THE ASSOCIATION OF NON-CORE FOODS ON ACADEMIC PERFORMANCE AMONG GRADE FIVE STUDENTS IN NOVA SCOTIA

by

Colleen Sameoto

Submitted in partial fulfillment of the requirements
for the degree of Master of Science

at

Dalhousie University
Halifax, Nova Scotia
July 2015

DEDICATION PAGE

I dedicate this work to my family and many friends, whose words of encouragement and continued support helped me throughout the entire master's program.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

This study examines the association between non-core food intake and academic performance among children.

Grade five students in Nova Scotia were surveyed as part of the Children's Lifestyle and School-Performance Study (CLASS II). Regression methods were used to examine the association between non-core food intake and academic performance while adjusting for confounding variables.

Students who had higher intakes of non-core food were more likely to perform poorly in reading, writing, and mathematics. However, this association was negated when core food consumption was adjusted for. Core food consumption had a positive association with academic performance that remained significant after mutually adjusting for all variables.

Even though there was a negative association between non-core food and academic performance, the influence did not remain significant after core food consumption was accounted for. Therefore, these results highlight the importance for children's diets to be high in core food in order to support learning.

LIST OF ABBREVIATIONS USED

CLASS II	2011 Children's Lifestyle and School-Performance Study
CCHS	Canadian Community Health Survey
PA	Physical Activity
FFQ	Food Frequency Questionnaire
DQI-I	Diet Quality Index-International
YAQ	Harvard Youth/Adolescent Food Frequency Questionnaire
BMI	Body Mass Index
OR	Odds Ratio
PR	Prevalence Ratio
CI	Confidence Interval
BDNF	Brain-Derived Neurotropic Factor

ACKNOWLEDGEMENTS

I would like to sincerely thank my thesis supervisor, Sara Kirk, for her guidance throughout the completion of this thesis. I have greatly appreciated her intellectual contribution to this research and her recommendation of using core and non-core food. This classification is highly practical from the perspective of health promotion and I am happy to have had the opportunity to apply it to the research setting.

As well, I would like to express my appreciation to those involved with the Children's Lifestyle and School-performance study (CLASS) II research project. CLASS II was by the Canadian Institute of Health Research (University of Alberta; nominated principal applicant, Paul Veugelers). I want to thank Dr. Paul Veugelers and Dr. Sara Kirk, principle investigators on the CLASS II project for providing the opportunity to work with the data for my thesis, Connie Lu, who assisted with data management, and to Dr. Stefan Khule who supported me with the statistical analysis.

Finally, I would like to thank Melanie Keats for her continued support and valuable input throughout the writing process.

CHAPTER 1 INTRODUCTION

According to Health Canada, a healthy diet consists of eating a variety of foods to feel good and maintain health (Health Canada, 2015). It ensures optimal nutrition is known to have a variety of benefits on over-all health and well-being (Sofi, Cesari, Abbate, Gensini, & Casini, 2008). There is evidence that a healthy diet is also linked to improved cognitive and academic performance in children (Feinstein et al., 2008). The majority of studies that address the role of nutrition focuses on the importance of breakfast and the effects of insufficient food intake on cognitive functioning (Kleinman et al., 2002; Hall et al., 2001). There is limited research on the association between poor nutrition and academic performance; however the few studies that do exist have noted a negative influence between unhealthy food consumption and school achievement (Tobin, 2013; Feinstein et al., 2008; Fu, Cheng, Tu, & Pan, 2007). Unhealthy food choices include eating foods that are energy-dense and nutrient-poor (Health Canada, 2012). Consumption of these food choices can increase risks to nutritional health.

It is important to understand the relationship between health behaviors, such as diet and physical activity, and school performance. This will allow policy makers to be better informed, which can lead to more effective health strategies. Health promotion programs and policies that are delivered through the schools can help children develop and practice healthy behaviors from an early age. The influence that dietary behaviors may have on student performance should be more extensively studied. This will allow educators, parents, and other stakeholders to become informed about children's health behaviors they can help modify. This information can then be used to tailor school food policies and implement nutrition programs that help students achieve optimal success. By using data from the 2011 Children's Lifestyle and School-Performance Study (CLASS II), this study aims to further investigate the association between diet and academic performance in a population survey of grade five students in the Canadian province of Nova Scotia.

1.1 CURRENT DIETARY HABITS

Over the past few decades, the food environment of North Americans has shifted from the consumption of fresh, home-cooked meals to oversized portions of convenience foods, such as burgers and French fries that are typically high in sugar, fat and salt (Schluter, 1999). The changes in the food landscape include an increasing number of commercially prepared meals and convenience foods (Schluter, 1999), increasing portion sizes (Piernas & Popkin, 2011), and an increase of added sugars and fats (Drewnowski, 2003; Piernas & Popkin, 2011). This modern food environment has had an impact on the way children eat. Trends in food consumption of North American children have been examined using cross-sectional surveys since the 1970s (Jahns, Siega-Riz, & Popkin, 2001). These surveys have indicated a shift from consuming meals at home to consuming meals at restaurants or fast food establishments (Nielsen, Siega-Riz, & Popkin, 2002). This shift has led to an increase in the consumption of sugar-sweetened beverages, pizza, candies, and savory snacks (Nielsen et al., 2002; Piernas & Popkin, 2011).

Dietary quality reflects nutrient adequacy, which refers to a diet that meets the requirements for energy and essential nutrients. A high-quality diet emphasizes fruits, vegetables, and whole grains, and limits the amount of sodium, refined sugars, saturated fat, and cholesterol (*Dietary Guidelines*, 2010). Whereas a low-quality diet is characterized by an intake of high fat, excess sugar, low fibre, low vitamins, and too few whole grains, fruits or vegetables (Johnson, van Jaarsveld & Wardle, 2011). The risk of many chronic diseases, including heart disease, stroke, diabetes and some cancers can be reduced by consuming high-quality diets (*Dietary Guidelines*, 2010). High-quality foods also play an important role in the growth and development of children and adolescents. They can help prevent health problems such as obesity, iron deficiency and osteoporosis (*Dietary Guidelines*, 2010).

Canada's Food Guide to Healthy Eating is a tool that helps guide food selection and promotes the nutritional health of Canadians. It takes into account nutrient standards and the prevention of chronic diseases. The Food Guide separates foods into four groups: grain products, vegetables and fruit, milk and alternatives, and meat and alternatives. An "other foods" category includes foods that are: mostly fats, oils or sugar, high-fat and/or high-salt snack foods, beverages, and herbs, spices and condiments (Canada's Food Guide, 2007). For children ages nine to 13, the recommended daily servings are six for vegetables and fruit, six for grain products, three to four for milk and alternatives, and two to three for meat and alternatives. However, Canadian children are currently not meeting all of the Canadian food guidelines. According to the 2004 Canadian Community Health Survey (CCHS), Canadian children and adolescents are consuming an average of 4.5 servings of vegetables and fruit a day (Garriguet, 2006). In the Atlantic Provinces, 79 percent of children and adolescents are consuming fewer than five daily servings of vegetables and fruit compared to 64 percent of children and adolescents for

Canada overall (Garriguet, 2006). A majority of Canadians ages 10 to 16 are not meeting the recommended minimum of three daily servings of milk and alternatives. From the 2004 CCHS, 61 percent of boys and 83 percent of girls were consuming less than three servings of milk and alternatives a day (Garriguet, 2006). In 2006, a study of the physical activity (PA) levels and dietary intakes of children and youth in Nova Scotia was conducted. The study yielded similar figures to the 2004 CCHS, with approximately 80 percent of grade seven students not meeting the recommended servings of vegetables and fruit, and just over 50 percent not meeting the recommended servings of milk and alternatives (St John et al., 2008).

The number one energy source for children is grain products, providing 31 percent of the daily calories (Garriguet, 2006). The Food Guide recommends a moderate consumption of "other foods", meaning not eating these foods to extremes; however "other foods" rank second in supplying energy to children, providing, on average, 22 percent of the daily calories. The most commonly consumed "other" food was sugar-sweetened beverages (Garriguet, 2006). In 2003, all grade five students in Nova Scotia were invited to participate in the Children's Lifestyle and School-performance Study and to have their dietary intakes assessed. From the results, nearly half of the children did not meet the minimum recommendations of Canada's Food Guide for vegetables and fruit. More than half did not meet the recommendations for grain products (54 percent) or meat and alternatives (74 percent) and 42 percent did not meet the recommendations for milk products (Veugelers, Fitzgerald, & Johnston 2005). The Canadian records from the 2001/02 World Health Organization *Health Behavior in School-Aged Children Survey* observed a low reported intake of healthy foods among the youth aged 11 to 16 years

(Janssen, Katzmarzyk, Boyce, King, & Pickett, 2004). In terms of "other food" consumption, about a quarter of the adolescents reported drinking soft drinks and eating sweets, such as candy and chocolate, more than once per day (Janssen et al., 2004).

Consistent research and policy development regarding food consumption is limited due to a lack of clear terminology to classify foods and dietary patterns. Dietary quality is characterized in many different ways; for example, an unhealthy diet could be characterized by high fat, excess sugar, and low vitamins. However, this approach reflects nutrient intakes which are difficult to translate into practical dietary advice. An alternative approach is to use foods to represent dietary quality, instead of nutrients (McCarthy, Robson, & Livingstone, 2006). With this perspective, defining foods as healthy and unhealthy, or good and bad is problematic. Food itself is neutral, all foods can be a part of a healthy, well-balanced diet if the focus is on variety and moderation. Labeling foods as good or bad implies a black and white way of thinking, and can lead to guilt associated with 'bad' foods. An alternative approach is to categorize foods as core or non-core to a healthy diet. Core foods are foods that are essential in providing the nutrients the body needs (Johnson et al., 2011). Foods included in the four food groups of *Canada's Food Guide* are considered core foods. Non-core foods are not essential for providing nutrients the body needs, and are superfluous to a healthy diet. They are more energy dense and lower in nutrients than core foods and are typically eaten for pleasure rather than health (Johnson et al., 2011). A diet based on core foods should adequately meet essential nutrient requirements. Even though some non-core foods can provide useful nutrients, for example potassium in French fries, any nutrition from non-core foods is considered extra in the diet. Overall, non-core foods contribute few micronutrients to the diet and are high in fat and/or sugar and therefore energy. A dietary pattern of non-core food consumption may contribute to excessive energy intakes, replace core foods in the diet, and may lead to decreased intakes of micronutrients essential for optimal health (Webb et al., 2006). Classifying food intakes as core and non-core provides a relatively simple index of diet quality and will therefore be used in this research project.

1.2 NUTRITION AND COGNITIVE ABILITIES AND PERFORMANCE

Nutrition plays a crucial role in the development and maintenance of brain function. The brain's neurochemistry may be affected by diet in several important ways. First, the availability of precursors required for the synthesis of neurotransmitters is affected by the ingestion of food. Second, vitamins and minerals obtained through food sources are essential co-factors for the enzymes that synthesize neurotransmitters; and third, dietary fats have an effect on neural function by altering the composition of the nerve cell membrane and the myelin sheath (Greenwood & Craig, 1987).

Neurotransmitters are responsible for relaying chemical messages throughout the brain and body; these chemical messages pass between nerve cells, called "neurons" (Greenwood & Craig, 1987). Amino acids and choline from dietary sources are important in the maintenance of the brain's neurons, which are responsible for releasing chemicals such as serotonin, acetylcholine, and norepinephrine (Colby-Morley, 1981). These neurotransmitters have important roles in cognition. Serotonin is involved with memory and learning, whereas acetylcholine and norepinephrine both play roles in attention (Colby-Morley, 1981).

Cognitive abilities are brain-based skills that are required to carry out tasks. Examples of cognitive abilities include memory, concentration and attention (Finn et al., 2014). The main components of food – protein, carbohydrates, and fat – are essential in maintaining cognitive abilities (Erickson, 2006). Protein is used to create neurotransmitters, and a lack of protein in the diet can lead to poor student performance (Erickson, 2006). Carbohydrates supply the body with glucose, which along with oxygen, is the fuel for brain cells. Certain fats, such as Omega-3 and Omega-6, are also essential for the proper functioning of the brain. Omega fatty acids are important for the production and maintenance of brain cells, but must be supplied through the diet (Erickson, 2006). A deficiency of Omega-3 fatty acids has been associated with an increased risk of mental disorders, including attention-deficit disorder and dyslexia, which both have an effect on learning (Freeman et al., 2006). A six month trial by Richardson and Montgomery (2005) found that reading, spelling and behavior improved in children with developmental coordination disorder after receiving fatty acid supplementation.

