The association of cost and diet quality of children in Canada

By

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ABSTRACT

Healthy diets help reduce risk for chronic disease (obesity, type 2 diabetes, cardiovascular disease and several cancers). High consumption of non-nutrient dense foods (e.g., sugar-sweetened foods, processed meats, and high fat foods) and low consumption of healthier foods (e.g., vegetables, fruit, and whole grains) may contribute to increasing chronic disease rates amongst Canadians. One potential reason for unhealthy dietary choice could be a price disadvantage of healthy foods.

The purposes of this thesis are: (1) to assess the daily costs of diets consumed by grade 5 students in Alberta, Canada by using grocery store prices; (2) to examine the association between the daily cost of diets and diet quality among the same population when diet quality is assessed using Diet Quality Index (DQI) and four food groups in Canada's Food Guide (CFG). These objectives were addressed using population based data collected in 2014 with the Raising Healthy Eating and Active Living Kids in Alberta surveys.

The results revealed the average daily dietary cost of a child per 2000kcal and the average daily dietary cost of a child for each of the food categories in the Food Frequency Questionnaire (FFQ). The average daily cost of children's diets was estimated to be CAD 13.19. This was CAD 12.12, 13.27 and 13.51 for students with poor, moderate and high diet quality respectively. The analysis further showed that there was significant association of increasing cost of diet with DQI. For every one-unit increase in DQI, the cost of the diet increased by seven cents. Based on CFG's recommendations, there was no significant association of cost of diet with grain products. Fruits and vegetables, milk and alternatives and meat and alternatives showed significant positive association with the cost of diet. The results suggest that reducing price of healthier diets

should not be the only priority as a strategy to encourage healthy eating. Public health policies that reduce the cost of healthful diets, as well as education of shopping and food preparation methods that may help reduce dietary costs should be enforced to reduce the perception that consumption of a healthful diet increases daily costs of diets.

PREFACE

This Masters thesis is original work produced by Enid Kokushubila Bukambu. The two research papers which are included in this thesis received ethics approval from the University of Alberta Human Research Ethics Board, under the project name "An evaluation of New Provincial Programs to Promote Healthy Weights Among Children and Youth in Alberta" No. Pro00003799 which expires April 18, 2018.

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LIST OF ABBREVIATIONS

APPLE Schools	Alberta Project Promoting active Living and healthy Eating in Schools
CCHS	Canadian Community Health Survey
CFG	Canada's Food Guide
CNF	Canadian Nutrient File
CPI	Consumer Price Index
CRIO	Collaborative Research and Innovation Opportunities
DQI	Diet Quality Index
FDA	Foods and Drug Authority
FFQ	Food Frequency Questionnaire
GST	Goods and Service Tax
HEI-2010	Healthy Eating Index-2010
MAR	Mean Adequacy Ratio
REAL Kids Alberta	Raising healthy Eating and Active Living Kids in Alberta
SES	Socio-Economic Status
USDA	United States Department of Agriculture
WHO	World Health Organization

CHAPTER 1: Introduction

1.1 Background

Since the late 1970s, the prevalence of overweight and obesity has been rising among children and adolescents in Canada (Roberts, Shields, de Groh, Aziz, & Gilbert, 2012). Excess weight in children has been linked to poor emotional health, diminished social well-being and lower health related quality of life (Roberts et al., 2012). Between 2009 and 2011, 19.8% of five to 17-year olds were classified as overweight and 11.7% as obese (Roberts et al., 2012). More specifically between the ages of five and 11, 19.5% of boys were obese and 6.3% of girls were obese (Roberts et al., 2012). The 2016 report from the Standing Senate Committee on Social Affairs, Science and Technology also indicated that 13% of children were obese and another 20% were overweight (Ogilvie, Standing Senate Committee on Social Affairs, Science and Technology, & Eggleton, 2016). When further broken down by sex, 15% of boys were obese and 11% of girls were obese (Ogilvie et al., 2016). In Alberta, the 2004 prevalence of overweight and obese children and youth was 14.3% and 7.5% respectively (Moffatt & Coupland, 2005); in 2014, the prevalence of overweight or obesity increased to 36.0% (Maximova et al., 2016). Public health professionals are concerned because children with obesity often continue to be obese even when they are adults (Roberts et al., 2012). Hence, if these trends continue, by 2040, up to 70% of adults aged 40 years will be either overweight or obese (Le Petit & Berthelot, 2006).

Already during childhood, children with obesity incur higher healthcare costs (Roberts et al., 2012), so when they become adults with obesity, they are likely to have more health problems such as bone and joint problems, obstructive sleep apnea, asthma attacks, non-alcoholic fatty liver disease, kidney problems, polycystic ovary syndrome, hypertension, type 2 diabetes, heart disease, gallbladder disease, stroke, and certain types of cancer, including breast and colon

cancer (Le Petit & Berthelot, 2006), cardiovascular diseases and psychosocial problems such as poor self-esteem and depression (Roberts et al., 2012).

Childhood obesity is associated with economic consequences that can be characterized by both direct and indirect costs (Dykman, 2016). The direct costs are mainly medical costs such as prescription drugs, emergency room costs, and outpatient and inpatient visits related costs while indirect costs include absenteeism and presenteeism due to increased morbidity (Dykman, 2016). The 2016 report from the Standing Senate Committee on Social Affairs, Science and Technology also indicated that the economic burden (direct and indirect health care costs) associated with obesity is estimated to be between $4.6 billion and $7.1 billion in Canada annually (Ogilvie et al., 2016).

Obesity, hypertension, heart disease, stroke, diabetes and cancer continue to increase globally which cost billions of dollars every year (Niebylski, Redburn, Duhaney, & Campbell, 2015). It is estimated that more than 60% of these diseases can cause a death, and it is estimated that 40% of these deaths are attributed to dietary factors such as lack of vegetables and fruit, excess intakes of sodium, sugar-sweetened beverages and foods, saturated fats and trans-fatty acids which are commonly added during food processing (Niebylski et al., 2015). The World Health Organization (WHO) recommends less intake of energy-dense foods and higher intakes of vegetables and fruit as a way of curbing the obesity epidemic but few people are meeting these recommendations (Andrieu, Darmon, & Drewnowski, 2006; Darmon & Drewnowski, 2015) . In Canada in 2004, 62% of girls and 68% of boys aged nine to 13 did not meet Canada's Food Guide minimum recommendation (at least six daily servings) of vegetables and fruit (Garriguet, 2007).

The established risk factors for obesity are physical inactivity, high level of screen time and consumption of energy dense foods (Obesity in canada – determinants and contributing factors.). Addressing these factors early in a person's life helps to reduce the likelihood of becoming overweight or obese in adolescence and adulthood. Since obesity is linked with chronic diseases and other health problems listed previously, promoting healthy eating and active living as a tool for chronic disease prevention are keys to maintaining health of Canadians (*31% of canadian kids are overweight or obese*2012; Ascentum, 2011; Dykman, 2016; Kingston, 2013; Moffatt & Coupland, 2005; Niebylski et al., 2015; Rao, Afshin, Singh, & Mozaffarian, 2013; Roberts et al., 2012).

There has been an increase in consumption of less healthy non-nutrient dense diets amongst Canadians (Rao et al., 2013; Roberts et al., 2012; Shields, 2006). High consumption of less healthy non-nutrient energy-dense foods (e.g., sugar-sweetened beverages and foods, processed meat, and high fat foods) and low consumption of healthful foods (e.g., vegetables, fruit, whole grains, nuts and seeds) may contribute to increasing chronic disease rates amongst Canadians (Rao et al., 2013; Shields, 2006). One reason for this trend can be a potential price disadvantage of healthy foods (Rao et al., 2013). This has created a debate as to whether healthier diets cost more than less healthy diets (Andrieu et al., 2006; Rao et al., 2013).

Some researchers believe that the fast food sector which is growing rapidly around the world is an important contributor of the decline in diet quality (Fried, 2005; Lobstein, Baur, & Uauy, 2004). For example, some beverages such as coke, which are among the less healthy options, are now sold in more than 200 countries (Popkin, 2006). North American food chains have grown so rapidly around the globe that even local restaurants have copied these chains and are serving the same dishes (Darmon & Drewnowski, 2015; Popkin, 2006). The increased habits of fast foods

consumption increase the risk of overweight and obesity (Powell, Auld, Chaloupka, O'Malley, & Johnston, 2007).

Foods prepared away from home encompassed 40% of spending among the US population in 1995 (French, 2003), which includes foods obtained from fast food establishments, schools, restaurants, other public places and vending machines (French, 2003). Such foods are usually ready-to-eat so the consumer has limited control over the portion size and nutritive value (French, 2003). It is documented that portion sizes for foods purchased in fast food places and restaurants have increased sharply since 1982 (Young & Nestle, 2002). Fast food restaurants market supersized sandwiches such as the Big Mac (216g; 570kcal) and supersized French fries (198g; 610kcal) (French, 2003), and prepackaged foods purchased in grocery and convenience stores are also being marketed in larger sizes (French, 2003). Candy bars and potato chips that used to be prepackaged in 1-oz servings are now marketed in 2 to 3oz single serving packages (Young & Nestle, 1995). Bagels and muffins that used to be 2 to 3 oz are now 4 to 7 oz (Young & Nestle, 1995).

Food choices may also be influenced by a wide variety of individual factors (French, 2003) including taste, convenience, perceived value (which includes price and portion size) and perceived nutritional quality of foods (French et al., 1999; Glanz, Basil, Maibach, Goldberg, & Snyder, 1998). Foods vary along each of these evaluative dimensions and individuals also vary in terms of their importance placed on each dimension (French et al., 1999; Glanz et al., 1998; Solheim & Lawless, 1996). For example, those with lower socioeconomic status may place preference on perceived value, whereas those concerned with their health and nutrition may place a greater importance on the nutritional quality of foods (Solheim & Lawless, 1996). In general, French (2003) suggested that people may have knowledge about healthy foods but still

choose foods that are tastier, cheaper and less nutritious (French, 2003). However, there are other factors that may affect healthy eating such as food accessibility depending on location (Heart and stroke foundation report asks: What's in store for canada's heart health?2009). Individuals living in remote communities may have difficulties accessing healthy foods even if they have the money and want to eat healthy (Heart and stroke foundation report asks: What's in store for canada's heart health?2009). Also, lack of knowledge about healthy eating, food eating habits and food cost variation depending on location (Heart and stroke foundation report asks: What's in store for canada's heart health?2009; Carlson & Frazão, 2014; Patricia L. Williams et al., 2012; Rao et al., 2013) are among other factors that may affect healthy eating.

While food choice is influenced by a great number of factors, still, it is believed that price of foods is an important predictor of food choice (Murakami, Sasaki, Takahashi, Uenishi, & Japan Dietetic Students' Study for Nutrition and Biomarkers Group, 2009). The question remains whether that is why many North Americans consume energy-dense foods. That is, are people consuming less healthy options because healthy options are costlier?

