition policies either had their own policies implemented or participated in a coordinated program (Annapolis Valley Health Promoting Schools Project – AVHPSP)	rates of overweight and obesity than students at schools with nutrition program	
Day et al. (2008)	Objective: To determine if a whole-school intervention with active participation of the school community is effective in: 1) increasing the consumption of FV, 2) enhancing knowledge, attitudes and perceptions regarding FV, and 3) increasing willingness to try new FV Exposure: Intervention vs. usual practice Outcomes: FV consumption; FV knowledge, attitudes and	• Cross-sectional • n = 444 • ANOVA (to determine differences between conditions at baseline) • Repeated measures ANOVA (determine main and interaction effects over time between conditions)	• FV servings increased by 0.18 at intervention schools, significantly different from usual practice schools • Percentage of tried increased in intervention schools	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	perception; willingness to try new			
Drapeau et al. (2016)	Objective: Evaluate the impact of Team Nutriathlon on vegetables and fruit (VF) and dairy product (DP) consumption of children Exposure: Intervention vs. Control Outcomes: Daily measervings of VF and DP	• Longitudinal • Team Nutriathlon: 8-week nutrition intervention in schools • n = 404 • Linear mixed effects models for repeated measures (to assess change over time)	• Significant group by time effect for VF and DP servings → intervention group reported more servings during and after the intervention • Intervention group consumed an average of 3.1 servings of VF and 2.0 servings of DP more than control group during and after the 8-week intervention period	• Study participant were volunteers, potential for bias • No blinding of teachers
Adamo et al. (2013)	Objective: (1) test the effectiveness of the pre-existing Canadian Marketing Produce Association-designed and endorsed Freggie Friday program; and (2) examine whether the program modified children's potential indicators, such as personal factors, perceived social environment, and perceived physical environment	• Prospective, quasi-experimental trial design • n = 807 • Chi-square test (for sex differences at baseline) • Linear mixed-effect regression models (to assess effect of intervention on outcomes)	• No significant difference in frequency of FV consumption between groups after intervention • When looking at grades 1-4 independently, children at intervention schools reported consuming vegetables significantly more	• Assignment to intervention not randomized, control group schools were randomly selected • Large loss to follow-up

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	Exposure: Intervention vs. Control Primary outcome: The difference in frequency of children's FV consumption from baseline to follow-up Secondary outcomes: children's personal factors, perceived social environment, and perceived physical environment		often after the intervention compared to control schools	
Fitzpatrick et al. (2017)	Objectives: (1) identify school types (groupings of schools) that are similar based on selected features of the school food environment; (2) examine whether school type is related to neighbourhood deprivation; and (3) explore the relation between school type, measured at baseline and child adiposity outcomes 2 years later Exposure: School type Outcomes: BMI Z-scores, % body fatness, % central body fat	• Prospective longitudinal design • k-cluster analysis • ANOVA (to examine differences in neighbourhood deprivation between school types) • Generalized estimation equations to account for nesting of children within schools • Multiple imputation for missing data at follow-up	• 3 clusters for school type • School types: 'overall healthful food environment', 'unhealthful food environment inside the school', 'overall unhealthful food environment' • Overall healthful schools had significantly less material deprivation than overall unhealthful schools • Overall healthful schools were in areas with significantly	• Possible social desirability or recall bias with principal reports

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			less social deprivation than other school types • Unhealth food environment inside the school and overall unhealthful schools were significantly associated with greater % central adiposity	
Fung et al. (2012)	Objective: Examine the changes in diet, physical activity, and weight status among grade 5 students in Alberta Project Promoting active Living and healthy Eating (APPLE) schools in comparison with students elsewhere in the province Exposure: Intervention vs. Control Outcomes: Changes in diet, physical activity, and weight status	• Longitudinal • APPLE is a 3-year intervention in 10 schools in Alberta • n = 3,421 (2008) • n = 3,389 (2010) • Chi-square test, Rao-Scott Chi-square test, t-test (for differences between baseline and two-year post-intervention) • Multilevel regression methods (to examine effect of Comprehensive School Health) • Analyses adjusted for confounders	• Students at APPLE schools consumed significantly fewer calories than other students in Alberta	• Schools not selected randomly (limited generalizability)