It is suggested that zinc and iron play an important role in memory and cognition (Wood, 2001). Zinc contributes to the brain's structure and function and is found in the gray matter of the hippocampus, which is a region associated with memory and spatial navigation (Black, 1998; 2003). Through animal and human studies, there has been evidence to suggest that zinc deficiency may lead to delays in cognitive development (Black, 1998; 2003). Research by Wood (2001) tested zinc's effect on verbal memory and found that the subject's ability to remember everyday words slowed significantly after consuming a low-zinc diet for three weeks (Wood, 2001). Trials of zinc supplementation in Chinese and American children suggest that zinc may impact specific cognitive processes, such as attention and reasoning, rather than general performance tasks (Penland et al., 1997; Sanstaed et al., 1998). Like zinc, iron is found in brain tissue, and areas that are important for cognition – such as the hippocampus – are sensitive to iron deficiency (Beard, 2001). Iron is a co-factor for several enzymes involved in neurotransmitter synthesis. Those enzymes help synthesize the neurotransmitters serotonin, dopamine and norepinephrine, which play a role in attention and cognition (Youdim & Yehuda, 2000). An association between hemoglobin levels and cognitive development or school achievement has been identified by several studies (de Andraca et al., 1990; Hurtado et al., 1999; Lozoff et al., 1991 & 2000). In addition, a study by Halterman, Kaczorowski, Aligne, Auinger, and Szilagyi (2002) noted that iron-deficient children and adolescents scored lower on standardized tests compared to children with normal iron status. These findings demonstrate the influence of nutrition on brain and cognitive development in children.

Cognitive performance encompasses basic cognitive abilities such as attention, concentration, and memory, as well as information processing (Trudeau & Shepard, 2008). It is a mental function that is measured using age appropriate intelligence tests, such as the Wechsler Intelligence Scale for Children that assess IQ (Trudeau & Shepard, 2008). Specific nutrients such as iron, iodine, and folate are important for the proper development of the brain (Bryan et al., 2004), and are obtained through a well-balanced diet. A series of experiments in the 1980s demonstrated the importance of vitamin and mineral status among children and its effect on cognitive ability. Benton and Roberts (1988) examined whether a deficiency of dietary vitamins and minerals were preventing optimal psychological functioning in children. Sixty Welsh children received either a multi-vitamin/mineral supplement or a placebo for eight months. At the end of the trial, the supplement group showed a significant increase in non-verbal intelligence, while the placebo group did not (Benton & Roberts, 1988). Non-verbal intelligence is represented by the ability to solve problems using hands-on reasoning (Cianciolo & Sternberg, 2004). It is not limited by language abilities, and non-verbal tasks include understanding mathematical concepts. Verbal intelligence is represented by the ability to solve problems using language-based reasoning (Cianciolo & Sternberg, 2004). Verbal tasks include understanding and comprehending reading and language arts.

Crombie et al. (1990) tried to replicate the Benton and Roberts design and they detected a small, but non-significant difference in non-verbal intelligence between the control and supplementation groups. A similar study was carried out in the United States with 26 delinquent juveniles, aged 13 to 16. The subjects were randomly assigned to receive either a multi-vitamin/mineral supplement or a placebo for 13 weeks. There was no significant change in verbal scores, however non-verbal intelligence in the supplement group increased by an average of six IQ points (Schoenthaler, Amos, Doraz, Kelly, & Wakefield, 1991). On the basis of these previous findings, Benton and Cook (1991) sought to further validate the relationship between vitamins/minerals and intelligence. They studied 47 British six-year-olds from two schools, who received either a multi-vitamin/mineral supplement or a placebo for six or eight weeks (Benton & Cook, 1991). The children's intelligence and reaction time were assessed before and after the trial. The overall intelligence score of those taking the supplements increased by 7.6 points, whereas taking the placebo was associated with a decrease of 1.7 points (Benton & Cook, 1991). Greater changes were experienced in non-verbal intelligence than verbal intelligence. The non-verbal scores of the children taking supplements increased by 10.8 points, compared to an increase of 1.3 among the children taking the placebos (Benton & Cook, 1991). When Benton and Cook tested the concentration ability of the children, those who received the supplements demonstrated an increased ability to concentrate when faced with a difficult task. Of the two schools involved in the study, one was from an economically deprived area while the other was from a more affluent area. The students from the lower socioeconomic area had a greater response to the supplementation compared to the students from the higher socioeconomic area (Benton & Cook, 1991). Similar findings have led to the conclusion that it is possible to improve IQ scores with micronutrient supplementation, but only in children with inadequate diets (Benton 1991; Nelson, 1992; Eysenck, 1997). This enhancement of non-verbal intelligence reflects brain functions that are influenced by certain nutrients in the diet (Schoenthaler, Bier, Young, Nichols, & Jansenns, 2000). It appears that rather than inducing cognitive enhancement, supplementation of certain nutrients can help reverse the adverse effects of poor nutritional status (Schoenthaler et al., 2000).

Nearly all of the positive effects demonstrated between nutrition and cognitive functioning had an influence on non-verbal intelligence rather than verbal intelligence. Since non-verbal intelligence can be represented by analytical problems, it would appear that proper nutrition would have a more beneficial influence on non-verbal school subjects such as mathematics, instead of verbal subjects involving reading and writing. However, there have been no studies conducted that have examined this association.

1.3 DIETARY PATTERNS AND ACADEMIC PERFORMANCE

Cognitive abilities are associated with academic performance and have been used to predict achievement in children and adolescents (St. Clair-Thompson & Gathercole, 2006). Since specific nutrients have an effect on cognitive abilities, it can be theorized that dietary patterns would influence cognitive performance. Northstone et al. (2012) hypothesized that a more healthy diet would be associated with increased IQ scores among children during early to mid-childhood. Dietary patterns were assessed at 3, 4, 7 and 8.5 years of age, while IQ was assessed only at 8.5 years. The 'processed' dietary pattern, which was characterized by high fat and sugar content, was negatively associated with IQ, whereas the 'health conscious' dietary pattern characterized by fruit, vegetables, and fish, was positively associated with IQ (Northstone, Joinson, Emmett, Ness & Paus, 2012). This evidence suggests that diet quality during early childhood may be associated with intelligence later in life. Small increases in IQ may be associated with a healthy diet, consisting of high intakes of nutrient rich foods, while small reductions in IQ may be associated with a poor diet, consisting of high fat, sugar, and processed foods (Northstone et al., 2012).

If good nutrition is needed for optimal cognitive performance it would then appear that a healthy diet would also help contribute to good academic performance among students, whereas a poor diet would hinder such achievement. Academic performance is generally assessed by academic achievement, which is measured by formal assessments such as standardized test scores or school grades (Trudeau & Shepard, 2008). In 2003, the Children's Lifestyle and School-Performance Study (CLASS) was conducted in Nova Scotia and over 5200 grade five students were surveyed

(Florence, Asbridge, & Veugelers, 2008). It was one of the first studies to assess overall diet quality in relation to academic performance. It demonstrated that students with decreased diet quality were significantly more likely to perform poorly on literary assessments (Florence et al., 2008). Additionally, students with an increased intake of fruit and vegetables and lower intake of dietary fat were less likely to fail the assessment (Florence et al., 2008).

Shi et al. (2013) has more recently examined the association between dietary behaviors and academic outcomes among children in the United States. They noted that students who were classified as "healthier eaters" had a lower prevalence and probability of having academic problems, such as poor grades (Shi, Tubb, Fingers, Chen, & Caffrey, 2013). A similar study from Taiwan demonstrated the negative effects of unhealthy eating on school performance. Elementary school children with a greater number of unhealthy eating patterns, which included high intake of low-quality foods and low intake of nutrient-dense foods, were more at risk for poor overall school performance (Fu et al., 2007).

Schools that have launched healthy meal initiatives have noted many benefits among children, which includes improvement in academic performance. A two-year obesity prevention intervention was implemented among four elementary schools in the United States with two control schools. School-provided breakfasts, lunches, and snacks were modified in the intervention schools in order to provide healthier options. Menus included more high-fiber items, fewer high-glycemic items, and lower amounts of total, saturated, and trans fats (Hollar et al., 2010). Over the two-year period, math and reading scores were compared between the intervention and control schools. Overall, children attending the intervention schools had significantly higher math scores than children in the control schools. Reading scores were also higher among intervention children, but the difference was not significant (Hollar et al., 2010).

Another health initiative, which was highly publicized in the UK, was Jamie Oliver's "Feed Me Better" campaign. The British chef implemented a new menu for the schools in order to offer healthier meals to the children. Traditionally, school meals were based on low-budget processed foods, such as burgers and chips, sausage rolls, and fish fingers. These processed foods are high in fat, and do not provide essential nutrients. The aim of the campaign was to substitute all junk or processed food with healthy alternatives. In order to assess changes in academic performance, test score results were compared before and after the implementation of the campaign. Educational outcomes improved significantly in English and science with a similar, but not statistically significant improvement in mathematics (Belot & James, 2011). These results indicate that changing dietary habits in children can have positive short-term effects on educational achievements (Belot & James, 2011).

Feinstein et al. (2008) also assessed the importance of diet; however he examined the relationship during different stages of childhood. The impact of dietary intake on school achievement was assessed at ages 3, 4 and 7. It was noted that higher 'junk food' dietary pattern scores, characterized by foods high in fat and/or sugar, were associated with lower test results at all three ages. In contrast, a positive association was observed between the 'health conscious' dietary pattern and school attainment at all three stages of early childhood (Feinstein et al., 2008). A similar trend was found between diet quality and learning difficulties in Norwegian adolescents. Students who consumed fruits regularly had lower odds of mathematical difficulties, while a high intake of foods representing a poor diet was associated with increased odds of mathematical difficulties (Overby, Ludemann, & Hoigaard, 2013). Another study involving Norwegian school children yielded corresponding results. Sigfusdottier, Kristjansson, and Allegrante (2007) utilized data from the 2000 Icelandic study and found that the consumption of fruits and vegetables was positively correlated with academic performance, whereas the consumption of 'bad' foods, such as sweets, crisps, fried foods, and pizza, was negatively correlated with academic performance (Sigfusdottier, Kristjansson, & Allegrante, 2007). A negative association between fast-food consumption and math and reading scores has also been observed. Tobin (2013) examined data collected by the Early Childhood Longitudinal Study- Kindergarten Cohort, and found that students with a higher-than-average consumption of fast foods had lower test scores in math and reading. The findings of the current studies contribute to the presumption that consuming core foods, which are required for optimal health, will help students to achieve their full academic potential. Whereas the consumption of non-core foods, that are energy-dense and nutrient poor, may hinder academic achievement among students.

1.4 MEASURES OF DIETARY ASSESSMENT

Collecting accurate and reliable dietary data from children is difficult. Young children have lower literacy levels and difficulties in estimating portion size. The age at which a child can reliably report their dietary intake varies across research. Previous research suggests that by the age of eight to ten years children are often as reliable as their parents in reporting dietary intake, while other research suggests that children are not able to accurately self-report until the age of 12 (Livingstone, Robson, & Wallace, 2004). However, the age at which a child can report varies by dietary assessment method (Livingstone et al., 2004). There are several methods that can be used, such as the 24-hour dietary recall, food diary, and food frequency questionnaire (FFQ). A 24-hour dietary recall is a retrospective method where the participant is interviewed about their food and beverage consumption during the previous day (Blanton, Moshfegh, Baer & Kretsch, 2006). Drawbacks of using this method are that it is not representative of habitual intake, and is expensive and time consuming to carry out. A food diary is a prospective method where the participant records details of foods and beverages consumed at the time of consumption (Krall & Dwyer, 1987). This method is also time consuming as it requires the participant to record their dietary intake for several days. A third assessment method is the FFQ, which assesses habitual diet by asking about the frequency of food items consumed over a reference period (Liu et al., 2013). Over-estimation is common, particularly for foods perceived as 'healthy' or foods that are eaten less often. However the FFQs have a lower respondent burden than the other assessment methods and are easier to administer. For studies involving a large number of participants, the FFQ provides a cost-effective method to estimate the usual dietary intake over a long time span. Despite concerns regarding measurement error, the FFQ remains the most commonly used dietary measurement method for dietary studies (Thomson et al., 2003). The Harvard Youth Adolescent Food Frequency Questionnaire (YAQ) is a FFQ specifically developed for children and adolescents. The format and questions are designed to be simple for children to understand. The YAQ has been validated in the literature and serves as a self-administered tool that provides nutritional information about children (Rockett et al., 1997).

1.5 PHYSICAL ACTIVITY AND ACADEMIC PERFORMANCE

In the literature, there is a growing body of evidence that suggests a connection between physical activity and positive academic outcomes. It is hypothesized that physical activity increases cognitive function and improves academic skills, such as reading and writing abilities (Donnelly & Lambourne, 2011). Several mechanisms have been suggested for why physical activity is beneficial for cognition (Singh, Uitdewilligen, Twish, van Mechelen, & Chinapaw, 2012). The effect of physical activity could; (1) increase the flow of blood and oxygen to the brain (Jorgensen, Nowak, & Ide, 2000), (2) increase endorphins, which can improve mood (Yeung, 1996), and (3) increase synaptic plasticity/changes in brain function (Schinder & Poo, 2000). These mechanisms may have an influence on cognitive measures such as memory and concentration, which are the foundation for academic abilities (Sibley & Etnier, 2003).