Several studies around the world have examined whether healthier foods cost more than less healthy foods. Findings from Spain (Schröder, Marrugat, & Covas, 2006), Netherlands (Waterlander et al., 2010), United Kingdom (Cade, Upmeier, Calvert, & Greenwood, 1999; Mooney, 1990) and France (Andrieu et al., 2006; Drewnowski, Darmon, & Briend, 2004; Maillot, Darmon, Darmon, Lafay, & Drewnowski, 2007) show that healthier diets cost more than less healthy diets (Bernstein, Bloom, Rosner, Franz, & Willett, 2010). Various studies from the U.S have investigated if less frequent consumption of healthier diet is attributed to cost of the food items (Aggarwal, Monsivais, Cook, & Drewnowski, 2011; Bernstein et al., 2010; Rehm, Drewnowski, & Monsivais, 2011). Although some reports from U.S suggest that energy-dense

rich foods such as snacks and sweets cost less than vegetables and fruit, other reports suggest that healthier options can still be obtained at different price levels (Bernstein et al., 2010). Other findings argue that the association of diet quality and cost of the diet is inconclusive because the metric used to measure food prices makes a difference in whether healthy foods appear more expensive than less-healthy foods (Carlson & Frazão, 2014; Davis & Carlson, 2015; Lipsky, 2009); and other findings argue that at any spending level, there are households that spend their money on healthy and unhealthy options (Carlson & Frazão, 2014). Hence, these authors conclude that what is important to know is that healthier options are affordable, but there is a need to come up with mechanisms to educate people on the healthier choice of foods as a desirable choice (Carlson & Frazão, 2014; Davis & Carlson, 2015). Also, a study done in Sweden in children aged 4, 8 and 11 years found that healthy eating is associated with a higher diet cost due to the price differences of healthy and unhealthy foods but argued that the association was weak (CAD 0.47/1000kcal in 2010 value) (Ryden & Hagfors, 2011). A US-based intervention was done in 2003 to reduce price of fresh fruit and vegetables among adolescents, a population that perceives fruit and vegetables as less attractive (Krebs-Smith et al., 1996). The price reduction was implemented in two secondary school cafeterias. Fresh fruits and baby carrots had 50% price reductions (Krebs-Smith et al., 1996). Results showed that sales of fresh fruit increased from 14 items per week to about 63 items per week, and sales of baby carrots increased from 37 packets per week to 77 packets per week (Krebs-Smith et al., 1996).

1.2 Rationale of the thesis

In Canada, few studies have assessed if healthier foods cost more than less healthy foods. Three Canadian studies assessed price differences between healthy and less healthy foods and found that healthy foods cost more than less healthy foods (Heart and stroke foundation report asks:

What's in store for canada's heart health?2009; Patricia L. Williams et al., 2012; Rao et al., 2013). One of these studies found that for a family of four in the year 2008, healthy foods on average cost about CAD 139 per week more than less healthy foods (Heart and stroke foundation report asks: What's in store for canada's heart health?2009). In this study, a list of foods for a family of four per week was created based on Canada's National Nutritious Food Basket. It is however not enough to make such conclusion because it compared healthy and less healthy versions of the same foods and prices of food products rather than prices of the usual diet. Moreover, these studies assessed food expenditure at household level rather than expenditures for individual diets (Heart and stroke foundation report asks: What's in store for canada's heart health?2009; Patricia L. Williams et al., 2012).

The aim of this thesis was to assess the association between diet quality and cost of the diet in a sample of grade 5 students from Alberta, Canada. In this study, the costs of the actual diets consumed were used. While Alberta is promoting healthy eating and active living in children through various projects such as APPLE Schools (Alberta Project Promoting active Living and healthy Eating) (Fung et al., 2011), it is also essential to understand why children eat less healthier diets. This study will provide an understanding of the relationship between cost and the quality of the usual diet. The results are expected to contribute to forming appropriate dietary strategies by public health policy makers to promote healthy eating in children. It is important for public health policy makers to understand the real cause of unhealthy eating to be able to formulate suitable policies that encourage healthy eating.

1.3 Overall study objectives

To examine the association between diet quality and cost of the diets among grade 5 students in Alberta, Canada.

1.3.1 Specific objectives

1. To determine the daily costs of diets consumed by grade 5 students in Alberta, Canada by using grocery store prices.
2. To examine the association between the daily cost of diets and diet quality among grade 5 students in Alberta when diet quality is assessed using Diet Quality Index-International (DQI) and the four food groups from Canada's Food Guide (CFG).

1.4 The structure of this paper-based thesis

This first chapter provides the general background and objectives of the thesis. The second chapter provides the daily costs of diets consumed by grade 5 students in Alberta, Canada by using grocery store prices. The third chapter examined the association between the daily cost of diets and diet quality among the same population when diet quality is assessed using DQI and the four food groups in CFG. The fourth chapter discusses these findings and their implications for public health policy.

1.5 My contributions

This is a research embedded in ROI4Kids (Return On Investment for Kids Health) and the data used was accessed from REAL Kids Alberta (Raising healthy Eating and Active Living kids in Alberta) project. The project has been collecting data in Grade 5 classrooms across the province to track provincial trends. Data collected include dietary habits and nutrient intake using Harvard Food Frequency Questionnaire for Children and Youth (FFQ), measurement of height and weight to determine the prevalence of overweight and obesity from calculation of Body Mass Index. Parents or guardians of participating students complete a self-administered survey about their home environment (education, income and food security information). My thesis builds on

this earlier work and I collected the costs of food items in the FFQ, conducted all data analyses, and I wrote the chapters and the literature review.

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CHAPTER 2: The daily costs of diets consumed by grade 5 students in Alberta, by using grocery store price

2.1 Introduction

Vegetables and fruit, considered a very important part of a healthy diet are consumed infrequently and in small portions among the Canadians compared to fats, sweets and grains (Chu, Farmer, Fung, Kuhle, & Veugelers, 2013). In Canada, most children do not meet the required servings of vegetables and fruit (Chu et al., 2013). Findings from 2004 Canadian Community Health Survey showed that 62% to 68% of Canadian children aged nine to 13 do not meet the recommended daily servings (6 servings) of vegetables and fruit (Chu et al., 2013). In Europe and United States, the consumption of vegetables and fruits is much less than the recommended intake (Darmon & Drewnowski, 2015). However, there is lacking evidence as to why children under consume vegetables and fruit and other healthy food items. Such diet behaviour may continue when the children become adults, showing that there is a need to understand factors related to dietary behaviours when they are children (Chu et al., 2013).

Ancel Keys, an American psychologist reported that food intake has a great role in determining people's health status. He investigated the role of bad cholesterol on atherosclerosis and other cardiovascular diseases which paved a way to a huge field of research verifying what philosophers have always suspected (Bonaccio, Iacoviello, de Gaetano, & Moli-Sani Investigators, 2012). He believed that human beings are what they eat, and their health is linked to what they have for breakfast, lunch and dinner every single day (Bonaccio et al., 2012).

More studies were done to research the relationship between eating habits and health (Trichopoulou, Costacou, Bamia, & Trichopoulos, 2003). These observations established an impressive relationship between a standardized score to set the adherence to the traditional

Mediterranean diet and the reduction of cardiovascular disease risk. The latter was accompanied by a comparable reduction of both cancer and total mortality (Trichopoulou et al., 2003).

There are several reasons as to why people opt for less healthy diets. Taste, cost and convenience are believed to be major determinants of food choice (Darmon & Drewnowski, 2015). The availability and cultural acceptability also pose obstacles to promote healthy eating (Rao et al., 2013). However, cost is undoubtedly believed to be an important determinant of food choice, an assumption which is justified as to why many Canadians are overweight (Kentaro Murakami et al., 2008; Rao et al., 2013). Various studies have studied the relationship between diet quality and cost of diet. They have used various methods to cost out food products in relation to diet quality (Aggarwal et al., 2011; Andrieu et al., 2006; Cade et al., 1999; Drewnowski, Monsivais, Maillot, & Darmon, 2007; Kentaro Murakami et al., 2008; Monsivais, Perrigue, Adams, & Drewnowski, 2013; Murakami et al., 2009; Raynor, Kilanowski, Esterlis, & Epstein, 2002; Ryden & Hagfors, 2011; Schroder et al., 2016; Stender et al., 1993). These studies have collected dietary costs either from key supermarkets by using food intake information from dietary assessment methods (such as 24-hour recall and Food Frequency Questionnaire) (Aggarwal et al., 2011; Cade et al., 1999; Monsivais et al., 2013; Raynor et al., 2002), from food price databases or dietary surveys (Andrieu et al., 2006; Mitchell et al., 2000; Murakami et al., 2009; Schroder et al., 2016), from retail stores by using 4-day dietary records (Kentaro Murakami et al., 2008; Ryden & Hagfors, 2011; Timmins et al., 2013) or from estimated household food expenditures from recall or actual food expenditure reports (Stender et al., 1993).

The dietary assessment methods where an average food price is assigned to the foods as reported consumed by individuals and food price databases are commonly used in comparing diet cost and diet quality (Timmins et al., 2013). These methods are used because they have an advantage

over household expenditure measures in assessing individual expenditure (Timmins et al., 2013). Little is known about the reliability of food price databases as they may not reflect individuals' true experiences of their food purchases (Timmins et al., 2013). Monsivais et al., (2013) did not recommend the use of food price databases because they may underestimate the true differences in purchasing power across income groups.

Two studies have measured diet cost at an individual level, one in children and one in adult population. In U.S, Monsivais et al., (2013) compared three different methods of estimating individual level diet costs of adults by using a) 4-day diet diaries and individual food expenditures, b) diet diaries and supermarket prices and c) FFQ data and supermarket prices, a commonly used method (Monsivais et al., 2013). The authors concluded that there is no gold standard for assigning monetary costs to diets. It is therefore important to ensure that the methods used to assign prices to dietary assessment instruments support the measures of expenditure (Kentaro Murakami et al., 2008; Monsivais et al., 2013; Timmins et al., 2013). Ryden et al., (2011) estimated diet cost in children in Sweden (Ryden & Hagfors, 2011) by using 4-day food diary and consumer food prices collected by Statistics Sweden and from two online stores.

To date, there are no Canadian studies that have estimated daily dietary cost at individual level particularly in children. Also, there are no Canadian studies that have used FFQ to assess daily dietary cost differences of healthier vs less healthy overall dietary patterns containing very different foods (Rao et al., 2013). The aim of this study is to determine the daily costs of diets consumed by grade 5 students in Alberta, measured by FFQs using grocery store price.

2.2 Study Methods

2.2.1 Participants and recruitment

This study was done using data collected for the **R**aising healthy **E**ating and **A**ctive **L**iving kids in Alberta (REAL Kids) project. This project was a large population-based survey that was conducted between March 2014 and June 2014 among grade 5 students (10 or 11 years of age) and their parents in Alberta. A random sampling strategy was used to select Alberta schools with enrolled grade 5 students. All schools in Alberta were categorized into metropolitan, city or rural-town regions and were randomly selected in each category to ensure equal representation. For the 2014 survey, 143 schools were invited to participate. A total of 4,992 home survey and parental consent forms were sent home with students. Out of these, 3,284 home surveys were returned, and 2,958 students were permitted by their parents to participate in the student survey. A total of 2,866 student surveys were completed and 10 students declined to participate. The students were surveyed on different topics such as dietary intake, meeting food groups as per Canada's Food Guide (Government of Canada, 2007b), information on physical activity and screen-time, height, weight and arm span measurements. Parents also provided information on parental support for health-related policy in schools, socioeconomic background, and home and community environment. All survey instruments can be found on the REAL Kids Alberta project website: http://www.realkidsalberta.ca. All survey procedures were approved by the University of Alberta Health Research Ethics Board. The participation rate was 57.4% (parents' consent, students' consent, surveys returned by parents and students' completed surveys).