Author	Objective/Exposure/Outcome	Methods	Results	Comments
		• Analyses of dietary outcomes adjusted for energy intake		
Godin et al. (2018)	Objective: To examine associations between Canadian adolescents' sugar-sweetened beverage (SSB) consumption and several school food environment characteristics, and to investigate differences in these characteristics between schools in provinces with voluntary (Alberta) vs. mandatory (Ontario) provincial school nutrition policies Exposure: Voluntary (Alberta) vs. mandatory (Ontario) provincial school nutrition policy Outcomes: Number of weekdays participants reported consuming each of (i) soft drinks, (ii) sweetened coffee/teas and (iii) energy drinks, and (iv) a composite weekday SSB score	• Cross-sectional • n = 3,330 (Alberta) • n = 38,499 (Ontario) • Chi-square analyses, two-sided Wilcoxon rank-sum procedures and Fisher's exact test (to assess provincial differences across variables) • Hierarchical Poisson regression models (to examine association between student- and school-level variables and SSB consumption)	• Students in Alberta consumed significantly more SSB than those in Ontario • The proportion of Albertan schools that had SSBs available was significantly higher than Ontarian schools • Availability of sweetened coffees/teas in vending machines and access to restaurants within 1km of the school were significantly associated with higher SSB consumption	• Self-reported data, possible social desirability and recall bias
Mâsse et al. (2014)	Objective: Examine the extent to which the school food	• Cross-sectional • n = 11,385	• % of postsecondary education	• Possible non-response bias

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	environment of grades 7 to 12 students in BC, Canada was associated with consumption of SSBs, specific food items, and BMI Exposure: School food environment Outcomes: consumption of SSBs, specific food items, and BM	• • Hierarchical mixed-effects linear and logistic regressions to account for nesting of students within schools • Multiple imputation to deal with missing data	surrounding the school neighbourhood, sex, school guidelines, and availability of SSBs at school were all significantly associated with SSB consumption • Postsecondary education and sex were both significantly associated with the Food Consumption Index • Students from schools in suburban and rural settings had higher odds of being overweight and obese • Girls had lower odds of being overweight and obese than boys • Students at schools with SSBs readily available and who reported consuming more than one SSB per day had higher odds of being obese	• Self-reported consumption (social desirability, recall bias)

Author	Objective/Exposure/Outcome	Methods	Results	Comments
Minaker et al. (2016)	Objective: To examine FV consumption and predictors of meeting FV recommendations in a 2012-2013 nationally generalizable, school-based sample of Canadian grades 6-12 students Outcome: Odds of meeting FV recommendations	• Cross-sectional • n = 47,203 • Large sample • Survey weights • Logistic regression model (to examine variables associated with odds of FV consumption)	• Grade 6 students had significantly higher odds of meeting FV serving recommendations compared to grade 8-12 students • Students in Newfoundland & Labrador, Prince Edward Island and Nova Scotia had significantly lower odds of meeting FV serving recommendations compared to students in Ontario • Students receiving more than $11 spending money per week had higher odds of meeting recommendations compared to students who did not receive weekly spending money • Students identifying as Aboriginal, Latin American and "other" had higher	• Low response rates in schools that required active permission • FV consumption measure used not validated

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			odds of meeting recommendations • Only 10% of grade 6-12 students in Canada met daily FV recommendations	
Moffat and Galloway (2008)	Objective: Investigate food consumption in children attending three elementary schools in urban Hamilton, Ontario	• Cross-sectional • n = 92 • 24-hour dietary recall • Students' reported servings compared to CFG recommendations	• 76.4% of students ate less than the minimum recommended daily servings of FV • 58.4% of students consumed less than the minimum recommended daily servings of milk products • 57.3% of students consumed less than the minimum recommended daily servings of grain products • Children consumed an average of 5.6 servings of "other" foods	• Small sample size • Potential bias due to low participation • Diet variation may not be fully captured due to only collecting one dietary recall
Neilson et al. (2016)	Objective: To assess the type and quantity of foods children brought and consumed at school in the balanced school day (BSD), with two 20-	• Cross-sectional • n = 321 • Chi-square test (to assess proportion of children receiving	• A significantly higher proportion of children in BSD schools had SSBs and snacks packed	• Testing 1/3 of daily servings at school does not necessarily mean that total daily