The majority of cross-sectional studies indicate a positive association between physical activity and academic performance (Trudeau & Shepard, 2008). Nelson and Gordon-Larsen (2006) observed that adolescents who were active in school were more likely to have higher grades in English and mathematics. Whereas a study by Field, Diego and Sanders (2001) found that more active students had higher GPAs. Time spent in physical education was demonstrated to have a positive influence on academic performance. Tremarche, Robinson and Graham (2007) noted students who received more hours of physical education scored higher on Standardized English tests.

In terms of intervention studies, there are few that have examined the relationship between physical activity and academic performance. However a study by Donnelly et al. (2009) demonstrated that an intervention to promote daily physical activity improved academic achievement scores over three years. Whereas an intervention that increased physical education classes from 2 days per week to daily found that the increased physical education was positively associated with reading, writing and mathematics test scores (Ericsson, 2008).

Nutrition and physical activity are important factors in overall health, and evidence suggests that both may play a role in student success. Health behaviors are interconnected, and an effect on one usually has an effect on the other, therefore it is difficult to study the influence of diet among children without considering the influence of physical activity. For this research, physical activity has been treated as a confounder in order to determine if an independent relationship exists between diet and academic performance.

1.6 OTHER INFLUENCES ON ACADEMIC PERFORMANCE

Many factors besides nutrition and physical activity appear to have an influence on academic performance. Those factors include weight status, food security/sufficiency, and socioeconomic status. A national childhood study was conducted in the United States which examined the effect of obesity on academic achievement. The results found that children who were overweight had significantly lower reading and mathematics scores compared to children who were not overweight (Datar & Sturm, 2006). A recent study by Goldberg et al. (2013) examined the association between IQ and obesity in adolescents. Regardless of sex, subjects experiencing obesity were found to have the lowest IQ scores; whereas those in the normal body mass index (BMI) group had the highest IQ scores (Goldberg et al., 2013). A similar association was found between weight status and academic performance, where BMI was negatively associated with reading and mathematics performance among third and fifth grade students (Castelli, Hillman, Buch, & Erwin, 2007).

Food insecurity and insufficiency may also have an impact on cognitive functioning among children. Food insecurity is a broad term that refers to limited availability of, or inability to acquire nutritionally adequate foods due to lack of financial resources (Bickel, Nord, Price, Hamilton, & Cook, 2000). Whereas food insufficiency is a more specific term that refers to an inadequate amount of food intake (Sahyoun & Basiotis, 2000). Studies have shown that children from families that experience food insecurities and/or food insufficiencies have lower reading and mathematics scores, and are more likely to have repeated a grade (Jyoti, Frongillo, & Jones, 2005; Alaimo, Olson, & Frongillo, 2001). Nearly all studies that examine factors influencing academic achievement have consistently noted that socioeconomic status is a strong correlator that often contributes more than all other variables. Student performance is influenced by a multidimensional set of variables. Each of these variables mentioned are intertwined, and a change in one will undoubtedly affect another. The purpose of this study is to examine the influence of core and non-core dietary patterns on academic performance while controlling for other health behaviors, such as physical activity, and determinants, such as socioeconomic status.

1.7 RESEARCH QUESTIONS

The research questions that will direct the proposed study are:

1. Will grade five students in Nova Scotia, who consume high intakes of non-core food, be more likely to have academic difficulties than students who consume low intakes of non-core foods?
2. Do dietary patterns of grade five students have a greater influence on non-verbal school subjects (mathematics) than verbal school subjects (reading and writing)?

1.8 HYPOTHESES

The two hypotheses of this study are:

$\mathbf{H_1}$: Students who consume high intakes of non-core foods will have an increased probability of poor academic performance.

$\mathbf{H_2}$: Dietary patterns of core and non-core foods will have a greater influence on non-verbal scores (mathematics) than verbal scores (reading and writing).

1.9 CONTRIBUTIONS

The CLASS II project was conducted to assess heath behaviors, school performance and socioeconomic determinants among grade five students in Nova Scotia. Of the many health outcomes that were assessed in CLASS II, nutrition was chosen to be the main focus of this thesis project. Therefore, this study examined a small piece of the CLASS II project in order to gain a more comprehensive understanding of dietary influences.

This research builds on earlier work by Florence et al. (2008) who reported on various dietary indices from the 2003 CLASS project including the Diet Quality Index-

International (DQI-I). This thesis project expands on this previous research by examining dietary intake classified as core and non-core food.

CHAPTER 2 METHODS & PROCEDURES

2.1 RESEARCH DESIGN & METHODOLOGY

This study aims to explore the association between dietary intake and academic performance. For the purpose of this study, an analysis of the data from the 2011 Children's Lifestyle and School-Performance Study (CLASS II) was conducted. The CLASS II was a province-wide, cross-sectional study that aimed to assess the importance of health behaviors for school performance, while accounting for socioeconomic determinants among grade five students in Nova Scotia.

The research design of this study was descriptive, non-experimental research that used quantitative data to examine correlations within a range of health outcomes. In 2011, over 5,500 students, aged 10-11 years, from 269 schools participated in this study. A second data set was used from the Nova Scotia Department of Education that linked the health outcomes from CLASS II to the corresponding school performance of the participating students. The school performance data was collected in 2012, when the students were in grade six, therefore it offers a prospective analysis on academic performance.

2.2 INTAKE DATA

Trained research assistants visited the schools and administered surveys to the students and completed anthropometric measurements. Standing height was measured to the nearest 0.1 cm after students had removed their shoes, and body weight was measured to the nearest 0.1 kg on calibrated digital scales. The student survey gathered information on physical activity, screen time, mental health and body image, however physical activity was the only variable from the student survey assessed in this analysis. The home survey was completed by the parents and gathered information on socio-demographic factors such as parental education, household income, and urban/rural residency. Dietary intake and mealtime behaviors were measured with the YAQ which was slightly modified for Canadian dietary settings. The YAQ is a validated tool that provides a measure of nutritional information for children and adolescents aged 9 to 18 years (Rockett et al., 1997).

2.3 OUTCOME VARIABLES

The primary outcome variable was academic performance which was measured using the Nova Scotia Assessment for Reading, Writing, and Mathematics. It is a standardized assessment that is administered to grade six students in Nova Scotia by the Department of Education and Early Childhood Development. Teacher assigned grades can be biased and can vary across schools (Sallis et al., 1999); therefore, the use of a standardized assessment is important for this study to limit any discrepancies in relation to academic outcomes. The reading, writing, and mathematics assessment was administered in the fall of 2011, and included tasks that reflected the end of grade five curriculum expectations. For the reading and writing assessment, students read a variety of texts and answered questions about what they read. For the mathematics assessment, a variety of multiple choice and problem solving questions were given to reflect understanding of mathematical domains. The assessments were collected and sent to the Department of Education and Early Childhood Development to be centrally scored.

Academic performance was assessed according to students' performance in relation to pre-determined expectations on the standardized assessments (described as 'does not meet expectations' and 'meets expectations'). A continuous score for reading and mathematics performance was also collected and that data was presented as a z-score, ranging from -3 to +3.

The primary independent variable was the consumption of core and non-core foods, which was determined using the food frequency questionnaire (Appendix A). Core foods and beverages were defined as those in the following five food groups: (1) bread, cereals, rice, pasta and noodles; (2) vegetables; (3) fruit; (4) yogurt, cheese, milk and (5) meat, fish, poultry, eggs, nuts and legumes. All other foods and beverages were classified as non-core and examples can be seen in Table 1. Response options for the YAQ were listed as 'never', 'once per month', 'once per week', '2 or more per week, '5 or more per week', '1 time per day', '2 or more per day' etc. The collected data were recoded to reflect frequencies per day, as indicated by each response option. For example, 'every day' was recoded as 1 (time/day), 'once a week' was recoded as 1/7 (times/day), and 'once a month' was recoded as 1/30 (times/day), etc. A summary of all of the YAQ response options and corresponding frequencies per day can be found in Appendix B. The total daily consumption frequency (times/day) of core and non-core foods were calculated by summing the daily intakes of each category. This method of scoring, which has been used in previous studies (McGowan, Croker, Wardle, & Cooke, 2012), was then constructed into three categories to represent low, medium and high consumption. The categories were determined by dividing the total daily consumption scores into tertiles, so that non-core food could be compared simply by low or high intakes on an individual level. In order to avoid any misclassification of dietary intake all servings from the YAQ were standardized to a 2000 kcalorie diet before creating the tertiles.

Table 1 Criteria used to classify foods as core and non-core.

Category	Foods
Core	Breads (all types), rice, pasta Breakfast cereals Fruits and vegetables (all) Dairy (all) Meat and meat alternatives (not crumbed or battered)
Non-core	Crumbed or battered meat and meat alternatives Fried food; pizza, hot dogs, hamburgers Cakes, muffins, cookies, pies, pastries Snack foods Frozen/fried potato products Ice cream and ice confection Chocolate and confectionary Fast food restaurants/meals Fruit drink Sugar sweetened drinks High fat/sugar/salt spreads

2.4 COVARIATES

Weight status of the students was defined by BMI using the anthropometric measurements collected at the schools. Age and sex specific cutoff points for overweight and obesity were established by the World Health Organization's International Obesity Task Force, and were 20 kg/m^2 and 24 kg/m^2, respectively (Cole, Bellizza, Flegal, &

Dietz, 2000). A physical activity score was defined using the physical activity questionnaire for children (PAQ-C). The PAQ-C was calculated by combining physical activity questions from both the student and parent survey. Questions from the survey asked students about their physical activity habits from the past seven days. A copy of the survey can be seen in Appendix C. The PAQ-C is represented as a continuous variable, and there are no published data to support a cut off value where children are considered "active" or "not active". For this analysis, the physical activity scores were divided into tertiles so that children in the lowest tertile could be compared with children in the highest tertile, representing low, medium and high activity.

Other covariates include student gender, urban or rural residency, parental education, and household income levels, which were be obtained through the home surveys delivered to the parents. Food security was not included as an independent variable. Household income levels and parental education have been shown to be considered proxy indicators and were used in this study (Kirk et al., 2013; Jones, Ngure, Pelto & Young, 2013).

2.5 METHOD OF DATA ANALYSIS

All Nova Scotian public schools with grade five students were invited to participate in the survey. Out of the 286 eligible schools, 269 (94.1%) agreed to participate. Informed consent was obtained from 5913 parents, resulting in an average response rate of 67.7% per school. Students who reported an energy intake of less than 500 kcal/day and more than 5000 kcal/day were judged as unreliable and excluded from the analysis, as is common practice in nutritional epidemiology (Willet, 2013). Students were also excluded if they were without academic test results. After the exclusions, 4825 observations remained. All statistical analyses were weighted to account for non-response bias.

The statistical analyses of the data were performed using SPSS version 21, and STATA version 13. SPSS was used to analyze descriptive statistics which were calculated for the total sample by sex, residency, household education, household income, weight status, and physical activity. Food consumption patterns were assessed in SPSS by performing a cross-tabulation to compare the individual intake of the core and non-core food tertiles.

In accordance to the conditions granted by the ethics for this study, the analysis involving the academic performance data was conducted at the IWK Health Center, and was performed with STATA. The analyses for the dichotomous outcomes of academic performance were performed using Poisson regression with robust standard errors. Logistic regressions are commonly used with binary outcomes, however the Poisson method was chosen for this analysis in order to avoid overestimation of the relative risk. When the prevalence of an outcome is high (for example, prevalence rates above 10%), the estimated odds ratio (OR) from a logistic regression is quite different than the estimated prevalence ratio (PR) from a Poisson regression. With a high prevalence rate, the OR can overestimate the relative risk, therefore researchers recommend using a method that estimates the PR instead of the OR (Barros & Hirakata, 2003; Deddens & Petersen, 2008). The academic outcome of 'not meeting expectations' was used to represent academic difficulty. The prevalence of individuals 'not meeting expectations' for reading, writing and mathematics were (12%, 11%, and 29%, respectively), therefore the PR's were calculated using Poisson regression. The outcome for the Poisson model is failing the academic assessment, which has practical value for schools, and will be used in answering the research questions of this study. Understanding what factors influence academic failure is valuable information, and can be used to help increase student success.

Continuous reading and mathematical z-scores were available from the data provided by the Department of Education. They were used in multiple linear regressions as an additional analysis to compare the influence of non-core food on academic performance. Normality was tested for the reading and mathematical z-scores and was found to be acceptable for both linear regression models. Unadjusted Poisson and linear regression models were run to examine the associations between core and non-core food intake and academic performance. The models were then adjusted for sex, parental education, parental income, weight status, and physical activity.