2.2.2 Measures of dietary intake

Dietary intake was assessed through the completed Harvard Youth/Adolescent Food Frequency Questionnaire (FFQ) that includes 147 food items distributed into seven categories (beverages,

dairy products, main dishes, miscellaneous foods, breads and cereals, fruit and vegetables and snack and desserts). Children were asked to indicate their usual intake of each food using five frequency options ranging from "never/less than one per month" to "five or more times per week" or "one or more times per day." Average portion sizes consumed by a 10 to 11-year-old child and daily dietary intake were calculated according to data and nutrient information from the 2007 Canadian Nutrient File database (Government of Canada, 2007a). In total, 2,851 children completed the FFQ survey, and among these, 120 observations of daily energy intake were either below 500kcal/d or above 5000kcal/d and defined as outliers (Chu et al., 2013). They were excluded from analysis, leaving a final sample of 2,731 children.

2.2.3 Retail food price determination

To calculate the costs of the diet for each student, regular retail prices were collected for each of the 147 food items included in the food survey from four common grocery retailers in Alberta (Superstore, Wal-Mart, Sobeys and Save-On-Foods). The costs were estimated based on the assumption that all foods were purchased from a grocery store. For those foods whose prices were not available online, their prices were collected from the stores in the city of Edmonton by visiting them and checking the price labels. For those foods whose online prices were different from the stores, the stores prices were used. All prices were collected in December 2016 and the price level reflects that timing.

For the food items where both brand name and generic options were available, prices for both types of items were collected and then the average was used as the final price. For the foods where a store had different brand names or different generic brands, the lowest cost brand name or generic brand option was chosen. Baked goods were costed using the prices of commercial baked rather than homemade baked prices. Main dishes such as tacos, burritos, lasagna, pizza,

chicken nuggets, fish stick, meat balls and eggrolls were priced based on frozen pre-prepared foods. For all sandwiches and burgers, it was assumed that white bread/buns were used. Package sizes chosen (e.g., 1L of juice) were first based on what is used in the Consumer Price Index (CPI) survey (Statistics Canada, 2017). If the package size was not available from the CPI, then the package sizes available from the Ontario Nutritious Food Basket (Ministry of Health Promotion, 2010) were used. If information was not available in either of these resources, then professional judgement was used.

Since for most foods, the FFQ does not include portion sizes, some assumptions were made about food portion sizes. When available, it was assumed that each time someone ate the specific food that the portion size was the same as provided in Canada's Food Guide; both Canada's Food Guide as well as the extended lists of foods belonging to Canada's Food Guide available from the Health Canada website were consulted (Government of Canada, 2007b). If the food did not belong to Canada's Food Guide, standard portion sizes from the Canada Nutrient File (CNF) were used. If the food was not available from the CNF or the portion size was unclear, portion sizes listed on the Nutrition Facts panel were used. Sandwich fillings were assumed to match portion sizes from Canada's Food Guide (Government of Canada, 2007b). If Canada's Food Guide did not provide a serving size for a specific sandwich filling (e.g. jam), portion sizes from the Canadian Nutrient File were used (Government of Canada, 2007a).

All cost calculations considered food refuse, which applies to foods such as vegetables, fruit, and meat. The Canada Nutrient File indicates portions that are ready to eat, therefore, for those foods that contain refuse during purchase, the portion sizes were recalculated to reflect the amount of food purchased (e.g. a raw banana has 36% refuse as indicated in the Canada Nutrient File while an eaten banana contains 118g. The portion of the refuse was calculated and added on to the

118g, resulting in total of 184.38g). Also, some foods such as soft drinks, unessential snacks and desserts and frozen pre-prepared main dishes had 5% GST added as per the GST/HST Memoranda Series Guidelines (eg., soda, popsicles, muffins, potato chips, chicken nuggets and hot dogs) (Government of Canada, 2016).

The price of a portion of each food in the FFQ was calculated by taking the price of the package multiplied by the food portion size and divided by the package size. The portion price was then multiplied by the amount of the specific food consumed to obtain the daily dietary cost for each food. The daily dietary costs were then energy-adjusted to 2000kcal in order to evaluate diet quality while controlling for diet quantity (Ryden & Hagfors, 2011), and also to minimize the influence of systematic under and over reporting (Murakami et al., 2009); a phenomenon that is well documented for FFQs (Willett, 2000).

The average daily cost of a child for each food category in the FFQ was calculated. For example, the daily cost of vegetables and fruits was calculated by adding together the daily cost of each food in the vegetable and fruit category for each child. This was then energy-adjusted to 2000kcal.

2.2.4 Statistical Analysis

All statistical analyses were performed using Stata IC version 14 (StataCorp, College Station, TX, USA). When comparing the groups, the independent sample *t* test, chi2 and ANOVA were used. *P* values below 0.05 were considered to be statistically significant and all costs are in CAD using 2016 values.

2.3 Results

From the surveyed children 52% were female, 31% resided in metropolitan areas, 51% in rural town areas and 18% in cities (Table 1-1). The average child's daily energy intake was 1,834kcal/d. Approximately 65% of the children had a normal body weight and 8% of them were obese. In total, 49% of parents had highest income of ≥ $100,001 and 37% of parents had attained a university or graduate degree. In total, 90% of the parents were food secure (did not worry that food would run out before getting money to buy more) and 94% of the parents were financially secure (the food bought lasted and there was money to buy more). The cost per 2000kcal ranged from $5.61 to $33.43 with a median of $13.00 and the interquartile range of $3.86 ($11.09 to $14.95).

The costs of food items in the stores are shown in the appendix. If a parent bought one portion of each food in the FFQ, the overall total cost was $77.00 for the 147 food items, which translates to an average of $0.62 per one portion of food. The average prices of one portion of food/beverage from each category in the FFQ were also estimated; ($0.27 for beverages, $0.65 for dairy products, $0.27 for breads and cereals, $0.54 for snack foods/desserts, $0.49 for vegetables and fruit, $1.26 for main dishes). Fruit punch, cottage cheese, couscous, snickers, tofu and shrimps showed to have highest prices in each FFQ category, respectively.

The daily costs of diets are shown in Table 1-2. The average daily cost of a child's diet per 2000kcal was estimated to be $ 13.19 and $12.02 for unstandardized daily cost. The average daily dietary cost per 2000kcal was $13.34 for girls and $13.02 for boys (P=0.006). The main dishes in the FFQ were responsible for the most average daily cost per 2000kcal ($6.76) followed by the dairy products ($2.62), vegetables and fruit ($1.91), snacks and desserts ($1.39) and breads and cereals ($0.51) (Figure 1).

2.4 Discussion

This study estimated portion size costs of 147 food items from a FFQ and used those costs to estimate the daily costs of diets consumed by 10 to 11-year-old children in Alberta. The overall findings show the average daily dietary cost per 2000kcal of a child is $13.19. This study also shows for the first time in Alberta the cost difference for individual food portions from different FFQ food categories. The average portion size costs of fruits and vegetables and snack foods/desserts which are considered healthier and less healthy food options, respectively, showed very little to no cost difference. Additionally, the average daily cost of vegetables and fruit per 2000kcal was $0.52 higher than less healthy/non-essential foods (e.g. snack foods/desserts, pop, iced tea and fruit punch). The results of this study suggest that the beliefs that healthier diets are costlier than unhealthy alternatives should be addressed so that the cost of a healthy diet is not seen as a barrier in the adoption of positive dietary changes (Raynor et al., 2002).

There are some reasons that help to explain why healthier diets are more expensive. One reason may be due to price differences among healthy and less healthy food products within food categories (Ryden & Hagfors, 2011). It is important to note that healthier options within a food category may not necessarily be more expensive. The average cost per serving size portion of vegetables and fruit category in the FFQ was slightly cheaper compared with snacks and desserts. In addition, within the vegetables and fruit category, some foods were about twice as expensive as the total average while others were about twice as cheap as the total average. Dairy products such as cottage cheese and instant breakfast drink, on the other hand, were about twice as expensive as the total average dairy category portion size price. This indicates that within some food categories, it is possible to choose healthy alternatives without increasing food costs, whereas in other food categories, food costs are likely to increase if healthier alternatives are chosen.

Healthier diets may also be more expensive due to the amount of intake within more expensive food categories (Ryden & Hagfors, 2011). The meats that were costed out in the main dishes category consisted of healthier options such as lean meat and low-fat products (Ministry of Health Promotion, 2010), also, other main dishes contained ready meals which explains the highest average portion size cost. Therefore, total food cost will increase if healthier food choices lead to higher intake from food categories in which average prices are high.

Because this is the first study in Canada to examine portion size costs and daily cost of diet in children, comparison of our Alberta results with other Canadian studies cannot be made. Nevertheless, the estimation of costs of diets using FFQ and food prices from grocery retailers is similar to other studies that have used same methods to estimate daily dietary costs for adults, a widely used approach internationally (Aggarwal et al., 2011; Cade et al., 1999; Monsivais et al., 2013). In adult population, a study done in US found that an average daily dietary cost ($/8.4MJ) was USD $9.61 for men and $10.48 for women in 2009 value (Aggarwal et al., 2011). A study in U.K found that the average daily dietary cost was £3.43 for women in 1995 value (Cade et al., 1999). Another US-based study found that an average daily cost per 2000kcal was USD $8.19 in 2006 value (Monsivais et al., 2013).

There are strengths to this study. It has compared healthy and less healthy versions of different foods and prices of individual servings, and provides food expenditure at individual level in 10 to 11-year-old children in Alberta and Canada as a whole. The daily dietary cost estimates and estimates of each food group in the FFQ will be a useful guide to Canadian dietitians for future referencing and decisions by public health policy makers. Also, knowing the daily cost of diet is critical as it helps to understand the purchase and consumption of diets in different food groups and groups of people (Monsivais et al., 2013).

There are also limitations to this study. This study provides an estimation of a daily cost per 2000kcal of a child in Alberta. It does not consider differences that may arise such as where the participants live and purchase food items and the extent they eat out at restaurants and takeaways. If these children eat out a lot, these daily costs would be underestimated. The diet costs were based on FFQ which is known to have some biases (Drewnowski, 2001); the participants may not be able to recall every food they consumed in the past one year (Drewnowski, 2001), details about specific brands of food and beverages consumed are lacking (Donna L Hollinger, 2015; Drewnowski, 2001) and the FFQ only covers 147 foods which does not cover all of the foods that an individual may eat (Drewnowski, 2001). All the prices were collected in December 2016 while the study was done in March to June 2014 which may have imposed the seasonal differences in the prices of fruits and vegetables. Moreover, with the food intake data being collected in 2014 may mean that prices of all the foods may have changed between 2014 and 2016.

The assumption that the diet costs were based on direct payment of foods only may have led to lower estimates because there are other indirect and intangible costs (Drummond, Sculpher, Stoddart, Torrance, & O'Brien, 2005). Time taken to prepare and shop for these foods has not been accounted for in this study. Also, the study did not account for spoilage and away-from-home consumption hence the costs for providing these services have been left out (Drummond et al., 2005; Monsivais et al., 2013). The use of regular prices also ignored the possibility that different participants may have incurred different costs for the same foods which can vary by retail outlet (Monsivais et al., 2013).