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	minute eating periods, versus the traditional schedule (TS), with one 20-minute lunch Exposure: BSD vs. TS Outcome: Servings of food groups according to CFG	food categories in their packed lunch and proportion meeting 1/3 of the daily CFG recommendations) • Independent sample t-tests (to compare mean daily servings between BSD and TS schools)	compared to children in TS schools • Children in BSD had significantly more servings of milk and alternatives, SSBs and snacks packed than the TS group • Children in BSD schools consumed significantly more servings of SSBs and snacks • A significantly higher proportion of packed lunches in BSD schools included 1/3 of daily recommended servings of milk and alternatives • In children aged 4-8 years, the mean daily intake of failed to meet 1/3 of CFG recommendations • In children aged 9-13 years, the mean daily intake of , grain products, and milk and alternatives failed to meet 1/3 of	servings are not met outside of school • Direct observation used to assess foods packed (parents did not know the date of observation, to minimize influence)

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			CFG recommendations	
Skinner et al. (2012)	Objective: To examine the dietary intakes of students participating in the snack program compared to those who did not participate, using a validated web-based survey called the Waterloo Web-based Eating Behaviour Questionnaire (WEB-Q) Exposure: Intervention (snack program) vs. Control (no snack program) Outcomes: Food group consumption and nutrient intake	• Longitudinal • n = 63 (2004) • n = 50 (2007) • Data collected from 24-hour dietary recalls • ANOVA (to compare differences by intervention group, gender and grade)	• In 2004, students participating in the snack program had significantly higher intake of , folate, dietary fibre, vitamin C, calcium and iron • In 2007, students participating in the snack program had significantly higher intake of milk and alternatives, "other" foods, vitamin A, calcium and vitamin D	• Potential for recall bias
Wadsworth et al. (2012)	Objective: Identify and describe the proportion of participants whose reported intakes met: (i) the Dietary Reference Intake (DRI) values for nutrients important to growth and development; and (ii) minimum food group serving recommendations in CFG to Healthy Eating (CFGHE)	• n = 1469 • 108 schools randomly selected • Food Behaviour Questionnaire (FBQ) • Potential for underreporting and recall bias in dietary recall • Only weekday intakes collected, potential omission of differences in diet on	• Boys had significantly higher reported intake of energy and nutrients compared to girls in both grade 7 and 11 • Boys in both grades had significantly higher reported median intakes of food groups except for	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	Exposure: Grade 7 vs. Grade 11 Outcome: Proportion of students whose reported dietary intakes met guidelines	weekends (e.g. higher consumption of SSBs or higher-energy low-nutrient foods)	• Boys in grade 11 had significantly greater reported servings consumed of foods from outside the CFGHE • Over 50% of girls in grade 7 reported intakes that did not meet the minimum recommendations by CFGHE for grain products, , and milk and alternatives • Over 2/3 of girls in grade 11 reported intakes that did not meet the minimum recommendations by CFGHE for any of the four main food groups • Over 2/3 of boys in grade 7 and 11 reported intakes that did not meet recommendations for or grain products • About 2/3 of boys in grade 11 reported that intakes that did not meet	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			recommendations for meat and alternatives • Overall, more than 80% of boys and girls did not meet CFGHE recommendations for FV servings • Approximately 26% of energy intake came from food and beverage outside of the four major food groups • Approximately 7-8% of energy intake came from SSBs • Grade 7 students reported significantly more consumption of pop, salty snacks, french fries and other fried potatoes	
Taylor et al. (2012)	Objective: To assess the nutritional quality of lunchtime food consumption among elementary-school children in Prince Edward Island according to the source of food consumed (home vs. school)	• Cross-sectional • n = 1980 • In-class cross-sectional survey to collect data • Foods and beverages consumed were coded using 2007	• Median calcium, magnesium, zinc, vitamin A, D, C, B6 and folate intake at lunchtime fell below 1/3 of the Recommended Daily Allowance	• Data only for one meal out of the day, may not be accurate of children's total daily intake of nutrients