CLASS II collected data on students from different schools, over different areas of the province. The data therefore has a cluster structure, which needs to be taken into account. Observations within schools would be expected to be more similar than observations between schools. This leads to intra-cluster correlations, meaning observations in the same school are more likely correlated to each other. If intra-cluster correlations are not accounted for, wrong conclusions about statistical testing could be reported. In order to account for the clustering of schools, the regression models in this analysis were run with robust standard error. For all analyses, the threshold of statistical significance was set at $p \leq 0.05$ to indicate at least a moderately strong relationship between variables.

2.6 ETHICAL ISSUES

The CLASS II study is University of Alberta research; therefore ethical approval for this study was first obtained from the Health Research Ethics Board of the University of Alberta. Ethics approval was also obtained from the Health Research Ethics Board at Dalhousie University. Permission for data collection was granted from participating school boards and informed consent was obtained from the parents for the participating students.

For the data analysis, a memorandum of understanding was signed to gain access to the data from CLASS II. An amendment was approved by the Health Sciences Research Ethics Board for the academic data linkage and analyses involving the academic performance data were conducted on the premises of the IWK Health Center, where these data were held at the time of the analyses.

CHAPTER 3 RESULTS

3.1 DESCRIPTIVE STATISTICS

A description of the CLASS II sample that was weighted for non-response bias is provided in Table 2. The proportion of boys and girls in Nova Scotia was similar, at 52% and 48%, respectively. More students resided in an urban community than a rural community, with the proportions being 65% and 35%, respectively. For parental education attainment, 19% of the children had parents with secondary education or less, 42% had a college education, and 39% had a university education. Twenty percent of parents reported an annual household income of less than $40,000, while 21% reported an income of over $100,000 per year. Twenty percent preferred not to answer this question, while the remaining parents had an annual income between $40,000 and $100,000. Four percent of the student population was considered to be underweight, and the majority (61%) was considered to be normal weight. Twenty-three percent of the children were considered to be overweight, and 12% of the student population was considered obese.

Table 2 Descriptive characteristics of participants in the CLASS II.

Independent Variable	No. of Students	%
Sex		
Female	2305	48
Male	2520	52
Residence		
Urban	3129	65
Rural	1696	35
Parental Education		
Secondary or less	846	18
Community College	1932	40
University	1775	37
Annual Household Income ($)		
<40,000	965	20
40,001-60,000	627	13
60,001-100,000	1255	26
>100,000	1013	21
Preferred not to answer	965	20
Weight Status		
Underweight	182	4
Normal Weight	2799	61
Overweight	1037	23
Obese	533	12
Physical Activity		
First tertile (lowest)	1604	33
Second tertile	1610	33
Third tertile (highest)	1611	33

A cross-tabulation demonstrated that nearly two thirds (61%) of the children in the highest category of non-core food consumption were consuming low intakes of core food in their diet (Table 3). While two thirds (66%) of the children who were consuming low intakes of non-core food, were consuming high intakes of core food in their diet (Table 3).

Table 3 Cross-tabulation of consumption of core foods by the consumption of non-core foods.

	Non-core Food Intake		
Core Food Intake	Low	Medium	High
Low	6%	32%	61%
Medium	28%	43%	29%
High	66%	24%	10%

3.2 POISSON REGRESSION

The results of the Poisson regression show that as core food consumption increased, the prevalence of reading, writing, and mathematical difficulties decreased (*p* = <0.001). This information is depicted in Tables 4 and 5. The results for the adjusted model (Table 5), suggest that increasing core food consumption was significantly associated with a decreased prevalence of reading difficulties (PR: 0.43 (0.33-0.55), *p* = <0.001), writing difficulties (PR: 0.63 (0.51-0.78), *p* = <0.001), and mathematical difficulties (PR: 0.75 (0.65-0.85), *p* = <0.001).

Table 4 Results of univariate Poisson regression for the association between core food intake and academic difficulties.

	Reading Difficulties*			Writing Difficulties*			Mathematical Difficulties*		
Core food intake	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*
First tertile (lowest)	1.00			1.00			1.00		
Second tertile	0.56	(0.47–0.68)	<0.001	0.56	(0.44–0.70)	<0.001	0.77	(0.68–0.86)	<0.001
Third tertile (highest)	0.37	(0.29–0.46)	<0.001	0.57	(0.46–0.70)	<0.001	0.65	(0.57–0.74)	<0.001

*Difficulties defined as not meeting expectations.

Table 5 **Results of Poisson regression for the association between core food intake and academic difficulties while adjusting for confounding variables.**

Outcome	Reading Difficulties* PR	95% CI	*P*	Writing Difficulties* PR	95% CI	*P*	Mathematical Difficulties* PR	95% CI	*P*
Core Food Intake									
First tertile (lowest)		1.00			1.00			1.00	
Second tertile	0.63	(0.52–0.76)	<0.001	0.60	(0.48–0.76)	<0.001	0.84	(0.74–0.94)	0.003
Third tertile (highest)	0.43	(0.33–0.55)	<0.001	0.63	(0.51–0.78)	<0.001	0.75	(0.65–0.85)	<0.001
Sex									
Male		1.00			1.00			1.00	
Female	0.66	(0.56–0.79)	<0.001	0.53	(0.44–0.63)	<0.001	1.06	(0.96–1.17)	0.277
Parental Education									
Secondary or less		1.00			1.00			1.00	
College	0.83	(0.67–1.02)	0.072	0.86	(0.67–1.11)	0.245	0.83	(0.73–0.94)	0.002
University	0.56	(0.43–0.73)	<0.001	0.73	(0.55–0.97)	0.030	0.54	(0.46–0.63)	<0.001
Parental Income									
<40,000		1.00			1.00			1.00	
40,001 – 60,000	0.86	(0.67–1.09)	0.209	0.72	(0.54–0.96)	0.023	0.78	(0.67–0.90)	0.001
60,001 – 100,000	0.77	(0.59–1.00)	0.048	0.70	(0.52–0.94)	0.019	0.76	(0.66–0.87)	<0.001
>100,001	0.46	(0.33–0.65)	<0.001	0.49	(0.33–0.71)	<0.001	0.57	(0.47–0.69)	<0.001
Weight Status									
Normal		1.00			1.00			1.00	
Underweight	1.02	(0.68–1.53)	0.925	0.95	(0.60–1.50)	0.812	0.97	(0.74–1.27)	0.842
Overweight	1.00	(0.84–1.20)	0.958	1.18	(0.96–1.44)	0.116	0.98	(0.88–1.10)	0.786
Obese	1.04	(0.81–1.34)	0.760	1.13	(0.86–1.47)	0.379	1.11	(0.97–1.28)	0.135
Physical Activity									
First tertile (lowest)		1.00			1.00			1.00	
Second tertile	0.86	(0.69–1.07)	0.169	0.78	(0.64–0.95)	0.014	0.96	(0.86–1.07)	0.466
Third tertile (highest)	1.39	(1.13–1.71)	0.002	1.08	(0.90–1.30)	0.418	1.09	(0.97–1.23)	0.154

*Difficulties defined as not meeting expectations.

In regards to non-core food consumption, the Poisson regression shows that as non-core food consumption increased, the prevalence of reading, writing, and mathematical difficulties also increased. This is depicted in Tables 6 and 7. The results for the adjusted model (Table 7), show that an increase in non-core food consumption was associated with an increased prevalence of reading difficulties (PR: 1.53 (1.24-1.89), p = <0.001), writing difficulties (PR: 1.53 (1.21-1.92), p = <0.001), and mathematical difficulties (PR: 1.14 (1.00-1.30), p = 0.055). However, only reading and writing difficulties demonstrated a significant association. There was a significant association found with mathematical difficulties, but only in the second tertile (PR: 1.17 (1.02-1.33), $p = 0.026$).

Table 6 Results of univariate Poisson regression for the association between non-core food intake and academic difficulties.

	Reading Difficulties*			Writing Difficulties*			Mathematical Difficulties*		
Non-core food intake	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*
First tertile (lowest)		1.00			1.00			1.00	
Second tertile	1.63	(1.31–2.04)	<0.001	1.37	(1.08–1.34)	0.009	1.31	(1.14–1.50)	<0.001
Third tertile (highest)	1.78	(1.45–2.18)	<0.001	1.60	(1.28–2.02)	<0.001	1.35	(1.19–1.55)	<0.001

*Difficulties defined as not meeting expectations.

Table 7 **Results of Poisson regression for the association between non-core food intake and academic difficulties while adjusting for confounding variables.**

Outcome	Reading Difficulties*			Writing Difficulties*			Mathematical Difficulties*		
	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*
Non-core Food Intake									
First tertile (lowest)		1.00			1.00			1.00	
Second tertile	1.54	(1.24–1.92)	<0.001	1.34	(1.05–1.70)	0.016	1.17	(1.02–1.33)	0.026
Third tertile (highest)	1.53	(1.24–1.89)	<0.001	1.53	(1.21–1.92)	<0.001	1.14	(1.00–1.30)	0.055
Sex									
Male		1.00			1.00			1.00	
Female	0.63	(053–0.74)	<0.001	0.52	(0.43–0.62)	<0.001	1.04	(0.94–1.15)	0.502
Parental Education									
Secondary or less		1.00			1.00			1.00	
College	0.80	(0.66–0.99)	0.036	0.85	(0.66–1.09)	0.207	0.82	(0.73–0.93)	0.001
University	0.53	(0.41–0.68)	<0.001	0.71	(0.54–0.94)	0.018	0.52	(0.45–0.61)	<0.001
Parental Income									
<40,000		1.00			1.00			1.00	
40,001 – 60,000	0.87	(0.68–1.12)	0.280	0.72	(0.54–0.96)	0.026	0.79	(0.68–0.91)	0.001
60,001 – 100,000	0.76	(0.58–0.99)	0.044	0.70	(0.52–0.95)	0.020	0.75	(0.66–0.87)	<0.001
>100,001	0.45	(0.32–0.62)	<0.001	0.48	(0.33–0.70)	0.000	0.56	(0.46–0.69)	<0.001
Weight Status									
Normal		1.00			1.00			1.00	
Underweight	1.06	(0.70–1.59)	0.782	0.97	(0.62–1.51)	0.886	0.98	(0.75–1.28)	0.892
Overweight	0.99	(0.83–1.18)	0.908	1.17	(0.95–1.43)	0.133	0.98	(0.88–1.09)	0.691
Obese	1.00	(0.78–1.29)	0.972	1.10	(0.85–1.44)	0.462	1.10	(0.95–1.27)	0.193
Physical Activity									
First tertile (lowest)		1.00			1.00			1.00	
Second tertile	0.83	(0.67–1.04)	0.108	0.77	(0.63–0.94)	0.010	0.95	(0.84–1.06)	0.336
Third tertile (highest)	1.29	(1.05–1.57)	0.014	1.05	(0.87–1.27)	0.578	1.06	(0.94–1.19)	0.358

*Difficulties defined as not meeting expectations.

The results of the Poisson regression that was adjusted for both core and non-core food intake (Table 8) demonstrate that core food intake is associated with a decreased prevalence of academic difficulties. However, the association between non-core food intake and academic difficulties is diminished and is no longer significant.

Table 8 Results of Poisson regression for the association between core and non-core food intake and academic difficulties while adjusting for confounding variables.

	Reading Difficulties*			Writing Difficulties*			Mathematical Difficulties*		
Outcome	PR	95% CI	*P*	PR	95% CI	*P*	PR	95% CI	*P*
Core Food Intake									
First tertile (lowest)		1.00			1.00			1.00	
Second tertile	0.61	(0.49–0.74)	<0.001	0.63	(0.49–0.82)	0.001	0.82	(0.72–0.93)	0.002
Third tertile (highest)	0.42	(0.32–0.56)	<0.001	0.71	(0.54–0.93)	0.013	0.73	(0.63–0.86)	<0.001
Non-core Food Intake									
First tertile (lowest)		1.00			1.00			1.00	
Second tertile	1.14	(0.91–1.43)	0.257	1.22	(0.94–1.60)	0.139	1.05	(0.91–1.23)	0.468
Third tertile (highest)	0.94	(0.75–1.19)	0.622	1.24	(0.92–1.67)	0.158	0.96	(0.82–1.13)	0.633
Sex									
Male		1.00			1.00			1.00	
Female	0.66	(0.56–0.79)	<0.001	0.53	(0.44–0.64)	<0.001	1.06	(0.96–1.17)	0.269
Parental Education									
Secondary or less		1.00			1.00			1.00	
College	0.83	(0.67–1.02)	0.072	0.86	(0.67–1.11)	0.245	0.83	(0.73–0.94)	0.003
University	0.56	(0.43–0.73)	<0.001	0.74	(0.55–0.98)	0.034	0.54	(0.46–0.63)	<0.001
Parental Income									
<40,000		1.00			1.00			1.00	
40,001 – 60,000	0.86	(0.67–1.09)	0.209	0.72	(0.54–0.96)	0.025	0.78	(0.67–0.90)	0.001
60,001 – 100,000	0.77	(0.59–1.00)	0.047	0.70	(0.52–0.95)	0.023	0.76	(0.66–0.87)	<0.001
>100,001	0.46	(0.34– 0.64)	<0.001	0.49	(0.34–0.72)	<0.001	0.57	(0.47–0.69)	<0.001
Weight Status									
Normal		1.00			1.00			1.00	
Underweight	1.03	(0.69–1.55)	0.876	0.95	(0.60–1.50)	0.834	0.98	(0.75–1.28)	0.861
Overweight	1.00	(0.84–1.20)	0.990	1.17	(0.96–1.44)	0.118	0.98	(0.88–1.10)	0.767
Obese	1.04	(0.81–1.35)	0.726	1.12	(0.86–1.46)	0.394	1.12	(0.97–1.29)	0.120
Physical Activity									
First tertile (lowest)		1.00			1.00			1.00	
Second tertile	0.86	(0.69–1.07)	0.165	0.78	(0.64–0.95)	0.014	0.96	(0.86–1.07)	0.459
Third tertile (highest)	1.39	(1.13–1.70)	0.002	1.09	(0.90–1.31)	0.376	1.09	(0.97–1.23)	0.165

*Difficulties defined as not meeting expectations.