The generalizability of this study may be limited to Alberta only because the food costs were collected from grocery retailers that are largely available in Alberta. Additional studies that use

Consumer Price Index so that the costs may represent Canada would add valuable information to this study. Moreover, these findings suggest that cost should not be a significant barrier in adopting healthier options. Public health policies that reduce the cost of healthy diets at the same time educating people about shopping and preparation methods should be promoted to reduce the perception that consumption of a healthier diet increases daily food costs (Raynor et al., 2002).

Since this study has assessed the daily dietary costs in grade 5 children in Alberta, it is also useful to assess the association between the daily cost of diets and diet quality in the same population. The following chapter aims to assess the association of diet quality and cost of the diet.

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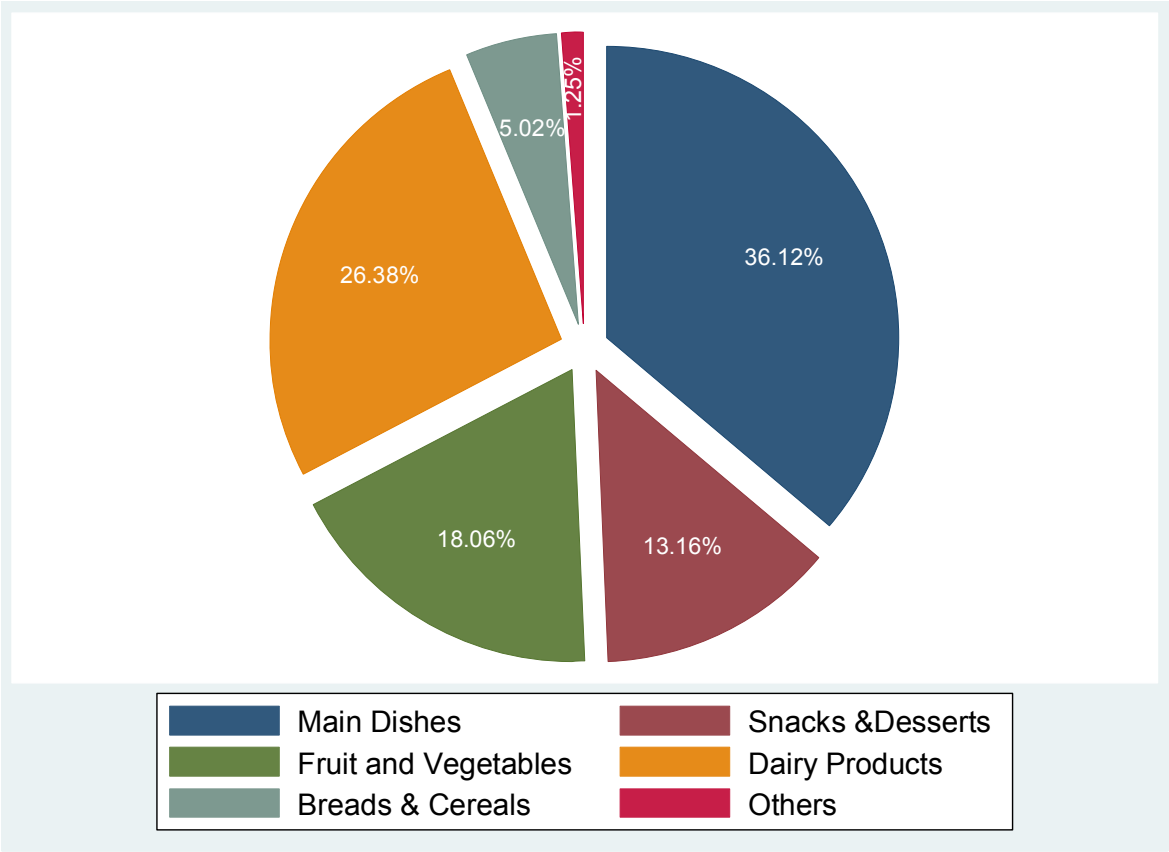
Table 2-1 Population characteristics

	Total (n)	Boys	Girls	p value
		n 1,273	n 1,458	
Daily cost (CAD/2000kcal), Mean (SD)	2,731	13.02 (3.0)	13.34 (3.1)	0.006
Parental Income n (%)				
≤ $ 50,000	326 (19%)	137 (17%)	189 (21%)	
$ 50,001-$75,000	237 (14%)	124 (15%)	113 (13%)	
$ 75,001-$ 100,000	302 (18%)	155 (19%)	147 (17%)	
≥ $ 100,001	838 (49%)	400 (49%)	438 (49%)	0.05
Parental Education n (%)				
Less than secondary	676 (26%)	293 (24%)	383 (28%)	
College degree	963 (37%)	457 (38%)	506 (37%)	
Graduate degree	949 (37%)	461 (38%)	488 (35%)	0.1
Food Security n (%)				
Worry that food would run out before getting money to buy more				
Yes	265 (10%)	107 (9%)	158 (12%)	
No	2,270 (90%)	1,086 (91%)	1,184 (88%)	0.021
The food bought did not last and no money to buy more				
Yes	159 (6%)	61 (5%)	98 (7%)	
No	2,364 (94%)	1,120 (95%)	1,244 (93%)	0.027
Urbanization status n (%)				
Metropolitan	839 (31%)	394 (31%)	445 (30%)	
Rural or town	1,387 (51%)	649 (51%)	738 (51%)	
City	505 (18%)	230 (18%)	275 (19%)	0.865
Bodyweight n (%)				
Normal	1,804 (65%)	966 (66%)	838 (65%)	
Overweight	806 (27%)	398 (26%)	408 (27%)	
Obese	222 (8%)	116 (9%)	106 (7%)	0.899

Table 2-2 Dietary expenditure characteristics

	Total (n)	Total Average Cost (SD)
Daily cost (CAD/2000kcal), Mean (SD)	2,731	13.19 (3.0)
Daily cost (CAD), Mean (SD)	2,731	12.02 (5.8)
Food groups in the FFQ (2000kcal)		
Unessential foods (snack foods/desserts, pop, iced tea and fruit punch), Mean (SD)	2,503	1.39 (0.7)
Vegetables and fruits, Mean (SD)	2,496	1.91 (1.1)
Breads and cereals, Mean (SD)	2,585	0.51 (0.3)
Dairy products, Mean (SD)	2,656	2.62 (1.7)
Main dishes, Mean (SD)	1,413	6.76 (2.8)

Figure 2-1: Percentage Costs by Food Category



CHAPTER 3: The Association of diet quality and the daily cost of the diets among grade 5 students in Alberta

3.1 Introduction

Price differences of healthier vs less healthy diets may be factors that limit people from adopting healthier diets, especially in low-income communities (Maillot et al., 2007). This has been shown

by studies in economics (Drewnowski & Darmon, 2005; Judy Putnam, Jane Allshouse, & Linda Kantor, 2002; Peter Basiotis, Mark Brown, S. R. Johnson, & Karen J. Morgan, 1983), marketing (Lennernäs et al., 1997), and consumer behaviour (Cabanac, 1995; French, 2003) literature. However, price differences may depend on how healthfulness is defined, ranging from definitions based on single nutrients (e.g., fat or sugar content) (Rao et al., 2013) to those based on food types or more complex diet patterns (Rao et al., 2013). The nature of the comparison could also affect the price difference, for example, a fast food meal versus a healthier home-cooked meal may reveal more pronounced differences than a comparison of low-fat versus high-fat cookie (Rao et al., 2013).

There are some studies that have evaluated whether healthier foods or diets cost more than less healthy options (Heart and stroke foundation report asks: What's in store for canada's heart health?2009; Aggarwal et al., 2011; Bernstein et al., 2010; Drewnowski & Eichelsdoerfer, 2009; Kentaro Murakami et al., 2008; Murakami et al., 2007; Murakami et al., 2009; Rao et al., 2013; Ryden & Hagfors, 2011). They have compared healthier and less healthier versions of the same food (Heart and stroke foundation report asks: What's in store for canada's heart health?2009), while other studies have assessed the price differences of healthier vs less healthy overall diet patterns, containing very different foods (Aggarwal et al., 2011; Bernstein et al., 2010; Caivano

& Semramis Martins lvares Domene, 2013; Rao et al., 2013; Ryden & Hagfors, 2011). These studies have defined a healthful diet in different ways when assessing the association of diet quality and cost of diet. Some have defined it in terms of adherence to a Mediterranean style diet (Drewnowski & Eichelsdoerfer, 2009; Schröder et al., 2006), or a Healthy Eating Index (Ryden & Hagfors, 2011; Schröder et al., 2006) or a Diet Quality Index (Caivano & Semramis Martins lvares Domene, 2013) or as reflected by intake of select macro- and micronutrients (Maillot et al., 2007). Various authors have used two diet quality indices which are the Healthy Eating index-2010 (HEI-2010) (Beydoun et al., 2015) and the Mean Adequacy Ratio (MAR) (Kumcu & Kaufman, 2011).

The Diet Quality Index (DQI) has been previously used as a measure of diet quality for children in Canada (Ferland, Chu, Gleddie, Storey, & Veugelers, 2015; Paul J. Veugelers, Angela L. Fitzgerald, & Elizabeth Johnston, 2005), USA (S. Kim, Haines, Siega-Riz, & Popkin, 2003), China (Kim et al., 2003) and Korea (Kim & Bae, 2010). The DQI has been widely used because it incorporates both nutrient and food perspectives of the diet in the assessment, providing a means with which to better describe the diversity of consumption when there is a cross-national comparison of diet quality between countries (Kim et al., 2003). Caivano et al; (2013) added that the index includes moderation components intended to indicate foods that may represent a risk when in excess, and adequacy components that include sources of key nutrients and bioactive compounds in order to help individuals meet their nutritional requirements (Caivano & Semramis Martins lvares Domene, 2013).

This study has also used Canada's Food Guide (CFG) to assess the association of diet quality and cost of the diet (Government of Canada, 2007b). It is a help in the battle to get Canadians to eat better and achieve a healthy weight. It describes a pattern of eating that is healthy. While Canadians are encouraged to follow the CFG recommendations, it is important to understand if it

costs more to meet these recommendations. Moreover, this assessment gives an indication of the percentage of children who meet the recommendations, an added incentive to public health policies.

When comparing costs of diets, studies show mixed results; cross-sectional dietary surveys show that healthier diets cost more (Andrieu et al., 2006; Bernstein et al., 2010; Cade et al., 1999; Darmon, Briend, & Drewnowski, 2004; Schröder et al., 2006; Townsend, Aaron, Monsivais, Keim, & Drewnowski, 2009; Waterlander et al., 2010) while in intervention studies, on the other hand, findings show that the healthy diets are often less expensive than the less healthy options (Burney & Haughton, 2002; Goulet, Lamarche, & Lemieux, 2008; Mitchell et al., 2000; Raynor et al., 2002). Although there is evidence that healthier diets cost more, the need for additional studies is inevitable.

The aim of the present study was to assess the association between diet quality and cost in Alberta children when diet quality is assessed using DQI and CFG. It is the only study in Canada that has assessed the relationship between diet quality and cost in children. The findings are important incentive for updated public health policies.