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	Exposure: Food sourced from home vs. school Outcomes: Micronutrient and macronutrient intakes	Canadian Nutrient File • Median nutrient intakes compared to 1/3 of the Estimated Average Requirement (EAR) or Adequate Intake (AI) to assess dietary quality • Wilcoxon signed rank test to compare nutrient intake differences in food from home vs. food purchased at school • Chi-square test to test association between sex and dietary adequacy at lunchtime	• Median K intakes fell below the recommended AI levels • Median Na intakes were above the recommended AI levels • Median fibre intakes were below 1/3 of recommended AI levels • More than half of children did not meet the recommended intakes of magnesium, zinc, vitamins A, C, B6, B12 and folate at lunchtime • There was a gender difference for adequate intake of some nutrients • The median intake of all micro and macronutrients were higher in lunches brought from home compared to those bought at school	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
Vine & Elliott (2014)	Objective: To explore local-level factors shaping the implementation of a school nutrition policy	• Qualitative • n = 8 (community-level) • n = 14 (school-level) • Semi-structured interviews with community and school-level participants • ANGELO framework used as a coding template for interviews	• Cost of healthy food was a concern, especially in schools with a larger proportion of low-income students • Revenue loss in cafeterias from higher price of healthy food and less sales • Having fast-food restaurants in close proximity to the school is a barrier to policy implementation • Some respondents felt the nutrition policies were too restrictive • Stigma surrounding students who can't afford to purchase food at school or don't have enough food to eat	
Rossiter et al. (2012)	Objective: To evaluate the eating behaviours of students from low income communities in grade six, and three years	• Longitudinal • Better Beginnings, Better Futures (longitudinal	• In grade 6, 5% of males and 7% of females met the minimum serving recommendations for	• Dietary information collected from a survey with 25 items, not

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	later when they were in grade nine, relative to the 2007 CFG Exposure: Grade 6 vs. Grade 9 Outcome: Servings of food groups consumed according to 2007 CFG	primary prevention initiative) • n = 647 (Grade 6) • n = 520 (Grade 9) • Self-administered questionnaire in classrooms for dietary recall • McNemar analysis to assess differences in compliance with CFG recommendations between grade 6 and grade 9 • Chi-square test to assess differences in compliance with CFG recommendations between males and females	all food groups from CFG • In grade 6, 15% of males and 21% of females met the minimum recommended servings of ; 9% of males and 11% of females met the minimum recommended servings of grain products • In grade 6, the mean number of fruits and vegetable servings was significantly lower for males (3.8) compared to females (4.1) • In grade 9, 0.4% of males and 2% of females met the minimum serving recommendations for all food groups from CFG • In grade 9, 4% of males and 7% of females met the minimum	validated, may have missed some items

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			recommended servings of ; 2% of males and 5% of females met the minimum recommended servings of grain products • Among males, there was a statistically significant decline in the mean number of servings of from grade 6 to grade 9 • Among females, there was a statistically significant decline in the mean number of servings of grain products and milk and alternatives from grade 6 to grade 9	
Florence et al. (2008)	Objective: Investigate the association between diet quality and academic performance in a sample of 5200 grade 5 students in the province of Nova Scotia, Canada	• CLASS study • n = 4589 • Poor academic performance defined as failing both reading and writing assessments as part of the standardized Elementary Literacy	• Students with higher DQI-I or HEI scores were significantly less likely to fail the literacy assessment • Boys were twice as likely to fail the literacy assessment compared to girls	• Cannot determine direction of association from cross-sectional survey

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	Exposure: Indicators of diet quality (DQI-I, HEI) Outcome: Poor academic performance (dichotomous)	Assessment in Nova Scotia • Multilevel logistic regression (to examine association between diet quality and academic performance)	• Students with parents who have higher income and greater educational attainment had significantly lower odds of poor academic performance • Children living with a single or widowed parent had significantly higher odds of poor academic performance • Children living in urban areas had significantly lower odds of poor academic performance compared to those in rural areas	
Colley et al. (2019)	Objectives: (1) synthesize academic research on Canadian school nutrition programs by identifying existing interventions and their impacts on children's nutrition; (2) identify dietary behaviour changes regarding	• Systematic review • Canada • Search conducted in March 2017 • Search limited to studies published after 1990	• 11 articles included • Most interventions were multi-component and included an education component	• Looked at elementary schools only