The first research question for this study was "will grade five students in Nova Scotia who consume high intakes of non-core food be more likely to have academic difficulties than students who consume low intakes of non-core foods?" To answer this, the null hypothesis predicted that students who consumed high intakes of non-core foods *would not* have an increased probability of poor academic performance. When using the results from the Poisson regression adjusted for non-core foods, but not core foods (Table 7), the null hypothesis can be rejected for all three measures of academic performance. From that model, children who consumed high intakes of non-core foods were more likely to have reading, writing and mathematical difficulties than those who consumed low intakes of non-core foods. However, the null hypothesis cannot be rejected when using the results from the mutually adjusted Poisson model that includes both core and non-core food (Table 8). The combined Poisson model demonstrates that the relationship between non-core food intake and academic performance is no longer significant ($p > 0.05$) when core food intake is accounted for (Table 8). Therefore, the answer to the main research question of this study is no, students who consume higher intakes of non-core food are not more likely to have academic difficulties than students consuming low intakes of non-core food.

By contrast, core food consumption had a positive association with all three measures of academic performance. Children who consumed the highest intakes of core food performed better in reading, writing, and mathematics than those who consumed the lowest amounts of core food. The association between core food intake and academic performance remained significant ($p < 0.05$) in the combined Poisson model with non-core food (Table 8). This indicates that the positive influence of core food consumption is independent of any influence non-core food consumption may have on academic performance.

The results of the Poisson regressions indicated no association between weight status and academic performance (Table 6, Table 7). There was no trend between increasing weight status, and all *p*-values were greater than 0.05, indicating little or no relationship. The only significant association found between physical activity and academic performance was with the third tertile and reading difficulties (PR: 1.29 (1.05-1.57), $p = 0.014$) and the second tertile and writing difficulties (PR: 0.77 (0.63-0.94), $p = 0.010$). The association demonstrated that children who participated in the highest levels of physical activity were more likely to have reading difficulties, while children in the medium tertile of physical activity were less likely to have writing difficulties.

Both parental education and parental income were predictors of academic achievement among the students. Children who had parents with higher levels of education were less likely to perform poorly in reading, writing and mathematics. Compared with parents who had an education level of secondary or less, children with parents who had a college education were 15-20% less likely to have reading, writing and mathematical difficulties, and children with parents who had a university education were 30% less likely to have writing difficulties (PR: 0.71 (0.54-0.94), $p = 0.018$), and nearly 50% less likely to perform poorly in reading (PR: 0.53 (0.41-0.68) $p = <0.001$) and mathematics (PR: 0.52 (0.45-0.61) $p = <0.001$) (Table 7).

Parental income levels followed a similar trend, with the prevalence of academic difficulties decreasing with increasing parental income. Children with parents in the two highest income brackets (\$60,001-\$100,000 and >\$100,000), were less likely to have reading and writing difficulties than children from the lowest parental income level of less than \$40,000. Children from the highest income bracket were over 50% less likely to perform poorly in reading (PR: 0.45 (0.32-0.62) $p = 0.000$) and writing (PR: 0.48 (0.33-0.70) p = 0.000) compared to children from the lowest income bracket (Table 7). For mathematics, all three income brackets showed an improvement in performance compared with the lowest parental income. Once again, as income increased, the prevalence of mathematical difficulties decreased, with children in the highest income category being the least likely to have difficulties (PR: 0.56 (0.46-0.69) $p = 0.000$) (Table 7).

Finally, there were sex differences, with girls being less likely than boys to perform poorly in reading (PR: 0.63 (0.53-0.74), $p = 0.000$), and writing (PR: 0.52 (0.43-0.62), $p = 0.000$). For performance in mathematics, boys fared slightly better than girls (PR: 1.04 (0.94-1.15) $p = 0.502$), however the association was not significant (Table 7).

The second research question aimed to determine if dietary patterns of grade five students have a greater influence on non-verbal school subjects (mathematics) than verbal school subjects (reading and writing)? The null hypothesis predicted that dietary patterns of core and non-core foods would have a lesser influence on mathematics scores than reading and writing scores. Given the results of the Poisson regression, this hypothesis cannot be rejected. Even though the prevalence ratios are different for each subject, the 95% confidence intervals overlap (Table 6 – 8). Therefore there is no significant difference between dietary influences on verbal and non-verbal school subjects.

3.3 LINEAR REGRESSION

Multiple linear regressions were conducted using a z-score for reading and mathematics. The results found that an increase in core food intake was positively associated with reading scores ($\beta = 0.48$ (0.39-0.56) $p = 0.000$), and mathematics scores ($\beta = 0.26$ (0.17-0.34) $p = 0.000$) (Table 9).

Table 9 Results of linear regression for the association between core food intake and academic difficulties while adjusting for confounding variables.

	Reading z-score			Mathematics z-score		
Outcome	Coef.	95% CI	*P*	Coef.	95% CI	*P*
Core Food Intake						
First tertile (lowest)		0.00			0.00	
Second tertile	0.28	(0.20–0.36)	<0.001	0.14	(0.07–0.22)	<0.001
Third tertile (highest)	0.48	(0.39–0.56)	<0.001	0.26	(0.17–0.34)	<0.001
Sex						
Male		0.00			0.00	
Female	0.25	(0.19–0.31)	<0.001	-0.05	(-0.11–0.01)	0.094
Parental Education						
Secondary or less		0.00			0.00	
College	0.17	(0.06–0.28)	0.002	0.16	(0.08–0.25)	<0.001
University	0.44	(0.33–0.55)	<0.001	0.44	(0.35–0.54)	<0.001
Parental income						
<40,000		0.00			0.00	
40,001 – 60,000	0.23	(0.11–0.34)	<0.001	0.25	(0.14–0.35)	<0.001
60,001 – 100,000	0.24	(0.12–0.36)	<0.001	0.25	(0.15–0.35)	<0.001
>100,000	0.44	(0.32–0.56)	<0.001	0.42	(0.31–0.53)	<0.001
Weight Status						
Normal		0.00			0.00	
Underweight	0.00	(-0.17–0.17)	0.966	-0.07	(-0.22–0.08)	0.347
Overweight	-0.02	(-0.10–0.05)	0.537	-0.06	(-0.12–0.01)	0.106
Obese	-0.08	(-0.19–0.03)	0.159	-0.09	(-0.19–0.01)	0.075
Physical Activity						
First tertile (lowest)		0.00			0.00	
Second tertile	-0.02	(-0.10–0.07)	0.680	0.04	(-0.03–0.10)	0.290
Third tertile (highest)	-0.25	(-0.34– -0.17)	<0.001	-0.07	(-0.14–0.00)	0.051

An increase in non-core food intake was negatively associated with reading scores (β = -0.21 (-0.29-0.14) p = <0.001), and mathematics scores (β = -0.08 (-0.16- -0.01) p = 0.023) (Table 10).

Table 10 Results of Linear Regression for the association between non-core food intake and academic difficulties while adjusting for confounding variables.

Outcome	Reading z-score Coef.	95% CI	*P*	Mathematics z-score Coef.	95% CI	*P*
Non-core Food Intake						
First tertile (lowest)		0.00			0.00	
Second tertile	-0.20	(-0.28–0.12)	<0.001	-0.10	(-0.18–0.02)	0.013
Third tertile (highest)	-0.21	(-0.29–0.14)	<0.001	-0.08	(-0.16– -0.01)	0.023
Sex						
Male		0.00			0.00	
Female	0.28	(0.22–0.35)	<0.001	-0.03	(-0.09–0.03)	0.303
Parental Education						
Secondary or less		0.00			0.00	
College	0.19	(0.09–0.30)	<0.001	0.17	(0.09–0.26)	<0.001
University	0.48	(0.37–0.59)	<0.001	0.47	(0.37–0.56)	<0.001
Parental income						
<40,000		0.00			0.00	
40,001 – 60,000	0.21	(0.10–0.33)	<0.001	0.24	(0.13–0.35)	<0.001
60,001 – 100,000	0.25	(0.12–0.37)	<0.001	0.25	(0.15–0.35)	<0.001
>100,000	0.46	(0.34–0.59)	<0.001	0.43	(0.32–0.54)	<0.001
Weight Status						
Normal		0.00			0.00	
Underweight	-0.01	(-0.19–0.16)	0.868	-0.08	(-0.23–0.07)	0.300
Overweight	-0.02	(-0.09–0.06)	0.687	-0.05	(-0.12–0.02)	0.155
Obese	-0.06	(-0.17–0.05)	0.300	-0.08	(-0.18–0.02)	0.120
Physical Activity						
First tertile (lowest)		0.00			0.00	
Second tertile	0.06	(-0.07–0.09)	0.857	0.05	(0.02–0.12)	0.133
Third tertile (highest)	-0.10	(-0.29– -0.12)	<0.001	-0.04	(-0.11–0.03)	0.289

When core and non-core food are mutually adjusted in one regression model, core food intake remains significantly associated with reading (β = 0.49 (0.39-0.56) p = <0.001), and mathematics performance (β = 0.29 (0.20-0.39) p = <0.001) (Table 11). However, non-core food intake no longer remains significantly associated with reading and mathematical performance when core food intake is adjusted for ($p > 0.05$).

Table 11 Results of linear regression for the association between both core and non-core food intake and academic difficulties while adjusting for confounding variables.

	Reading z-score			Mathematics z-score		
Outcome	Coef.	95% CI	*P*	Coef.	95% CI	*P*
Core Food Intake						
First tertile (lowest)		0.00			0.00	
Second tertile	0.30	(0.20–0.36)	<0.001	0.17	(0.09–0.24)	<0.001
Third tertile (highest)	0.49	(0.39–0.56)	<0.001	0.29	(0.20–0.39)	<0.001
Non-core Food Intake						
First tertile (lowest)		0.00			0.00	
Second tertile	-0.05	(-0.13–0.03)	0.249	-0.01	(-0.09–0.07)	0.852
Third tertile (highest)	0.05	(0.17–0.31)	0.274	0.07	(-0.01–0.15)	0.071
Sex						
Male		0.00			0.00	
Female	0.25	(0.19–0.31)	<0.001	-0.05	(-0.11–0.01)	0.085
Parental Education						
Secondary or less		0.00			0.00	
College	0.17	(0.06–0.28)	0.002	0.16	(0.07–0.25)	<0.001
University	0.44	(0.33–0.55)	<0.001	0.44	(0.35–0.54)	<0.001
Parental income						
<40,000		0.00			0.00	
40,001 – 60,000	0.23	(0.12–0.34)	<0.001	0.25	(0.15–0.36)	<0.001
60,001 – 100,000	0.24	(0.12–0.36)	<0.001	0.25	(0.15–0.35)	<0.001
>100,000	0.44	(0.32–0.56)	<0.001	0.42	(0.31–0.53)	<0.001
Weight Status						
Normal		0.00			0.00	
Underweight	0.00	(-0.17–0.17)	0.995	-0.07	(-0.22–0.08)	0.344
Overweight	-0.02	(-0.10–0.05)	0.543	-0.05	(-0.12–0.01)	0.102
Obese	-0.08	(-0.19–0.03)	0.141	-0.09	(-0.19–0.00)	0.058
Physical Activity						
First tertile (lowest)		0.00			0.00	
Second tertile	-0.02	(-0.10–0.06)	0.678	0.04	(-0.03–0.10)	0.289
Third tertile (highest)	-0.26	(-0.34– -0.17)	<0.001	-0.07	(-0.14– -0.00)	<0.001

The results of the linear regression coincide with the results from the Poisson regression. When non-core food intake is the main independent variable, there is a significant negative association with reading and mathematics scores, meaning children who consume higher amounts of non-core food are receiving lower scores on reading and mathematical tests. However when core food intake is adjusted for, the negative association of non-core food is diminished and is no longer significant. Therefore, as with the mutually adjusted Poisson regression, the null hypothesis of the research question cannot be rejected. The results of the mutually adjusted linear regression show that students consuming higher intakes of non-core food are not more likely to have lower reading and mathematics scores than students consuming low intakes of non-core food. Once again, it is interesting to note that core food intake remains to have an independent association on reading and mathematics scores. The core food results from the mutually adjusted linear regression model were relatively unchanged from the previous model that only included core food as a dietary factor. This validates that core food intake has an influence on reading and mathematics scores, that is independent of non-core food intake.