3.2 Study Methods

3.2.1 Participants and recruitment

This study was done using data collected for the 2014 **R**aising healthy **E**ating and **A**ctive **L**iving kids in Alberta (REAL Kids) project. Elementary schools with grade 5 students in Alberta, were included in the sampling frame. Schools were selected using a one-stage stratified random sampling design. Schools were stratified according to metropolitan, city or rural-town regions, and then randomly selected within each stratum to ensure proportional representation. For the 2014 survey, 143 schools were invited to participate. Schools that participated in the survey were

provided with a report of the findings. Between March 2014 and June 2014, 4,992 home surveys and parent consent forms were sent home, of which 3,284 were returned and 2,958 parents provided parental consent for their child to participate in the survey. After excluding children who were absent during data collection and those who did not complete the survey, a total of 2,866 completed surveys were collected. The students were surveyed on different topics such as dietary intake, meeting food groups as per Canada's Food Guide (Government of Canada, 2007b), information on physical activity and screen-time, height, weight and arm span measurements. All survey instruments can be found on the REAL Kids Alberta project website: http://www.realkidsalberta.ca.The Health Research Ethics Board of the University of Alberta approved all study procedures.

3.2.2 Measures of dietary quality

3.2.2.1 Diet Quality Index (DQI)

The Diet Quality Index-International (DQI) was used as a measure of diet quality. It is a measure of healthfulness of a diet using four categories of diet components which are variety, adequacy, moderation and overall balance (Kim et al., 2003). Scores for all four categories are summed resulting in the overall DQI score, ranging from 0 to 100 (where 0 = the poorest and 100 = the highest diet quality) (Kim et al., 2003) with values of < 50 representing poor diet quality, and values between 50 and 70 and above 70 representing moderate and high diet quality, respectively (Caivano & Semramis Martins lvares Domene, 2013; Ryden & Hagfors, 2011).

Dietary variety (score 0 to 20) captures diversity in food choices and protein sources such as meat, poultry, fish, dairy, beans and eggs. Dietary adequacy (score 0 to 40) captures the adequate intake of food groups and nutrients such as vegetables, grains, fibers, proteins, Fe, Ca and vitamin C. Dietary moderation (score 0 to 30) evaluates foods that are a risk to chronic

diseases such as foods with fat, cholesterol or sodium. Lastly, overall balance (score 0 to 10) captures the proportion of energy from carbohydrates, protein and fat, as well as the fatty acid composition. More details regarding DQI can be found elsewhere (Kim et al., 2003).

3.2.2.2 Canada's Food Guide (CFG)

Canada's Food Guide was also used as a measure of diet quality. It defines a healthy eating pattern for Canadians. Following Canada's Food Guide helps Canadians to meet their nutrient needs to reduce their risk of obesity and chronic diseases. Canada's Food Guide includes four groups which are vegetables and fruit, grain products, milk and alternatives and meat and alternatives. It recommends the number of food guide servings per person for a day from each of the four groups and these servings differ depending on the stage of life and sex. This study used the food guide servings required for children aged 9 to 13 since the age of the study population falls within this range (Government of Canada, 2007b).

Vegetables and fruit group have important nutrients such as vitamins, minerals and fibre. They usually are low in fat and calories. This group is the most prominent among the four, emphasizing the important role these foods play in a healthy eating pattern and can be in many forms: fresh, frozen, as juice, canned and dried. Grain products, particularly whole grains, are a source of fibre and typically are low in fat. Fibre rich foods can help people feel full and satisfied. Nutrients provided by grain products include carbohydrate, B vitamins (e.g., thiamin, riboflavin, niacin and folate), iron, zinc, magnesium and other components such as fibre. The milk and alternatives food group provide calcium, vitamins A, D and B12, riboflavin, zinc, magnesium, potassium, protein and fat. The Meat and Alternatives group provides important nutrients such as iron, zinc, magnesium, B vitamins (thiamin, riboflavin, niacin, vitamin B6 and vitamin B12), protein and fat (Government of Canada, 2007b).

3.2.3 Measures of dietary intake

Dietary intake was assessed through the completed Harvard Youth/Adolescent Food Frequency Questionnaire (FFQ) that includes 147 food items distributed into seven categories (beverages, dairy products, main dishes, miscellaneous foods, breads and cereals, fruit and vegetables and snack and desserts). Children were asked to indicate their usual intake of each food using five frequency options ranging from "never/less than one per month" to "five or more times per week" or "one or more times per day." Average portion sizes consumed by a 10 to 11-year-old child and daily energy intake were calculated according to data and nutrient information from the 2007 Canadian Nutrient File database (Government of Canada, 2007a). In total, 2,851 children completed the FFQ survey, and among these, 120 observations of daily energy intake were below 500kcal/d or above 5000kcal/d and were defined as outliers (Chu et al., 2013). They were excluded from analysis, leaving a final sample of 2,731 children.

3.2.4 Retail food price determination

To calculate the costs of the diet for each student we collected regular prices for each of the 147 food items included in the FFQ from four common grocery retailers in Alberta (Superstore, Wal-Mart, Sobeys and Save On Foods). The costs were estimated based on the assumption that all foods were purchased from a grocery store. For those foods whose prices were not available online, their prices were collected from the stores by visiting them and checking the price labels. For those foods whose online prices were different from the stores, the stores prices were used. All prices were collected in December 2016 and the price level reflects that timing.

For the food items where both brand name and generic options were available, prices for both types of items were collected and then the average was used as final price. For the foods where each store had different brand names or different generic brands, the cheapest one from each category (brand or generic) was picked. Main dishes such as tacos, burritos, lasagna, pizza,

chicken nuggets, fish stick, meat balls and eggrolls were priced based on frozen pre-prepared foods. For all sandwiches and burgers, it was assumed that white bread was used and fill-ins were portion sizes either from the Canada's Food Guide or Canada Nutrient File. Package sizes chosen (e.g., 1L of juice) were first based on what is used in the Consumer Price Index (CPI) survey (Statistics Canada, 2017). If the package size was not available from the CPI, then the package sizes available from the Ontario Nutritious Food Basket (Ministry of Health Promotion, 2010) were used. If information was not available in either of these resources, then professional judgement was used.

Since for most foods, the FFQ does not include portion sizes, some assumptions were made about food portion sizes. When available, it was assumed that each time someone ate the specific food that the portion size was the same as provided in Canada's Food Guide; both Canada's Food Guide as well as the extended lists of foods belonging to Canada's Food Guide available from the Health Canada website were consulted (Government of Canada, 2007b). If the food did not belong to Canada's Food Guide, standard portion sizes from the Canada Nutrient File (CNF) were used. If the food was not available from the CNF or the portion size was unclear, package portion sizes from the nutrition facts panel were used.

All cost calculations considered food refuse, which applies to foods such as vegetables, fruit, and meat. The Canada Nutrient File indicates portions per meal that are ready to eat, therefore, for those foods that contain refuse during purchase, the portion sizes were recalculated to reflect the amount of food purchased (e.g. a raw banana has 36% refuse as indicated in the Canada Nutrient File while an eaten banana contains 118g. The portion of the refuse was calculated and added on to the 118g, resulting in total of 184.38g). Also, some foods such as soft drinks, unessential snacks and desserts and frozen pre-prepared main dishes were charged GST (5%) accordingly as

per the GST/HST Memoranda Series Guidelines (eg., soda, popsicles, muffins, potato chips, chicken nuggets and hot dogs) (Government of Canada, 2016).

The price of a portion of each food in the FFQ was calculated by taking the price of the package multiplied by the food portion size and divided by the package size. The portion price was then multiplied by the daily serving to get the daily dietary cost for that portion. The daily dietary costs were then energy-adjusted to 2000kcal in order to evaluate diet quality while controlling for diet quantity (Ryden & Hagfors, 2011), and also to minimize the influence of systematic under and over reporting (Murakami et al., 2009); a phenomenon that is well documented for FFQs (Willett, 2000). The total daily intake of snacks and desserts from the FFQ for each child was also calculated by summing up all the daily intake of each snack and dessert for each child.

The average daily cost of a child for each food category in the FFQ was calculated. For example, the daily cost of vegetables and fruits was calculated by adding together the daily cost of each food in the vegetable and fruit category for each child. This was then energy-adjusted to 2000kcal.

3.2.5 Statistical Analysis

All statistical analyses were performed using Stata IC version 14 (StataCorp, College Station, TX, USA). Linear regression methods were applied to characterize the association of diet quality and the cost of the diet. When comparing the groups, the independent sample *t* test, chi2 and one-way ANOVA were used. Multiple linear regressions were used to assess relationships between dietary cost and DQI, dietary cost and the CFG food groups, adjusting for socio-economic status, sex, urbanization status and body weight status. *P* values below 0.05 were considered to be statistically significant and all costs are in CAD using 2016 values.

3.3 Results

The population characteristics according to DQI score are shown in Table 3-1. The average daily dietary cost of a child's diet per 2000kcal was CAD 12.12 (SD 3.5), 13.27 (SD 3.0) and 13.51 (SD 2.9) for students with poor, moderate and high DQI scores respectively ($p<0.001$). Moderate DQI scores were most often achieved (69%) followed by high DQI scores (27%). Many of the children with obesity and those whose parents had higher income had a moderate DQI score. About 90% of children's parents were food secure and over one-third had achieved graduate degree education.

Based on the recommendations from CFG, there was no difference in daily dietary cost of a child who met milk and alternatives and who did not (Table 3-2). Meat and alternatives showed the highest difference of $1.93 between a child who met the guidelines and who did not. Our results further showed that diet was less expensive for a child who fulfilled servings of three or all four groups of CFG than those who fulfilled two groups or less (Table 3-2).

The regression model showed that there was significant association of cost of diet with DQI, though the magnitude was low (Table 3-3). For every one unit increase in DQI, the cost of the diet increased by seven cents ($p<0.001$). The analysis was further controlled for demographics and socioeconomic factors; the results did not show significant difference. Higher parental income was significantly associated with higher costs of diet.

Snacks and desserts showed an inverse relationship with the cost of diet ($p<0.001$) (Table 3-4). When controlled for demographics and socioeconomic factors; there was no significant difference. Those with food insecurity and higher parental income were significantly associated with higher costs of diet.

Based on CFG's recommendations, there was no significant association of cost of diet with grain products. Fruits and vegetables, milk and alternatives and meat and alternatives showed

significant positive association with the cost of diet ($p<0.001$) (Table 3-4). The results did not change when controlled for demographics and socioeconomic factors, except for milk and alternatives which did not show significant difference. Higher parental income was significantly associated with higher costs of diets that ranged from $0.52 to $0.72 in all the four groups of CFG. Boys and overweight children incurred higher costs of diet in meat and alternatives servings group (Table 3-5).

3.4 Discussion

The present study showed that healthier eating was associated with higher dietary costs in 10 to 11-year-old children in Alberta. Children with higher total DQI scores had a more expensive diet. The magnitude of the difference in cost between children with high DQI score and poor DQI score might seem rather small ($1.39/2000kcal), but it corresponds to approximately $83/month and $1,000/year for a family with 2 children. A possible consequence of higher dietary costs when eating healthily is that low socio-economic groups may find it too expensive to adhere to a healthy diet (Rao et al., 2013). Also, the results showed that children from families with higher income reported higher spending on snacks and desserts. This suggests that there are desserts and snacks that are expensive although they are considered as less healthy food choices.