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	food preferences, willingness to try new foods, self-efficacy, attitudes and perceptions of healthy eating; and (3) assess direct measurements of food intake	• Search strategy contained four main concepts: "geographical location", "program type", "setting", and "initiative"	• All interventions included food provision • Children's nutritional knowledge increased, knowledge positively associated with interventions that were a year or longer in duration • Children's dietary behaviours improved → preferences, attitudes and willingness for nutrient-dense foods increased • More than half of studies reported greater consumption of F/V • Inconsistent delivery of interventions, lack of parental involvement, limited financial and human support identified as barriers to program implementation	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
Hiza et al. (2013)	Objective: To use the HEI-2005 to describe the diet quality of Americans with various sociodemographic characteristics Independent variables: age, sex, race, family income, education Dependent variable: Percentage of maximum HEI-2005 score	• Cross-sectional • US • 2003-2004 National Health and Nutrition Examination Survey • 24-hour dietary recall • Taylor series linearization method (to estimate variance of ratio) • Between-group differences were tested for statistical significance	• Children aged 2 to 5 had higher HEI scores than children aged 6 to 11 or 12 to 17 • Adults aged 55 to 64 had higher total HEI scores than all younger adults • Individuals aged 75 and older had the highest total HEI scores • Adult women had higher scores than adult men • Whites had higher scores than Hispanics, who had higher scores than Blacks • Adults with the highest income had higher HEI scores than those with the lowest income • Children in the highest income group had higher scores than children in the second-lowest income group	• Looked at how HEI scores vary by sociodemographic characteristics, rather than using a regression model to controls for each factor → cannot infer any effects

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			• Adults with the highest education level had higher total HEI scores than most of those with lower education levels	
Bennett et al. (2018)	Objective: To characterise sex differences in macronutrient intakes and adherence to dietary recommendations in the UK Biobank population Independent variable: Sex Dependent variable: Macronutrient intakes and adherence to dietary recommendations	• Cross-sectional • UK Biobank (large prospective cohort study in UK) • 24-hour dietary recall • General linear models (to obtain between-group differences) • Logistic regression analyses (to compute ORs) • Subgroup analyses by age, SES, and BMI	• Men had greater energy and macronutrient intake (unstandardized) • When standardized by body weight, women had higher energy intake than men • Macronutrient intake as a percentage of total energy intake was greater for women than men for all macronutrients • Differences in energy intake between men and women decreased with age • Sex differences in dietary intakes did not differ much by SES	• Did not examine sex differences in food group intake, micronutrients, or overall diet quality