For the co-variates, as with the Poisson regression, girls performed better than boys in reading (β = 0.25 (0.19-0.31) p = <0.001), but not in mathematics (β = -0.05 (-0.11-0.01) p = 0.085), however the association for mathematics was not significant (Table 11). In the combined regression model, higher levels of parental education and parental income were associated with higher reading and mathematics scores ($p < 0.005$) (Table 11). Once again, there was no association between weight status and reading and mathematics performance ($p > 0.05$) (Table 11). For physical activity, there was a negative association with reading (β = -0.26 (-0.34- -0.17) p = <0.001), and mathematical scores (β = -0.07 (-0.14-0.00) p = <0.001) for those in the highest physical activity tertile (Table 11).

CHAPTER 4 DISCUSSION

4.1 INTRODUCTION

The purpose of this study was to examine the association between non-core food intake and academic performance. Through the statistical technique of Poisson and multiple linear regression analysis, an influence between non-core food intake and academic achievement was noted. Academic performance is influenced by many different factors and in this study it was found that dietary intake, sex, and socioeconomic status had an influence on school performance among the participating students.

4.2 NON-CORE FOOD

Previous research has demonstrated an association between diet and academic performance (Florence et al., 2008; Overby et al., 2013); however few studies have looked at the link between consumption of low-quality, or non-core, foods and school achievement. Of those studies (Florence et al., 2008; Overby et al., 2013), the findings suggest a negative relationship between poor nutrition and school performance. The results in the current study suggest a similar trend. An association was found between high consumption of non-core food and poor reading, writing, and mathematical performance. Students who consumed the greatest amount of non-core foods were more likely to perform poorly on academic achievement tests than students who consumed low or medium amounts of non-core food. This suggests that high intakes of non-core food can have unfavorable effects on learning outcomes in children. It is important to note, the association between non-core food and academic performance was diminished after adjusting for core food intake, and is therefore not independent of core foods. A possible explanation for this finding is that the outcome of core versus non-core food is not sensitive enough to distinguish between high versus low quality diets. Florence et al. (2008) used the same instruments and analytic approach with the 2003 CLASS data, with the distinction of using DQI-I as the dietary outcome rather than core and non-core food. The DQI-I summarized scores that measured dietary variety, adequacy, moderation and overall balance. Since the analysis from Florence et al. (2008) showed a significant association with poor dietary quality and this analysis did not, it possible to conclude that the DQI-I is a more comprehensive measure for detecting differences in dietary quality than the classification of core and non-core food.

Several theories as to why diets high in non-core foods lead to decreased school performance point to the adverse effects of increased fats, sugar, and food additives. There is evidence that consumption of certain fats can affect cognition. Zhang, Hebert and Muldoon, (2005) used data from the Third National Health and Nutrition Survey and found that increased cholesterol consumption had a negative association with cognitive performance among children ages 6-16. Several studies have suggested that foods high in sugar may contribute to hyperactivity and other behavioral problems (Feinstein et al., 2008; Bellisle, 2004), while Bateman et al. (2004) found a similar association between artificial additives, such as food coloring, and hyperactivity in children. Hyperactivity in the classroom may lead to decreases in attention and concentration which can have an impact on retention of information learned, and ultimately academic achievement. Saturated fats, sugar, and artificial additives are common components in non-core foods, therefore their consumption may have an unfavorable effect on overall school performance.

It has also been suggested that the dietary components of non-core foods may have an effect on brain development. A study by Nyaradi et al. (2014) found that a higher intake of the 'Western' diet at age 14, characterized by high intakes of red and processed meats, as well as fried and refined foods, was associated with diminished cognitive performance at age 17. These findings suggest that diet may play a crucial role in brain development and affect cognitive performance in later years. Kanoski and Davidson (2011) linked refined sugars and saturated fats to the impaired functioning of the hippocampus, which is a brain structure involved in learning and memory. Since the 'Western' dietary pattern is strongly correlated with high intakes of total fat, saturated fat, and refined sugar (Nyaradi et al., 2014); it is possible that this diet may inhibit cognitive functioning. Certain foods characterized by the 'Western' diet contain a high amount of saturated fat and Omega-6 fatty acids. A balanced ratio (1:1) of Omega-3 to Omega-6 fatty acid is important for homeostasis and normal development. Today, Western diets have a ratio of 1:20/25 (Simopoulos, 2011), therefore those consuming this diet are ingesting less Omega-3 and more Omega-6 fatty acids, and are estimated to be deficient in Omega-3 fatty acids (Simopoulus, 2011).

Studies have indicated that Omega-3 fatty acids are essential for the normal development of the brain, including memory formation (Niemoller, Stark, & Bazan, 2009). Omega-6 and Omega-3 fatty acids are not interconvertible; therefore Omega-3 must be supplied by direct dietary sources. A recent study that examined the ratio between Omega-3 and Omega-6 fatty acids found that children with lower ratios between the fatty acids reported better cognitive functioning (Sheppard & Cheatham, 2013). This research suggests that children should increase their consumption of foods that contain Omega-3 fatty acids, such as fish and seafood, so that the ratio between fatty acids is more balanced.

The dietary trends from the current study demonstrate that the majority of children who are consuming high intakes of non-core food, are consuming low intakes of core food. This is a cause for concern, because children who are consuming low levels of core food may not be meeting their nutrient requirements set by *Canada's Food Guide*. Core foods are nutrient-dense and provide the body with essential vitamins and minerals for proper development and functioning (Erickson, 2006). It has been hypothesized that nutrient deficiencies can lead to developmental delays and impairment, which in turn can lead to poorer learning outcomes (Yehuda, Rabinovitz, & Mostofsky, 2006). Research interventions have been successful in addressing the negative influences of nutrient deficiencies by supplying children with multivitamin and mineral supplements (Schoenthaler et al., 1991). However, improvements in intelligence was only seen in children who had preexisting vitamin and mineral deficiencies (Benton & Butts, 1990, Schoenthaler et al., 1991). This suggests that adequate micronutrient consumption is important for achieving optimal cognitive development. This could explain why the influence of non-core food intake on academic performance is no longer independent when core food consumption is considered.

4.3 CORE FOOD

While the main focus of the study was to examine the association between non-core food intake and academic performance, the analysis yielded a more prominent association with core food consumption. A significant negative association was found between core food consumption and the prevalence of all measures of academic difficulties. Therefore, children who consumed greater amounts of core food were significantly less likely to have reading, writing, and mathematical difficulties. It is also interesting to note that the prevalence of academic difficulties decreased with each increasing core food tertile. A similar association was found with reading and mathematics scores; children consuming greater intakes of core food had higher scores than children consuming low intakes of core food. This suggests that the consumption of core foods has a positive influence on academic performance, and that this influence is enhanced with greater intakes. Most remarkably, is the positive influence of core food intake on academic performance is independent of the dietary intake of non-core food. This gives rise to the notion that core food has a greater influence on academic achievement than non-core food. These results coincide with other research studies that collectively point to a positive relationship between healthy eating and school performance of children (Taras & Potts-Datema, 2005). Previous studies have noted that high intakes of fruits and vegetables were correlated with higher test scores and higher levels of school performance (MacLellan, Taylor, & Wood, 2008; Abudayya, Shit, Abed, & Holmboe-Ottesen, 2011).

As previously mentioned, core foods provide the body with essential nutrients, including vitamins and minerals that are important for cognitive function. Children who consume higher intakes of core foods are therefore more likely to be meeting their nutrient requirements. A study by Nyaradi et al. (2014) found an association between higher intakes of fruit and leafy green vegetables and better cognitive performance. This may be due to the increased micronutrient content from those foods, which have a positive influence on cognitive development.

The association between core food intake and academic performance could be confounded by socioeconomic status, as well as other factors such as gender, weight status and physical activity. However, the association was still significant after adjusting for all variables, therefore these findings demonstrate the importance of including core foods in the diet of children.

4.4 VERBAL AND NON-VERBAL SUBJECTS

It has been suggested that diet may have a stronger impact on non-verbal intelligence than verbal intelligence, due to the fact that non-verbal tests are reflective of innate intellectual ability (Kaufman, 1994). Nutrients provided from the diet are important for proper brain development and function, as previously mentioned. Non-verbal school subjects, such as mathematics, could be affected by the adequacy of the diet, and it was predicted that the non-verbal school subject of mathematics would be greater influenced by dietary intake. However, the findings of this study indicated no significant difference between the influence of dietary patterns on verbal and non-verbal school subjects.

4.5 PHYSICAL ACTIVITY

In this study, there was no consistent trend found between physical activity and academic difficulties. Children in the median tertile for physical activity had a lower prevalence of writing difficulties compared to those in the lowest and highest range of physical activity. Whereas a negative association was observed between the highest tertile of physical activity and reading performance, meaning children partaking in the most physical activity were more likely to have reading difficulties. A negative association was also seen between the highest tertile of physical activity and reading and mathematics scores. These results were unexpected, as the literature suggests physical activity enhances academic performance in children. These results could be due to the limitation of the measurement, which did not assess the intensity levels of physical activity. A questionnaire that inquires about not only the frequency of physical activity, but the duration and intensity as well would be an improvement for future projects.

The scores from the PAQ-C were determined by self-reported questions and is subject to response bias. Therefore the PAQ-C may not accurately represent the physical activity habits of the children. The PAQ-C scores also cannot be defined by levels of intensity, so differences in activity levels and fitness of the children cannot be determined. Therefore, from this research, it cannot be deduced that certain activity levels affect academic performance. A measure that accurately calculates the level of intensity would be needed to properly assess the role of physical activity and to determine appropriate policy regulations targeted at helping children reach their optimal activity levels.

Recent research suggests that different intensity levels of physical activity have different influences on cognitive and academic performance (Coe, Pivarnik, Womack, Reeves, & Erwin, 2006; Morales et al., 2011). Vigorous physical activity has been shown to increase brain-derived neurotropic factor (BDNF), which supports the survival of many types of neurons (Yamada, Mizuno, & Nabeshima, 2002). It is suggested that BDNF is linked to learning and memory (Yamada et al., 2002), and that a deprivation of BDNF may lead to learning impairment (Yamada et al., 2002). From the studies that compared intensity levels, vigorous activity was shown as having the greatest positive association with academic performance (Coe et al., 2006; Kwak et al., 2009). An intervention study by Coe et al. (2006) reported that the vigorous physical activity was the only intensity level associated with higher grades. Therefore, it is hypothesized that there is a physical activity "threshold" level of intensity that is necessary to produce beneficial cognitive effects and that vigorous activity meets that threshold (Coe at al., 2006). It is possible that the absence of a relationship between physical activity and academic performance in this study was due to the fact that no distinction between intensity levels could be made. Future research examining the different intensity levels is needed in order to clarify the mechanisms between physical activity and academic performance, and to determine if there is an optimal level of physical activity to help improve school performance.

4.6 WEIGHT STATUS

The findings of this study did not yield any significant associations between weight status and academic performance; however negative trends were demonstrated between the weight classes. Children who were underweight, overweight or obese had a slightly higher prevalence of reading, writing, and mathematical difficulties, while the linear regression, which used the continuous test scores, demonstrated a negative association between increased weight status and reading and mathematical test scores. Many studies have commented on the influence of weight status on cognitive performance. A review by Taras and Potts-Detema (2005) showed that generally, overweight and obese children do not perform as well academically as their healthy counterparts. However, since the association was not significant in any of the adjusted regression models a relationship between weight status and academic performance cannot be confirmed in this study.

4.7 SEX

In terms of gender differences, this analysis found that boys were more likely to perform poorly in reading and writing, while girls were more likely to perform poorly in mathematics. This supports previous research by Florence et al. (2008), which found that boys were twice as likely to fail their literacy assessments as girls (Florence et al., 2008). Research by Considine and Zappala (2002) and Abudayya et al. (2011) observed a similar relationship with males being more likely to perform poorly in terms of literacy than females.