Based on CFG recommendations, those who met meat and alternatives servings showed to have the highest average daily cost per 2000kcal compared to those who did not and when compared to other groups. However, among the four groups, this was the group that was highly met (66%). This suggests that the beliefs that healthier diets are costly should be addressed so that they do not become a barrier in the adoption of positive dietary changes (Raynor et al., 2002). Also, it was 50 cents cheaper to meet recommendations for grain products, but only 18% of the children met these recommendations. This could mean that there is lack of knowledge of grains as a healthy diet.

Because this is the first study to examine the association between diet quality and cost among children in Alberta, comparison of our Alberta results with other Canadian studies cannot be made. However, the findings are in line with other studies showing that healthier diets cost more (Cade et al., 1999; Darmon et al., 2004; Drewnowski et al., 2007; Schröder et al., 2006; Townsend et al., 2009; Waterlander et al., 2010).

The group that is likely to be affected by higher dietary costs when opting for healthier diets is the low socioeconomic status (SES) group. In our study, we cannot make such conclusion; children whose parents earned $75,000 and less consumed less expensive diet but these cannot be totally categorized as low-income earners. In addition, Waterlander and his colleagues found no difference in dietary costs among income levels in adults (Waterlander et al., 2010). On the other hand, people with low income have been found to spend less on food (Inglis, Ball, & Crawford, 2009; Kirkpatrick & Tarasuk, 2003) and to have less healthy food purchasing behaviour (Giskes, Van Lenthe, Brug, Mackenbach, & Turrell, 2007; Turrell et al., 2009), indicating the likelihood of lower actual dietary costs with lower income.

Despite the different dietary instruments and measures of healthfulness used, most studies (Andrieu et al., 2006; Cade & Booth, 1990; Cade et al., 1999; Drewnowski et al., 2004; Maillot et al., 2007; Mooney, 1990; Schröder et al., 2006; Waterlander et al., 2010), but not all (Drewnowski & Eichelsdoerfer, 2009), conclude that healthier diets cost more. It is worth to note that the metric used to measure food quantity and cost has influence on conclusions about diet quality and cost (Drewnowski, Maillot, & Darmon, 2009). For example, the daily cost ($/kcal) of energy-light foods such as fruit and vegetables, is likely higher than the daily cost of energy-dense foods such as some snacks when energy-dense diets have higher total daily caloric intake (Lipsky, 2009). Additionally, Rao et al; (2013) argued that price differences particularly per calories may be limited because healthier foods such as fruit and vegetables often have fewer

calories; and evaluation of price differences in terms of calories may alter the conclusions (Rao et al., 2013).

Although several studies have concluded that healthier diets cost more, some researchers believe that cost is not the only factor or the number one factor for food choice (French et al., 1999; Glanz et al., 1998). Glanz et al. 1998 did a study on food consumption influences such as taste, nutrition, cost, convenience and weight control, and found that taste was the most important consideration for respondents followed by cost, nutrition, convenience and weight control (Glanz et al., 1998). The study concluded that people are most likely to consume food that they evaluate as tasty; hence taste can be considered a minimal standard for food choice (Glanz et al., 1998). The other four influences may therefore appear to be important in determining food choice as long as food is considered tasty (Glanz et al., 1998). French et al. 1999 also examined the influence of snack choices among both adolescents and adults. Their findings showed that snack taste was the most important factor for snack choice followed by price. The authors further pointed out that habits played a role on food choice whereby adolescents who frequently used vending machines were less likely to choose or plan to choose a low-fat vending snack (French et al., 1999). Young et al; (2002) added that unhealthy foods are not necessarily unhealthy but market competition of foods in the U.S has led to manufactures to greatly exceed USDA and FDA standard portions (Young & Nestle, 2002).

The present study offers some strength. It represents, to our knowledge, the broadest assessment of the evidence on prices of healthier vs less healthy overall diet patterns across very different selections of foods. Dietary data were based on provincially representative children using a FFQ.

Some limitations to our study are noted. Children with obesity tend to underreport their energy intake (Livingstone & Black, 2003) which makes it possible that the high DQI scores were overestimated. Due to lack of details about the foods consumed, it was necessary to use the

average price of some foods instead of actual food prices. Furthermore, food prices were collected two years after the FFQ survey was conducted. During these years, prices might have changed both within and among food categories (Monsivais & Drewnowski, 2007), which in turn could have affected dietary intake because cost is one determinant of food purchase (Glanz et al., 1998).

Our findings provide the amplest evidence in Alberta and Canada as a whole on price differences of healthier diet patterns, while also showing the prices of children who meet and those who do not meet CFG recommendations. Although our findings show that healthier diets cost more, it is too early to make such conclusion. There is a need for future research to include prices of meals from restaurants and fast food restaurants to add value to such research setting.

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Table 3-1 Population characteristics

	Total (n)	DQI<50	DQI=50-70	DQI >70
		***n* 325**	***n* 1,792**	***n* 614**
Daily cost (CAD/2000kcal), Mean (SD)**	2,731	12.12 (3.5)	13.27 (3.0)	13.51 (2.9)
Sex n (%)				
Boys	1,273 (47%)	153 (12%)	854 (67%)	266 (20%)
Girls	1,458 (53%)	172 (12%)	938 (64%)	348 (24%)
Parental Income n (%)				
≤ $ 50,000	326 (19%)	46 (14%)	211 (65%)	69 (21%)
$ 50,001-$75,000	237 (14%)	23 (9%)	159 (67%)	55 (23%)
$ 75,001-$ 100,000	302 (18%)	32 (11%)	207 (69%)	63 (21%)
≥ $ 100,001	838 (49%)	88 (11%)	567 (68%)	183 (22%)
Parental Education n (%)				
Less than secondary	676 (26%)	80 (12%)	438 (65%)	158 (23%)
College degree	963 (37%)	117 (12%)	648 (67%)	198 (21%)
Graduate degree	949 (37%)	107 (11%)	618 (65%)	224 (24%)
Food Security n (%)				
Worry that food would run out before getting money to buy more				
Yes	265 (10%)	40 (15%)	161 (61%)	64 (24%)
No	2,270 (90%)	260 (11%)	1,515 (67%)	495 (22%)
The food bought did not last and no money to buy more				
Yes	159 (6%)	23 (14%)	100 (63%)	36 (23%)
No	2,364 (94%)	272 (12%)	1,566 (66%)	526 (22%)
Urbanization status n (%)				
Metropolitan	839 (31%)	94 (11%)	537 (64%)	208 (25%)
Rural or town	1,387 (51%)	160 (12%)	938 (68%)	289 (21%)
City	505 (18%)	71 (14%)	317 (63%)	117 (23%)
Bodyweight n (%)				
Normal	1,804 (65%)	296 (12%)	1,601 (65%)	552 (23%)
Overweight	806 (27%)	20 (12%)	113 (69%)	30 (18%)
Obese	222 (8%)	9 (8%)	78 (66%)	32 (27%)

*$P<0.05$, **$P<0.001$

Table 3-2 Dietary expenditure characteristics

	Total (n)	Total Average Cost (SD)	DQI<50 *n* 325	DQI=50-70 *n* 1,792	DQI >70 *n* 614
Daily cost (CAD/2000kcal), Mean (SD)	2,731	13.19 (3.0)	12.12 (3.5	13.27 (3.0)	13.51 (2.9)
Daily cost (CAD), Mean (SD)	2,731	12.02 (5.8)	6.07 (2.5)	11.98 (5.5)	15.31 (5.3)
Food groups in the FFQ					
Unessential foods (snack foods/desserts, pop, iced tea and fruit punch), Mean (SD)	2,503	1.39 (0.7)	1.51 (0.86)	1.42 (0.67)	1.26 (0.58)
Vegetables and fruits, Mean (SD)	2,496	1.91 (1.1)	1.20 (0.84)	1.77 (0.97)	2.71 (1.23)
Breads and cereals, Mean (SD)	2,585	0.51 (0.3)	0.43 (0.24)	0.50 (0.25)	0.59 (1.0)
Dairy products, Mean (SD)	2,656	2.62 (1.7)	2.99 (2.4)	2.72 (1.6)	2.32 (1.4)
Main dishes, Mean (SD)	1,413	6.76 (2.8)	6.11 (3.1)	6.93 (2.6)	6.65 (2.6)
Meeting Food groups (Canada 's Food Guide)					
Grain products					
Yes, Mean (SD)	494 (18%)	12.84 (2.5)			
No, Mean (SD)	2,237(82%)	13.26 (3.2)			
Fruits and vegetables					
Yes, Mean (SD)	711 (26%)	13.58 (2.9)			
No, Mean (SD)	2020 (74%)	13.05 (3.1)			
Milk and alternatives					
Yes, Mean (SD)	1,217 (45%)	13.20 (2.7)			
No, Mean (SD)	1,514 (55%)	13.18 (3.3)			
Meat and alternatives					
Yes, Mean (SD)	1,806 (66%)	13.84 (2.9)			
No, Mean (SD)	925 (34%)	11.91 (3.0)			
Number of food groups met as per Canada Food Guide					
0, Mean (SD)	534 (20%)	11.91 (3.0)			
1, Mean (SD)	968 (35%)	13.35 (3.3)			
2, Mean (SD)	643 (23%)	13.82 (2.9)			
3, Mean (SD)	370 (14%)	13.51 (2.7)			
4, Mean (SD)	216 (8%)	13.15 (2.2)			

Table 3-3 Association of DQI, demographics and socio-economic factors with the cost of diet in 2016 Canadian dollars

	Base Model		***Multivariable Model***	
	***β* coefficient**	**95% CI**	***β* coefficient**	**95% CI**
DQI	0.07**	0.05-0.08	0.07**	0.05-0.09
Energy intake (1,000 kcal)	0.62**	0.77- (-0.46)	-0.55**	(-0.75)- (-0.34)
Constant	9.96**	9.23-10.68	9.37**	8.23-10.52
Gender				
Girls			Ref	
Boys			-0.15	(-0.44)-0.14
Parental Income				
≤ $ 50,000			Ref	
$ 50,001-$75,000			-0.02	(-0.56)-0.51
$ 75,001-$ 100,000			0.52*	0.00-1.03
≥ $ 100,001			0.65*	0.19-1.10
Food Security				
Worry that food would run out before getting money to buy more				
Yes			Ref	
No			0.64	(-0.05)-1.33
The food bought did not last and no money to buy more				
Yes			Ref	
No			-0.57	(-1.40)-0.26
Parental Education				
Less than secondary			Ref	
College degree			0.07	(-0.32)-0.46
University or Graduate degree			0.01	(-0.4)-0.41
Urbanization status				
Metropolitan			Ref	
Rural or town			0.1	(-0.25)-0.44
City			0.25	(-0.17)-0.68
Bodyweight				
Normal			Ref	
Overweight			0.6	(-0.15)-1.22
Obese			-0.6	(-1.28)-0.1
R^2	0.04		0.06	
Adj R^2	0.04		0.05	

*$P<0.05$, **$P<0.001$

Table 3-4 The association of snacks & desserts, number of servings of grain products, fruit and vegetables, milk & alternatives and meat & alternatives with the cost of the diet in dollars