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			• Obese individuals had smaller sex differences in intakes than individuals with a healthy BMI • Sex differences in non-adherence to dietary guidelines differed by the macronutrient • After standardizing for body weight, sex differences for some intakes increased with age and SES	
De Hoog et al. (2014)	Objective: To examine racial/ethnic differences in diet in young children Independent variables: Race, maternal BMI, maternal immigrant status, maternal perception of child's weight Dependent variable: Diet quality and types of food consumed	• Prospective cohort study • US • Project Viva • Semi-quantitative FFQ completed by mothers for their child's food consumption • Used Harvard nutrient composition database to calculate nutrients • Chi-square tests, ANOVA, and Kruskal-Wallis to	• Black and Hispanic children had higher consumption of SSBs and fast food compared to whites • Black and Hispanic children had lower consumption of skim/1% milk and snack foods compared to whites • Black children had lower intake of saturated fat and higher intake of	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
		examine differences between ethnic groups (unadjusted) • Negative binomial regression to examine ethnic differences in foods and food group consumption • Linear regression to examine ethnic differences in nutrient intake	polyunsaturated fat compared to whites • Children born outside the US had a more healthful nutrient intake • Children of mothers born in a foreign country had lower percentage of energy intake from trans fat and a higher intake of fibre	
Wang & Chen (2011)	Objective: Examine how much of racial/ethnic differences in diet, exercise, and weight status could be explained by nutrition- and health-related psychosocial factors (NHRPF) and SES Independent variables: NHRPF and SES Dependent variables: HEI, high diet quality (HEI, categorical: above or below the 80th percentile), exercise participation (yes or no), BMI, overweight/obesity (BMI above or below 25), obesity (BMI above 30)	• Cross-sectional • US • n = 4,356 • 1994-96 Continuing Survey if Food Intakes by Individuals (CSFII) • Diet and Health Knowledge Survey (DHKS) • Sample included individuals aged 20-65 • Calculated Cronbach's alpha coefficient to assess internal consistency reliability of NHRPF measures	• Higher SES was associated with better NHRPF and HEI scores • NHRPF factors didn't explain much of the racial differences in diet, exercise, and weight status • SES may explain some of the racial differences in diet, exercise, and weight status	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
		• ANOVA and chi-square tests to test differences in NHRPF and HEI by sociodemographic characteristics • Multivariable linear and logistic regressions to examine how much NHRPF and SES explain racial differences in diet, exercise, and weight status		
Tarraf et al. (2017)	Objective: To shed light on a number of issues that affect the food security situation of Canadian immigrants	• Literature review • Gathered information from peer-reviewed research and government publications	• Food insecurity higher among recent immigrants compared to long-term immigrants and non-immigrants • Immigrants were more likely to have deficient calcium, iron and protein intakes • Studies showed overall that immigrants' traditional diet was healthier than a	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			standard Canadian diet	
Wilcox et al. (2018)	Objective: To examine the diet quality and dietary intake among residents of disadvantaged neighborhoods in the Southeast United States and to examine associations between dietary and socioeconomic factors Independent variables: education, income, food security, food desert Dependent variables: Proportion of participants who met dietary guidelines, diet quality (HEI-2010)	• Cross-sectional • US • n = 465 • Participants were recruited for this study • Logistic regression models to test (1) whether SES factors were associated with proportion of the sample meeting each of the 12 dietary guidelines; and (2) whether SES factors were associated with diet quality (HEI)	• Most of the sample did not meet dietary guidelines for trans fat, fibre, fruits, vegetables, , whole grains, dairy, and sodium • More than half of the sample did not meet dietary guidelines for total fat, saturated fat, carbohydrates, and sweetened beverages • Participants who did not complete high school had lower diet quality than those who completed some post-secondary • Participants who were food secure had significantly better diet quality than those who were food insecure	
French et al. (2010)	Objective: To explore income-related differences in household level food purchases that might be	• Group-randomized trial • US • n = 90	• Households with higher income spent more on food per	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	influenced by access to food sources and by food costs Independent variable: household income Dependent variables: spending per person overall and on foods at home and eating out	• Data collected as part of a community-based household weight gain prevention intervention • Primary household shopper collected food receipts for four weeks • Receipt data used to calculate summary variables • Amounts spent on food for home was divided by the number of household members • Household income divided into tertiles • Jonckheere-Terpstra test to test for trends across household income	person, both at home and eating out • High income households spent more per person at premium chain grocery stores, wholesale stores and specialty food stores compared to low income households • High income households spent significantly more per person on FV at home purchases, snacks and sweets at home, and eating out, entrees, and sides • Overall, higher income households spent more on both healthy and unhealthy foods	
Bolton et al. (2016)	Objective: To examine the relationship between diet quality and health-related quality of life (HRQoL) in rural and urban Australian adolescents, and gender differences	• Cross-sectional • Australia • n = 1,144 • Surveys were administered to participants to collect information	• Rural students had higher HRQoL and healthy diet scores, and lower unhealthy diet scores • Students living in rural areas consumed	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	Independent variables: geographic area, gender Dependent variables: HRQoL, healthy diet score, unhealthy diet score	on dietary-related behaviours, HRQoL, and sociodemographic variables • Healthy and unhealthy scores calculated based on healthy and unhealthy dietary practices • Chi-square test and t-test to test associations • Linear regression to measure association between HRQoL and healthy/unhealthy scores • Stratification by geographic area (urban or rural) • Clustering by school was adjusted for in models	less soft drinks, less fast food, and a higher proportion ate breakfast compared to urban students • Overall, males had higher unhealthy diet scores and also higher HRQoL • Higher healthy diet score was significantly associated with an increase in HRQoL • Higher unhealthy diet score was significantly associated with a decrease in HRQoL	
Chamberland et al. (2017)	Objectives: (1) assess the impact of a web-based version of Team Nutriathlon on the consumption of vegetables and fruit (V/F) and milk and alternatives (M/A); (2) identify facilitators and/or	• Randomized, clustered intervention • Canada • n = 282 • Grade 7 and 8 students	• The intervention group had higher consumption of V/F and M/A at weeks three and five, and at the end of the intervention	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	barriers influencing its success among high school students Independent variable: intervention Dependent variables: V/F consumption, M/A consumption	• Classes were randomized to intervention or control • Intervention participants recorded their V/F and M/A consumption twice a day for six weeks • Repeated measures linear fixed effects models to assess impact of the intervention on consumption • Tukey-Kramer's post hoc test to determine between-group differences at each data collection time point	• There was no difference in consumption ten weeks after the intervention • No sex differences in consumption were reported • Students identified teachers and parents as important facilitators of the success of the intervention • Attendance at school and technical issues with the computer program were identified as barriers to success	
Darmon and Drewnowski (2008)	Objective: To explore the possible causal relationships between SES and diet quality	• Review of the Literature	• Higher SES was associated with consumption of whole grains, lower SES was associated with consumption of refined grains • Higher SES groups consumed more and a greater variety of	