4.8 PARENTAL EDUCATION AND INCOME

Parental education and income are determinates of socioeconomic status; this has been consistently shown to play a role in student academic achievement (Patterson, Kupersmidt, & Vaden, 1990; Considine & Zappala, 2002, Abudayya et al., 2011). Children from families with a higher socioeconomic status are at a lower risk of nutritional deficiencies (Serra-Majem et al., 2002), and more likely to have healthier habits than their counterparts from lower socioeconomic groups (Mazur, Marquis, & Jensen, 2003). Those from disadvantaged socioeconomic backgrounds are more likely to perform poorly academically, resulting in lower levels of school attainment (Florence et al., 2008).

The findings in this study are consistent with the literature; both parental education and parental income levels were strong predictors of academic performance. A negative association was found between parental education and income, and difficulties in reading, writing, and mathematics. As socioeconomic status increased, the prevalence of academic difficulties decreased; with higher parental income being association with high tests scores in reading and mathematics. This association was significant across all adjusted models. Similar results have been found in other dietary studies, with Florence et al. (2008) noting a decreased odds of poor academic performance with increased parental income and educational attainment.

4.9 STRENGTHS AND LIMITATIONS

The strengths of this study include the use of data from a large population survey with a high response rate, and the use of robust standard error to account for the clustering between schools. This improves the strength and validity of the results. The data for this study were collected at two time points: dietary patterns were assessed when the students were in grade five, and academic performance was measured when students were in grade six. This analysis could add a unique prospective association to a cross-sectional study by demonstrating how dietary patterns can have an association on performance later in childhood. This is also one of the few studies that have used the classification of core and non-core foods to describe dietary patterns. This classification focuses on the whole diet rather than one or two food groups, such as fruits and vegetables. Characterizing intakes this way is useful in policy and health promotion as it provides a simple index of diet quality. However, more sensitive measures of dietary quality should be used in research analysis in order to detect associations that may be missed by the simplification of core versus non-core food classification.

There are, however, a few limitations and possible improvements for moving forward with future research. First, cross-sectional data were used which does not provide a definitive causal relationship between the dietary patterns assessed and the academic outcomes. However, data was taken from two time points in this study. This offers a prospective association between dietary patterns and academic performance, which has rarely been researched by previous studies. To further validate our findings, research with longitudinal cohorts would be needed to strengthen the association that dietary intake has on student performance.

Second, the dietary data was collected by self-administered FFQ, which are subject to recall error as it relies on the participant's memory. The questionnaire was the only dietary assessment method used for the participants, however, the YAQ has been previously validated in other research as a suitable dietary tool for this age group (Rockett et al., 1997).

Third, academic performance was measured by standardized test results, which can be both a strength and a limitation. Standardized tests limit bias by either using teacher grades or self-reported assessments. It is important to note that they can be unreliable for those students who suffer from test anxiety. Incorporating more than one measurement of academic performance would minimize this limitation.

Finally, the measure of physical activity was self-reported and analyzed as a continuous score, and could not be quantified into levels of physical activity intensity. Assessing physical activity objectively is necessary in order to accurately determine the relationship between physical activity and student performance. Therefore, future studies should use a quantitative measurement that is accurate and can be easily interpreted into intensity categories. This kind of measure would provide valuable data on the effect size or physical activity in relation to academic scores, and could be translated into physical activity guidelines among schools. The most effective measure in this instance would be the use of accelerometers; however, their use on large scale studies is costly.

4.10 CONCLUSIONS

From this research, non-core food consumption was shown to be negatively associated with reading, writing, and mathematical performance, but only when the consumption of core food was not accounted for. In contrast, core food consumption was positively associated with all measures of academic performance; this association was independent of non-core food consumption. These findings suggest that consumption of core food has a greater influence on academic performance than consumption of non-core food. This is demonstrated by an independent association between core and non-core foods, meaning that children who consume high amounts of non-core foods could still perform well if they also consume high amounts of core foods. This outcome highlights the importance of micronutrients, which are supplied in the diet by core foods. Micronutrients play a role in cognitive abilities, and since cognitive abilities play a role academic performance, school nutrition programs should focus on the inclusion of core foods containing these micronutrients in order to positively influence their students' performance. A simple approach to ensure micronutrients are being included in school nutrition programs is to build a policy around core foods. It is easier to translate and understand dietary advice by focusing on whole foods rather than single nutrients. Core food consumption can be used as a proxy for dietary quality. A diet low in core foods would indicate a poor dietary quality, and a diet high in core foods would indicate a high dietary quality, where nutrient intakes are likely to be met. Focusing on the inclusion of core food in school settings can offer a simple guideline for healthy eating. The classification of food as core and non-core is easy to understand and is a term that can be easily adopted from policy makers to students.

School performance is confounded by many factors; however, the association between dietary patterns remained significant after many of these confounding variables were controlled for. It is important to encourage the intake of a varied diet that includes numerous core foods in order for children to meet *Canada's Food Guide's* recommended number of servings from each food group. Children spend the majority of their time at school and they learn many valuable life skills in the classroom, therefore schools offer an ideal setting to promote health programs that educate students on the importance of healthy eating and provide opportunities to be physical active. This is in line with the recommendations from the 2014 Nova Scotia Education Review; it suggests schools should create opportunities for students to receive life-skills training, which include fitness and nutrition. However, the inclusion of fitness and nutrition in Nova Scotia's schools is only mentioned in a small part of the comprehensive education review (Minister's Panel on Education, 2014).

The findings of this study provides evidence of the importance of core foods, and future investment in school nutrition programs should become a priority for school boards in order to aid in student success. An implementation of a school nutrition policy that focuses on the inclusion of core foods in schools and cafeterias should be considered. For example, if chicken or fish were offered in the cafeteria it should be served skinless, or lightly battered, with vegetables as a side dish instead of French fries. School programs should focus on the availability of core foods as children cannot eat foods that are not available to them.

Nutrition curriculum in schools should also be enhanced to provide students with basic food knowledge. Learning about differences in food quality can lead to more informed decisions when children are faced with making their own food choices. A simple way to accomplish this would be to incorporate traffic-light food labelling into the school setting. Traffic-light labelling uses red, yellow, and green signals to demonstrate whether a food product is high, medium, or low in fat, saturated fats, sugar and salt (Miller et al., 2015). These labels would help provide children with clear and simple guidelines to follow. For instance, foods with 'green' labels would be preferred over those with 'red' labels, and should be chosen most often, whereas foods with 'red' labels should be chosen least often. Traffic-light food labelling has already been successful in

Western Australia by reducing the purchase of 'red' items and increasing the purchase of 'green' items from school canteens (Miller, Pollard, Meng, Neeson, & Devine, 2015). Easy to understand labeling systems should be considered for school food policies to create changes in food consumption and improve diets among children here in Nova Scotia.

Regardless of the lack of association found in this study between physical activity and academic performance, policies and initiatives that encourage students to be physically active should be a focus for school boards and governments. There is substantial evidence in the literature to suggest that physical activity can help improve academic performance, and there does not appear to be any adverse impacts from increasing time dedicated to physical education. Therefore schools should be focusing on ways to increase the amount of time students spend in physical education classes and increasing the amount of time students engage in moderate to vigorous physical activity during those sessions. Physical activity can also be encouraged in the classroom environments by incorporating activity breaks between academic lessons. An example of an in-class activity is the 'Sparks Fly' initiative that has supplied schools in the Halifax region with stationary bikes. The bikes are placed in the classrooms and are available for students to use when they start to lose focus, or get antsy and have trouble sitting still. These short bouts of activity can help students relieve stress and improve classroom behavior. In addition, after school programs and organizations can incorporate physical activities into their events so that students have the opportunity to be active throughout the day.

Governments and municipalities need to be committed in promoting healthier schools and lifestyles for children. This can be achieved by implementing more innovative strategies that focus on the health and well-being of students. Future school nutrition programs should be tailored to focus on the positive health benefits of core foods and their inclusion in the diet. Nutrition plays a valuable role in overall health and it is essential for schools to continue to invest in health-conscious nutrition plans and provide curricula to educate students and parents on the importance of food choices. An extensive amount of research supports the idea that healthy bodies lead to healthy minds. To reiterate, health promotion programs that encourage healthy eating and physical activity may help children achieve their academic potential and encourage health-conscious behaviors to continue throughout their life.

REFERENCES

Abudayya, A., Shi, Z., Abed, Y., & Holmboe-Ottesen, G. (2011). Diet, nutritional status and school performance among adolescents in gaza strip. *Eastern Mediterranean Health Journal = La Revue De Sante De La Mediterranee Orientale = Al-Majallah Al-Sihhiyah Li-Sharq Al-Mutawassit, 17*(3), 218-225.

Alaimo, K., Olson, C. M., & Frongillo, E. A. (2001). Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. *Pediatrics*, *108*(1), 44-53.

Barros, A. J., & Hirakata, V. N. (2003). Alternatives for logistic regression in cross-sectional studies: An empirical comparison of models that directly estimate the prevalence ratio. *BMC Medical Research Methodology, 3*, 21.

Bateman, B., Warner, J. O., Hutchinson, E., Dean, T., Rowlandson, P., Gant, C., . . . Stevenson, J. (2004). The effects of a double blind, placebo controlled, artificial food colourings and benzoate preservative challenge on hyperactivity in a general population sample of preschool children. *Archives of Disease in Childhood, 89*(6), 506-511.

Beard, J. L. (2001). Iron biology in immune function, muscle metabolism and neuronal functioning. *The Journal of Nutrition, 131*(2S-2), 568S-579S; discussion 580S.

Bellisle, F. (2004). Effects of diet on behaviour and cognition in children. *The British Journal of Nutrition, 92 Suppl 2*, S227-32.

Belot, M., & James, J. (2011). Healthy school meals and educational outcomes. *Journal of Health Economics, 30*(3), 489-504.

Benton D, C. R. (1991). Vitamin and mineral supplements improve the intelligence scores and concentration of six year old children.*12*, 1151-1158.

Benton, D., & Buts, J. P. (1990). Vitamin/mineral supplementation and intelligence. *Lancet, 335*(8698), 1158-1160.

Benton, D., & Roberts, G. (1988). Effect of vitamin and mineral supplementation on intelligence of a sample of schoolchildren. *Lancet, 1*(8578), 140-143.

Bickel, G. W., Nord, M., Price, C., Hamilton, W., & Cook, J. (2000). *Guide to measuring household food security in the united states.* (No. 6). Alexandria, VA: Food and Nutrition Services.

Black, M. M. (1998). Zinc deficiency and child development. *The American Journal of Clinical Nutrition, 68*(2 Suppl), 464S-469S.

Black, M. M. (2003). The evidence linking zinc deficiency with children's cognitive and motor functioning. *The Journal of Nutrition, 133*(5 Suppl 1), 1473S-6S.

Blanton, C. A., Moshfegh, A. J., Baer, D. J., & Kretsch, M. J. (2006). The USDA automated multiple-pass method accurately estimates group total energy and nutrient intake. *The Journal of Nutrition, 136*(10), 2594-2599.

Bryan, J., Osendarp, S., Hughes, D., Calvaresi, E., Baghurst, K., & van Klinken, J. W. (2004). Nutrients for cognitive development in school-aged children. *Nutrition Reviews, 62*(8), 295-306.

Canada's food guide. (2007). Health Canada.

Castelli, D. M., Hillman, C. H., Buck, S. M., & Erwin, H. E. (2007). Physical fitness and academic achievement in third- and fifth-grade students. *Journal of Sport & Exercise Psychology, 29*(2), 239-252.

Cianciolo, A.T., Sternberg, T. J. (2004). Intelligence: a brief history. *Blackwell Publishing*.

Coe, D. P., Pivarnik, J. M., Womack, C. J., Reeves, M. J., & Malina, R. M. (2006). Effect of physical education and activity levels on academic achievement in children. *Medicine and Science in Sports and Exercise, 38*(8), 1515-1519.

Colby-Morley, E. (1981). Neurotransmitters and nutrition. *Orthomolecular Psychiatry*, 12: 38-43.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ (Clinical Research Ed.), 320*(7244), 1240-1243.

Considine, G., & Zappala, G. (2002). The influence of social and economic disadvantage in the academic performance of school students in australia. *Journal of Sociology 38*(2), 129-148.

Crombie, I. K., Todman, J., McNeill, G., Florey, C. D., Menzies, I., & Kennedy, R. A. (1990). Effect of vitamin and mineral supplementation on verbal and non-verbal reasoning of schoolchildren. *Lancet (London, England), 335*(8692), 744-747.

Datar, A., & Sturm, R. (2006). Childhood overweight and elementary school outcomes. *International Journal of Obesity (2005),30*(9), 1449-1460.

De Andraca, I., Walter, T., Castillo, M., Pino, P., Rivera, P., & Cobo, C. (1990). Iron deficiency anemia and its effects upon psychological development at preschool age: a longitudinal study. *Nestle Foundation annual report*, 53-62.

Deddens, J. A., & Petersen, M. R. (2008). Approaches for estimating prevalence ratios. *Occupational and Environmental Medicine, 65*(7), 481, 501-6.