	Base Model									
	Snacks & Desserts		**Grain Products**		**Fruit and Vegetables**		**Milk and Alternatives**		**Meat and Alternatives**	
	β coefficient	**95% CI**	**β coefficient**	**95% CI**	**β coefficient**	**95% CI**	**β coefficient**	**95% CI**	**β coefficient**	**95% CI**
Constant	*13.23***	*12.94-13.52*	*13.56***	*13.28-13.84*	*13.56***	*13.29-13.83*	*13.51***	*13.24-13.79*	*13.39***	*13.15-13.63*
Coefficient for food item	*-0.52***	*-0.62-0.42*	*0.01*	*-0.08-0.10*	*0.24***	*0.19-0.28*	*0.13***	*0.05-0.21*	***2.71****	*2.53-2.89*
Energy intake (1,000 kcal)	*0.46***	*0.27-0.65*	*0.22*	*-0.47-0.02*	*0.81***	*(-0.99)- (-0.64)*	*-0.40***	*-0.58- (-0.22)*	*-2.25***	*-2.43- (-2.07)*
R^2	*0.04*		*0.00*		*0.04*		*0.01*		*0.25*	
Adj R^2	*0.04*		*0.00*		*0.04*		*0.01*		*0.25*	

*$P<0.05$, **$P<0.001$

Table 3-5 The association of snacks & desserts, number of servings of grain products, fruit & vegetables, milk & alternatives and meat & alternatives, demographics and socio-economic factors with the cost of the diet in dollars

Multivariate Model

	Snacks & Desserts		Grain Products		Fruit and Vegetables		Milk and Alternatives		Meat and Alternatives	
	β coefficient	**95% CI**	**β coefficient**	**95% CI**	**β coefficient**	**95% CI**	**β coefficient**	**95% CI**	**β coefficient**	**95% CI**
Constant	*12.81***	*12.02-13.60*	*12.86**	*12.08-13.63*	*12.84***	*12.08-13.60*	*12.88***	*12.10-13.65*	*12.86***	*12.18-13.54*
Coefficient for food item	*-0.46***	*(-0.6)- (-0.32)*	*0.01*	*(-0.12)-0.13*	*0.23***	*0.17-0.29*	*0.07*	*(-0.03)-0.17*	*2.57***	*2.35-2.80*
Energy intake (1,000 kcal)	*0.42***	*0.17-0.67*	*-0.15*	*(-0.47)-0.17*	*-0.75***	*(-0.98)- (-0.51)*	*-0.25**	*(-0.48)-0.16*	*-2.1*	*(-2.33)- (-1.86)*
Gender										
Girls	*Ref*		*Ref*		*Ref*		*Ref*		*Ref*	
Boys	*-0.23*	*-0.52-0.07*	*-0.25*	*(-0.55)-0.037*	*-0.15*	*(-0.44)-0.14*	*-0.26*	*(-0.56)-0.03*	*-0.36**	*(-0.62)- (-0.1)*
Parental Income										
≤ $ 50,000	*Ref*		*Ref*		*Ref*		*Ref*		*Ref*	
$ 50,001-$75,000	*-0.01*	*-0.56-0.53*	*0.07*	*(-0.48)-0.61*	*0.08*	*(-0.45)-0.61*	*0.05*	*(-0.49)-0.6*	*0.02*	*(-0.46)-0.5*
$ 75,001-$ 100,000	*0.50*	*-0.03-1.03*	*0.62***	*0.09-1.14*	*0.57**	*0.06-1.09*	*0.59**	*0.06-1.12*	*0.52**	*0.06-0.98*
≥ $ 100,001	*0.57**	*0.11-1.04*	*0.72***	*0.26-1.18*	*0.68**	*0.23-1.13*	*0.68**	*0.21-1.14*	*0.66***	*0.25-1.06*
Food Security										
Worry that food would run out before getting money to buy more										
Yes	*Ref*		*Ref*		*Ref*		*Ref*		*Ref*	
No	*0.70**	*0.00-1.40*	*0.63*	*(-0.07)-1.33*	*0.53*	*(-0.16)-1.22*	*0.61*	*(-0.09)-1.31*	*0.60*	*(-0.01)-1.21*
The food bought did not last and no money to buy more										
Yes	*Ref*		*Ref*		*Ref*		*Ref*		*Ref*	
No	*-0.76*	*-1.61-0.09*	*-0.53*	*(-1.38)-0.32*	*-0.46*	*(-1.3)-0.37*	*-0.53*	*(-1.38)-0.32*	*-0.52*	*(-1.26)-0.22*
Parental Education										
Less than secondary	*Ref*		*Ref*		*Ref*		*Ref*		*Ref*	
College degree	*0.13*	*-0.28-0.53*	*0.11*	*(-0.29)-0.51*	*0.12*	*(-0.27)-0.51*	*0.11*	*(-0.29)-0.51*	*0.03*	*(-0.32)-0.38*
University or Graduate degree	*0.2*	*-0.21-0.62*	*0.12*	*(-0.29)-0.53*	*0.11*	*(-0.29)-0.52*	*0.12*	*(-0.29)-0.53*	*0.06*	*(-0.3)-0.42*
Urbanization status										
Metropolitan	*Ref*		*Ref*		*Ref*		*Ref*		*Ref*	
Rural or town	*0.09*	*-0.26-0.45*	*0.07*	*(-0.29)-0.42*	*0.10*	*(-0.25)-0.45*	*0.07*	*(-0.28)-0.42*	*0.07*	*(-0.24)-0.38*
City	*0.35*	*-0.08-0.79*	*0.31*	*(-0.12)-0.75*	*0.26*	*(-0.16)-0.69*	*0.33*	*(-0.11)-0.76*	*0.22*	*(-0.16)-0.59*
Bodyweight										
Normal	*Ref*		*Ref*		*Ref*		*Ref*		*Ref*	
Overweight	*0.53*	*-0.11-1.17*	*0.55*	*(-0.09)-1.18*	*0.60*	*(-0.02)-1.22*	*0.53*	*(-0.1)-1.17*	*0.55**	*0.00-1.11*
Obese	*-0.46*	*-1.16-0.23*	*-0.53*	*(-1.22)-0.17*	*-0.50*	*(-1.18)-0.18*	*-0.53*	*(-1.22)-0.17*	*-0.53*	*(-1.13)-0.08*
R^2	*0.05*		*0.02*		*0.06*		*0.02*		*0.25*	
Adj R^2	*0.04*		*0.01*		*0.05*		*0.02*		*0.25*	

CHAPTER 4: Discussion and Conclusion

4.1 Discussion

This thesis consists of two sequential papers, which assessed the daily costs of diets in grade 5 children and the association of diet quality and cost among the same population. The first paper found that when diet costs are broken down into portion sizes, there is very little difference in costs of diets. This implies that when people are provided knowledge with the portion size they need per meal, it may help to overcome the notion that healthier diets are costly.

Young and his colleagues noted that the issue at hand is not about cost of diets, but it's about the food portion sizes that have been expanding exceeding the standard portions set by authorities (Young & Nestle, 2002). The authors claim that even if governments decide to increase the cost of unhealthy foods, the problem may be more the proportion sized. Even if less unhealthy foods are consumed because of increased costs, the same less amount of unhealthy portion size consumed will still lead to health problems because it exceeds the recommended portion per meal (Young & Nestle, 2002).

The first paper analyzed for the first time portion size and daily cost of diet in Alberta and Canada as a whole. Although the results may not be generalizable, they pose a good indicator to dietitians when educating people about the portion size required per meal.

The second paper in this thesis sought to determine the association of diet quality and cost when diet quality is assessed using DQI and CFG recommendations. When assessing the association using DQI, the results indicated an increase in cost when consumption of diet quality is increased. Our findings further indicated that about 90% of the parents were financially and food secure and 65% of the children were normal weight. This may suggest that although healthier

diets cost more, it should not be a priority for public health policy makers to subsidize healthier diets. A difference in food cost between healthier and less healthy diets may not necessarily mean that healthier options are expensive, but since cost (money) is a sensitive issue, people can easily take advantage of the fact that healthier diets cost more if given an opportunity. Glanz and her colleagues further reported that consumers are usually concerned with reductions in the taste quality as the most mentioned obstacles to adopting healthy diets (Glanz et al., 1998).

Moreover, Raynor and her colleagues found that a change to a more healthful diet is not more expensive than a less healthful diet (Raynor et al., 2002). Their results conflict with cross-sectional findings that have been reported previously (Aggarwal et al., 2011; Cade et al., 1999; Murakami et al., 2007; Murakami et al., 2009; Murakami et al., 2009; Ryden & Hagfors, 2011). Cross-sectional studies are unclear how long the individuals on the more healthful diets had been on these diets (Raynor et al., 2002), which suggests that the length of time spent on a healthier diet may be an important factor of cost (Raynor et al., 2002). With time, people may change the kinds of foods they eat and the methods they use to cook them that allow for lower food costs (Raynor et al., 2002).

Although the present study adjusted diet costs to 2000kcal to account for underreporting and mistakes due to self-reporting, this may limit us to conclude that healthier diets cost more than less healthy diets. Price is not dependent on the number of kilocalories available in the foods, so it may be more feasible to research how much it costs to shift from unhealthy to healthier diet options rather than doing it in terms of calories.

Taxation is another option that has been talked about where governments are encouraged to subsidize healthy foods and tax unhealthy foods. In Canada, Goods and Service Tax (5%) is already charged on foods such as soft drinks, unessential snacks and desserts and frozen pre-

prepared main dishes; so, the problem at hand may be the amount of tax charged on these foods. Two investigations found that tax increases need to be so great (≥15%) to influence the end price to the consumer (Karevold, Grini, Slapo, & Lekhal, 2017; Niebylski et al., 2015). Karevold and his colleagues further noted that taxation needs to be considered in combination with other interventions (placing, prompts and portioning) to influence healthier consumption (Karevold et al., 2017).

4.2 Conclusion

To sum, we observed a gradient whereby diets of better quality are costlier. Our findings suggest that for families with low income, this additional cost may represent a genuine barrier to healthier eating. Yet, this daily price difference is trivial compared to the lifetime personal and societal financial burdens of diet-related chronic diseases (Rao et al., 2013). The annual cost of a healthy diet per child is approximately $500 while the 2013 total healthcare costs (direct and indirect costs) of an individual with obesity was $2,556 (Krueger, Krueger, & Koot, 2015). It shows that the annual costs of taking care of an individual with obesity are on the highest side compared to shifting budget towards healthy foods.

The results of this investigation suggest that reducing price of healthier diets should not be the only priority as a strategy to encourage healthy eating. One way to get people to eat vegetables and fruit may be for dietitians to suggest convenient ways to include them in the diet. It is important to teach people good cooking skills and encourage people to eat meals together as a family. This will as well help to promote healthy eating. Dietitians should also make efforts to design food plans including menus and recipes with good taste while still meeting the healthful guidelines. Also, efforts should be made to teach ways to cook tasteful food using lower cost healthy options. This way, nutrition campaigns can take advantage of existing beliefs to encourage consumption of healthy diets. Moreover, policies to introduce healthy school lunch

programs in Canada may help to encourage healthy eating among children. Hence, public health policies that reduce the cost of healthful diets, as well as the development of shopping and food preparation methods that may help reduce dietary costs should be promoted to reduce the perception that consumption of a healthful diet increases daily costs of diets.