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			• A meta-analysis found that FV consumption was associated with higher education level • Higher SES groups preferred skim or low-fat milk • Consumption of lean meats was associated with high SES • Association between SES and micronutrient intake was insignificant or not consistent across studies • Association between SES and total energy intake was also inconsistent across studies	
Patrick and Nicklas (2005)	Objective: To highlight some of the family and social factors that influence children's eating patterns and diet quality	• Review of the literature	• Parents with higher levels of education make healthier food choices • Children with parents of higher education levels consumed more servings of	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			vegetables and had a higher likelihood of consuming the recommended servings of dairy products • Higher education level among mothers was associated with less added sugar intake among preschoolers, and a lower percentage of energy from fat among adolescents • Households with parents with less than high school education had more exclusive use of whole milk, while reduced-fat milk use was greater among households with parents with a college education • Individuals of lower SES tend to consume fewer and have lower intake of many micronutrients	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
			• Individuals in families of higher SES were more likely to consume the recommended daily servings of dairy products	
Cullen et al. (2008)	Objective: To assess the effect of the Texas Public School Nutrition Policy on middle school student lunchtime food consumption	• Longitudinal • United States • n = 2671 (year 1), 5273 (year 2), 10234 (year 3) • Analysis of variance and covariance • Nonparametric tests	• After implementation of the policy, consumption of vegetables, milk, protein, fibre, vitamin A, vitamin C, calcium, and sodium increased at lunchtime • Consumption of sweetened beverages, snack chips, and percentage of energy from fat decreased at lunchtime • Fewer sweetened beverages and chips were purchased, but more were brought from home	
Jaime et al. (2009)	Objective: To review the effectiveness of school food and nutrition policies world	• Systematic review	• Three out of four studies found that schools with	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
	wide in improving the school food environment, student's dietary intake, and decreasing overweight and obesity	• 18 included studies • Studies from USA and Europe • Conducted a search of studies looking at food/nutrition policy • Included nutrition guidelines, regulation of food and beverage availability, and price intervention	nutrition interventions had a decrease in total and saturated fat on menus • All studies showed an increase in FV availability as a result of guidelines • All guidelines targeting fat intake had significant decreases in total and saturated fat intakes	
Silveira et al. (2011)	Objective: To evaluate the effectiveness of school-based nutrition education in reducing or preventing overweight and obesity in children and adolescents	• Systematic review • 24 articles included • Included studies of RCTs that included children age 5-18 and were school-based	• Most studies showed that school-based nutrition interventions decrease overweight and obesity, and increase consumption of FV	
Cullen et al. (2009)	Objective: To assess the statewide impact of the 2004 Texas Public School Nutrition Policy on foods and beverages served or sold in schools	• Longitudinal • United States • n = 47 schools • Collected information on foods sold in schools before and after policy implementation	• The number of high-fat vegetable items sold in cafeterias significantly decreased after policy implementation • Sales of large bags of chips significantly	

Author	Objective/Exposure/Outcome	Methods	Results	Comments
		• Wilcoxon signed-rank test • Chi-square test of independence	decreased post-policy, while sales of baked chips significantly increased post-policy	
Mendoza et al. (2010)	Objective: To assess the impact of Texas Public School Nutrition Policy on children's energy density by using a pre- and post-policy evaluation	• Longitudinal • United States • n = 2616 (year 1), 10,172 (year 2) • Analysis of variance/covariance • Nonparametric tests • Lunch food records collected at baseline and after policy implementation	• Energy density (foods only) and energy density (food and beverage) both significantly decreased after policy implementation	
Huot et al. (2004)	Objective: To determine the correlates of a high-fat diet in urban, suburban, and rural areas of Quebec, Canada	• Cross-sectional • Quebec, Canada • N = 5214 • Respondents completed a food-frequency questionnaire • Logistic regression	• Having a lower education level, being a smoker, and living in a rural environment were associated with poor diet quality	

Curriculum Vitae

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