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APPENDIX A: Cost of Foods

FFQ NO.	FOODS AND FOOD CATEGORIES	PACKAGE SIZE UNIT	AVERAGE PRICE PER SERVING	AVERAGE PRICE PER SERVING FOR EACH CATEGORY
	BEVERAGES			
16	Diet pop	4260 ml	0.37	**0.27**
17	Pop-not diet	4260 ml	0.37	
18	Hawaiian punch	2000 ml	0.46	
19	Iced tea	2000 ml	0.26	
20	Tea	225 g	0.08	
21	Coffee-not decaf	920 g	0.10	
	DAIRY PRODUCTS			**0.65**
23	Milk	4000 ml	0.32	
24	Chocolate milk	4000 ml	0.33	
25	Instant breakfast drink	400 g	1.27	
26	whipped cream	237 ml	0.14	
27	Yogurt	650 g	0.80	
28	Cottage cheese	500 g	2.15	
29	Cheese	450 g	0.68	
30	Cream cheese	250 g	0.71	
32	Butter	454 g	0.03	
33	Margarine	907 g	0.02	
	MISCELLANEOUS FOODS			**0.31**
63	Brown Gravy	21 g	1.05	
64	Ketchup	1000 ml	0.05	

65	Clear soup	284 ml	0.51	
66	Cream soup	284 ml	0.55	
67	Mayonnaise	890 ml	0.07	
68	Low calorie/fat salad dressing	475 ml	0.08	
69	Salad dressing (not low calorie)	475 ml	0.08	
70	Salsa	650 ml	0.10	
	BREADS & CEREALS			**0.27**
73	Cold breakfast cereal	680 g	0.15	
74	Hot breakfast cereal like oatmeal	1000 g	0.12	
75	White bread, pita bread or toast	675 g	0.14	
76	Dark bread	675 g	0.15	
77	English muffins or bagels	450 g	0.30	
78	Muffin	891 g	0.29	
79	Cornbread	680 g	0.26	
80	Biscuit/roll	356 g	0.32	
81	Rice	900 g	0.15	
82	Noodles, pasta	900 g	0.07	
83	Tortilla- no filling	340 g	0.37	
84	Other grains like couscous	198 g	0.87	
85	Pancakes or waffles	280 g	0.37	
86	French fries	1000 g	0.37	
87	Potatoes	1000 g	0.13	

	SNACK FOODS/DESSERTS			**0.54**
121	Potato chips	504 g	0.55	
122	Corn chips/Doritos (small bag)	504 g	0.40	
123	Nachos with cheese	400 g	1.09	
124	Popcorn	492 g	0.13	
125	Pretzels	400 g	0.51	
126	Peanuts,nuts	600 g	0.34	
127	Fun fruit or fruit rollups	175 g	0.21	
128	Graham crackers	400 g	0.34	
129	Crackers, like saltines or wheat thins	450 g	0.21	
130	Poptarts	400 g	0.42	
131	Cake	850 g	0.74	
132	Snack cakes, vachon cakes	324 g	0.49	
133	Danish sweetrolls	1168 g	0.18	
134	Donuts	250 g	0.82	
135	Cookies	350 g	0.42	
136	Brownies	270 g	0.28	
137	Pie	400 g	1.03	
138	Chocolate	100 g	0.74	
139	Other candy bars (Snickers)	208 g	1.30	
140	Other candy without chocolate (Skittles)	191 g	0.62	

141	JELL-O	85 g	0.24	
142	Pudding	113 g	0.50	
143	Frozen yogurt	2000 ml	0.39	
144	Ice cream	1500 ml	0.42	
145	Milkshake or frappe	310 ml	1.19	
146	Popsicles	600 ml	0.44	
	FRUITS & VEGETABLES			**0.49**
88	Raisins	196 g	0.19	
89	Grapes	1000 g	0.91	
90	Bananas	1000 g	0.32	
91	Cantaloupe	1361 g	0.46	
92	Apples	1000 g	0.79	
93	Pears	1000 g	0.85	
94	Oranges	1000 g	0.65	
95	Strawberries	600 g	0.77	
96	Peaches,plums,apricots	600 g	0.90	
97	Orange juice	2000 ml	0.23	
98	Apple juice	1000 ml	0.23	
99	Tomatoes	796 ml	0.29	
100	Tomato/spaghetti sauce	398 ml	0.44	
101	Tofu	350 ml	1.06	
102	String beans	398 ml	0.50	
103	Beans/lentils/soybeans	398 ml	0.54	
104	Broccoli	1000 g	0.41	

105	Beets	1000 g	0.33	
106	Corn	341 ml	0.54	
107	Peas or lima beans	398 ml	0.50	
108	Mixed vegetables	398 ml	0.50	
109	Spinach	500 g	0.72	
110	Greens/beet greens	1000 g	0.40	
111	Green/red peppers	1000 g	0.64	
112	Yams/sweet potatoes	1000 g	0.31	
113	Eggplant	1000 g	0.38	
114	Carrots, cooked	1000 g	0.18	
115	Carrots, raw	1000 g	0.18	
116	Celery	1000 g	0.15	
117	Lettuce	1000 g	0.29	
118	Coleslaw	397 g	0.33	
119	Potato salad	450 g	0.63	
	MAIN DISHES			**1.26**
36	Cheeseburger	904 g	2.18	
37	Hamburger	904 g	1.50	
38	Pizza	780 g	1.58	
39	Tacos/burritos	907 g	1.94	
41	Chicken nuggets	800 g	1.24	
42	Hot dogs	450 g	0.73	
43	Peanut butter sandwich	459 ml	0.49	
44	Chicken or turkey sandwich	175 g	2.77	

45	Ham sandwich	375 g	1.49	
46	Salami, bologna or other deli sandwich	500 g	1.37	
47	Tuna sandwich	170 g	1.08	
48	Chicken	1000 g	1.06	
49	Fish sticks	700 g	0.81	
50	Fresh fish as main dish	1000 g	2.04	
51	Beef or lamb as main dish	1000 g	1.73	
52	Pork or ham as main dish	1000 g	1.58	
53	Meatballs	1800 g	0.71	
54	Lasagna	1000 g	1.59	
55	Macaroni and cheese	225 g	0.19	
56	Spaghetti with tomato sauce	900 g	0.50	
57	Eggs	12 eggs	0.24	
58	Beef liver	1000 g	0.64	
59	Shrimp	400 g	2.97	
60	French toast	675 g	0.61	
61	Grilled cheese	675 g	0.99	
62	Eggrolls	680 g	0.70	
	OTHERS			**0.02**
14	Cooking oil	1420 ml	0.02	
4	Sugar	1000 g	0.01	

APPENDIX B: Recommended Number of Food Guide Serving per Day

Recommended Number of Food Guide Servings per Day

	Children			Teens		Adults			
Age in Years	2-3	4-8	9-13	14-18		19-50		51+	
Sex	Girls and Boys			Females	Males	Females	Males	Females	Males
Vegetables and Fruit	4	5	6	7	8	7-8	8-10	7	7
Grain Products	3	4	6	6	7	6-7	8	6	7
Milk and Alternatives	2	2	3-4	3-4	3-4	2	2	3	3
Meat and Alternatives	1	1	1-2	2	3	2	3	2	3

The chart above shows how many Food Guide Servings you need from each of the four food groups every day.

Having the amount and type of food recommended and following the tips in *Canada's Food Guide* will help:

- Meet your needs for vitamins, minerals and other nutrients.
- Reduce your risk of obesity, type 2 diabetes, heart disease, certain types of cancer and osteoporosis.
- Contribute to your overall health and vitality.

What is One Food Guide Serving?

Look at the examples below.

Fresh, frozen or canned vegetables
125 mL (½ cup)

Leafy vegetables
Cooked: 125 mL (½ cup)
Raw: 250 mL (1 cup)

Fresh, frozen or canned fruits
1 fruit or 125 mL (½ cup)

100% Juice
125 mL (½ cup)

Bread
1 slice (35g)

Bagel
½ bagel (45 g)

Flat breads
½ pita or ½ tortilla (35 g)

Cooked rice, bulgur or quinoa
125 mL (½ cup)

Cereal
Cold: 30 g
Hot: 175 mL (¾ cup)

Cooked pasta or couscous
125 mL (½ cup)

Milk or powdered milk (reconstituted)
250 mL (1 cup)

Canned milk (evaporated)
125 mL (½ cup)

Fortified soy beverage
250 mL (1 cup)

Yogurt
175 g
(¾ cup)

Kefir
175 g
(¾ cup)

Cheese
50 g (1 ½ oz.)

Cooked fish, shellfish, poultry, lean meat
75 g (2 ½ oz.)/125 mL (½ cup)

Cooked legumes
175 mL (¾ cup)

Tofu
150 g or
175 mL (¾ cup)

Eggs
2 eggs

Peanut or nut butters
30 mL (2 Tbsp)

Shelled nuts and seeds
60 mL (¼ cup)

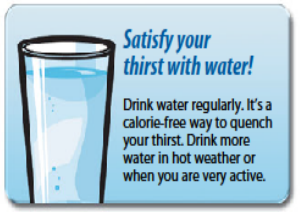
Make each Food Guide Serving count...

wherever you are – at home, at school, at work or when eating out!

- **Eat at least one dark green and one orange vegetable each day.**
  - Go for dark green vegetables such as broccoli, romaine lettuce and spinach.
  - Go for orange vegetables such as carrots, sweet potatoes and winter squash.
- **Choose vegetables and fruit prepared with little or no added fat, sugar or salt.**
  - Enjoy vegetables steamed, baked or stir-fried instead of deep-fried.
- **Have vegetables and fruit more often than juice.**
- **Make at least half of your grain products whole grain each day.**
  - Eat a variety of whole grains such as barley, brown rice, oats, quinoa and wild rice.
  - Enjoy whole grain breads, oatmeal or whole wheat pasta.
- **Choose grain products that are lower in fat, sugar or salt.**
  - Compare the Nutrition Facts table on labels to make wise choices.
  - Enjoy the true taste of grain products. When adding sauces or spreads, use small amounts.
- **Drink skim, 1%, or 2% milk each day.**
  - Have 500 mL (2 cups) of milk every day for adequate vitamin D.
  - Drink fortified soy beverages if you do not drink milk.
- **Select lower fat milk alternatives.**
  - Compare the Nutrition Facts table on yogurts or cheeses to make wise choices.
- **Have meat alternatives such as beans, lentils and tofu often.**
- **Eat at least two Food Guide Servings of fish each week.***
  - Choose fish such as char, herring, mackerel, salmon, sardines and trout.
- **Select lean meat and alternatives prepared with little or no added fat or salt.**
  - Trim the visible fat from meats. Remove the skin on poultry.
  - Use cooking methods such as roasting, baking or poaching that require little or no added fat.
  - If you eat luncheon meats, sausages or prepackaged meats, choose those lower in salt (sodium) and fat.

Oils and Fats

- Include a small amount – 30 to 45 mL (2 to 3 Tbsp) – of unsaturated fat each day. This includes oil used for cooking, salad dressings, margarine and mayonnaise.
- Use vegetable oils such as canola, olive and soybean.
- Choose soft margarines that are low in saturated and trans fats.
- Limit butter, hard margarine, lard and shortening.



*Health Canada provides advice for limiting exposure to mercury from certain types of fish. Refer to www.healthcanada.gc.ca for the latest information.