Dietary guidelines for americans. (2010). (No. 7th Edition). Washington, DC: U.S. Department of Agriculture, U.S. Department of Health and Human Services.

Donnelly, J. E., Greene, J. L., Gibson, C. A., Smith, B. K., Washburn, R. A., Sullivan, D. K., ... & Williams, S. L. (2009). Physical Activity Across the Curriculum (PAAC): a randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. *Preventive medicine*, *49*(4), 336-341.

Donnelly, J. E., & Lambourne, K. (2011). Classroom-based physical activity, cognition, and academic achievement. *Preventive medicine*, *52*, S36-S42.

Drewnowski, A. (2003). Fat and sugar: An economic analysis. *The Journal of Nutrition, 133*(3), 838S-840S.

Ericsson, I. (2008). Motor skills, attention and academic achievements. an intervention study in school years 1–3. *British Educational Research Journal, 34*(3), 301-313.

Erickson, J. (2006). Brain food: The real dish on nutrition and brain function.

Eysenck HJ, S. S. (1997). Raising IQ level by vitamin and mineral supplemention., 363-92.

Feinstein, L., Sabates, R., Sorhaindo, A., Rogers, I., Herrick, D., Northstone, K., & Emmett, P. (2008). Dietary patterns related to attainment in school: The importance of early eating patterns. *Journal of Epidemiology and Community Health, 62*(8), 734-739.

Field, T., Diego, M., & Sanders, C. E. (2001). Exercise is positively related to adolescents' relationships and academics. *Adolescence, 36*(141), 105-110.

Finn, A. S., Kraft, M. A., West, M. R., Leonard, J. A., Bish, C. E., Martin, R. E., . . . Gabrieli, J. D. (2014). Cognitive skills, student achievement tests, and schools. *Psychological Science, 25*(3), 736-744.

Florence, M. D., Asbridge, M., & Veugelers, P. J. (2008). Diet quality and academic performance. *The Journal of School Health, 78*(4), 209-15; quiz 239-41.

Freeman, M. P., Hibbeln, J. R., Wisner, K. L., Davis, J. M., Mischoulon, D., Peet, M., . . . Stoll, A. L. (2006). Omega-3 fatty acids: Evidence basis for treatment and future research in psychiatry. *The Journal of Clinical Psychiatry, 67*(12), 1954-1967.

Fu, M. L., Cheng, L., Tu, S. H., & Pan, W. H. (2007). Association between unhealthful eating patterns and unfavorable overall school performance in children. *Journal of the American Dietetic Association, 107*(11), 1935-1943.

Garriguet D. (2006). *Nutrition: Findings from the canadian community health survey.* (No. Cycle 2.2). Ottawa, Ontario: Health Canada.

Goldberg, S., Werbeloff, N., Fruchter, E., Portuguese, S., Davidson, M., & Weiser, M. (2014). IQ and obesity in adolescence: a population-based, cross-sectional study. *Pediatric obesity*, *9*(6), 419-426.

Greenwood, C. E., & Craig, R. A. (1987). Dietary influences on brain function: implications during periods ofneuronal maturation. *Current topics in nutrition and disease*.

Hall, A., Khanh, L. N., Son, T. H., Dung, N. Q., Lansdown, R. G., Dar, D. T., . . . Partnership for Child Development. (2001). An association between chronic undernutrition and educational test scores in vietnamese children. *European Journal of Clinical Nutrition, 55*(9), 801-804.

Halterman, J. S., Kaczorowski, J. M., Aligne, C. A., Auinger, P., & Szilagyi, P. G. (2001). Iron deficiency and cognitive achievement among school-aged children and adolescents in the united states. *Pediatrics, 107*(6), 1381-1386.

Health Canada. (2012). Healthy eating after school. *Government of Canada.*

Health Canada. (2015). What is healthy eating? *Government of Canada*.

Hollar, D., Messiah, S. E., Lopez-Mitnik, G., Hollar, T. L., Almon, M., & Agatston, A. S. (2010). Effect of a two-year obesity prevention intervention on percentile changes in body mass index and academic performance in low-income elementary school children. *American Journal of Public Health, 100*(4), 646-653.

Hurtado, E. K., Claussen, A. H., & Scott, K. G. (1999). Early childhood anemia and mild or moderate mental retardation. *The American journal of clinical nutrition*, *69*(1), 115-119.

Jahns, L., Siega-Riz, A. M., & Popkin, B. M. (2001). The increasing prevalence of snacking among US children from 1977 to 1996. *The Journal of Pediatrics, 138*(4), 493-498.

Janssen, I., Katzmarzyk, P. T., Boyce, W. F., King, M. A., & Pickett, W. (2004). Overweight and obesity in canadian adolescents and their associations with dietary habits and physical activity patterns. *The Journal of Adolescent Health : Official Publication of the Society for Adolescent Medicine, 35*(5), 360-367.

Johnson, L., van Jaarsveld, C. H., & Wardle, J. (2011). Individual and family environment correlates differ for consumption of core and non-core foods in children. *The British Journal of Nutrition, 105*(6), 950-959.

Jones, A. D., Ngure, F. M., Pelto, G., & Young, S. L. (2013). What are we assessing when we measure food security? A compendium and review of current metrics. *Advances in Nutrition: An International Review Journal*, *4*(5), 481-505.

Jorgensen, L., Nowak, M., & Ide, K. (2000). Cerebral blood flow and metabolism. *Exercise and circulation in health and disease*. 113-236.

Jyoti, D. F., Frongillo, E. A., & Jones, S. J. (2005). Food insecurity affects school children's academic performance, weight gain, and social skills. *The Journal of Nutrition, 135*(12), 2831-2839.

Kanoski, S. E., & Davidson, T. L. (2011). Western diet consumption and cognitive impairment: Links to hippocampal dysfunction and obesity. *Physiology & Behavior, 103*(1), 59-68.

Kaufman, A.S. (1994). Intelligence testing with the WISC-III. *Wiley*.

Kirk, S. F., Kuhle, S., McIsaac, J. L., Williams, P. L., Rossiter, M., Ohinmaa, A., & Veugelers, P. J. (2014). Food security status among grade 5 students in nova scotia, canada and its association with health outcomes. *Public Health Nutrition*, 1-9.

Kleinman, R. E., Hall, S., Green, H., Korzec-Ramirez, D., Patton, K., Pagano, M. E., & Murphy, J. M. (2002). Diet, breakfast, and academic performance in children. *Annals of Nutrition & Metabolism, 46 Suppl 1*, 24-30.

Krall, E. A., & Dwyer, J. T. (1987). Validity of a food frequency questionnaire and a food diary in a short-term recall situation.*Journal of the American Dietetic Association, 87*(10), 1374-1377.

Kwak, L., Kremers, S. P., Bergman, P., Ruiz, J. R., Rizzo, N. S., & Sjostrom, M. (2009). Associations between physical activity, fitness, and academic achievement. *The Journal of Pediatrics, 155*(6), 914-918.e1.

Liu, L., Wang, P. P., Roebothan, B., Ryan, A., Tucker, C. S., Colbourne, J., . . . Sun, G. (2013). Assessing the validity of a self-administered food-frequency questionnaire (FFQ) in the adult population of newfoundland and labrador, canada. *Nutrition Journal, 12*, 49-2891-12-49.

Livingstone, M. B., Robson, P. J., & Wallace, J. M. (2004). Issues in dietary intake assessment of children and adolescents. *The British Journal of Nutrition, 92 Suppl 2*, S213-22.

Lozoff, B., Jimenez, E., Hagen, J., Mollen, E., & Wolf, A. W. (2000). Poorer behavioral and developmental outcome more than 10 years after treatment for iron deficiency in infancy. *Pediatrics*, *105*(4), e51-e51.

Lozoff, B., Jimenez, E., & Wolf, A. W. (1991). Long-term developmental outcome of infants with iron deficiency. *New England journal of medicine*, *325*(10), 687-694.

Mazur, R. E., Marquis, G. S., & Jensen, H. H. (2003). Diet and food insufficiency among hispanic youths: Acculturation and socioeconomic factors in the third national health and nutrition examination survey. *The American Journal of Clinical Nutrition, 78*(6), 1120-1127.

MacLellan, D., Taylor, J., & Wood, K. (2008). Food intake and academic performance among adolescents. *Canadian Journal of Dietetic Practice and Research : A Publication of Dietitians of Canada = Revue Canadienne De La Pratique Et De La Recherche En Dietetique : Une Publication Des Dietetistes Du Canada, 69*(3), 141-144.

McCarthy, S. N., Robson, P. J., Livingstone, M. B. E., Kiely, M., Flynn, A., Cran, G. W., & Gibney, M. J. (2006). Associations between daily food intake and excess adiposity in Irish adults: towards the development of food-based dietary guidelines for reducing the prevalence of overweight and obesity. *International journal of obesity*,*30*(6), 993-1002.

McGowan, L., Croker, H., Wardle, J., & Cooke, L. J. (2012). Environmental and individual determinants of core and non-core food and drink intake in preschool-aged children in the united kingdom. *European Journal of Clinical Nutrition, 66*(3), 322-328.

Miller, M., Pollard, C., Meng, R., Neeson, M., & Devine, A. (2015). *Changes in Australian school food policy, community attitudes and consumption.* Presentation presented at the annual meeting of the International Society of Behavioral Nutrition and Physical Activity, Edinburgh, UK.

Minister's Panel on Education. (2014). Disrupting the status quo: Nova Scotians demand a better future for every student. Halifax, NS: Province of Nova Scotia.

Morales, J., Pellicer-Chenoll, M., Garcia-Masso, X., Gomez, A., Gomis, M., & Gonzalez, L. (2011). Relation between physical activity and academic performance in 3rd year secondary education students. *Perceptual and Motor Skills*, *113*(5), 539-546.

Nelson, M. (1992). Vitamin and mineral supplementation and academic performance in schoolchildren. *The Proceedings of the Nutrition Society, 51*(3), 303-313.

Nelson, M. C., & Gordon-Larsen, P. (2006). Physical activity and sedentary behavior patterns are associated with selected adolescent health risk behaviors. *Pediatrics, 117*(4), 1281-1290.

Nielsen, S. J., Siega-Riz, A. M., & Popkin, B. M. (2002). Trends in food locations and sources among adolescents and young adults. *Preventive Medicine, 35*(2), 107-113.

Niemoller, T. D., Stark, D. T., & Bazan, N. G. (2009). Omega-3 fatty acid docosahexaenoic acid is the precursor of neuroprotectin D1 in the nervous system. *World Review of Nutrition and Dietetics, 99*, 46-54

Northstone, K., Joinson, C., Emmett, P., Ness, A., & Paus, T. (2012). Are dietary patterns in childhood associated with IQ at 8 years of age? A population-based cohort study. *Journal of Epidemiology and Community Health, 66*(7), 624-628.

Nyaradi, A., Foster, J. K., Hickling, S., Li, J., Ambrosini, G. L., Jacques, A., & Oddy, W. H. (2014). Prospective associations between dietary patterns and cognitive performance during adolescence. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 55*(9), 1017-1024.

Overby, N. C., Ludemann, E., & Hoigaard, R. (2013). Self-reported learning difficulties and dietary intake in Norwegian adolescents. *Scandinavian Journal of Public Health, 41*(7), 754-760.

Patterson, C. J., Kupersmidt, J. B., & Vaden, N. A. (1990). Income level, gender, ethnicity, and household composition as predictors of children's school-based competence. *Child development*, *61*(2), 485-494.

Penland, J. G., Sandstead, H. H., Alcock, N. W., Dayal, H. H., Chen, X. C., Li, J. S., . . . Yang, J. J. (1997). A preliminary report: Effects of zinc and micronutrient repletion on growth and neuropsychological function of urban chinese children. *Journal of the American College of Nutrition, 16*(3), 268-272.

Piernas, C., & Popkin, B. M. (2011). Food portion patterns and trends among U.S. children and the relationship to total eating occasion size, 1977-2006. *The Journal of Nutrition, 141*(6), 1159-1164.

Richardson, A. J., & Montgomery, P. (2005). The oxford-durham study: A randomized, controlled trial of dietary supplementation with fatty acids in children with developmental coordination disorder. *Pediatrics, 115*(5), 1360-1366.

Rockett, H. R., Breitenbach, M., Frazier, A. L., Witschi, J., Wolf, A. M., Field, A. E., & Colditz, G. A. (1997). Validation of a youth/adolescent food frequency questionnaire. *Preventive Medicine, 26*(6), 808-816.

Sallis, J. F., McKenzie, T. L., Kolody, B., Lewis, M., Marshall, S., & Rosengard, P. (1999). Effects of health-related physical education on academic achievement: Project SPARK. *Research Quarterly for Exercise and Sport, 70*(2), 127-134.

Sandstead, H. H., Penland, J. G., Alcock, N. W., Dayal, H. H., Chen, X. C., Li, J. S., . . . Yang, J. J. (1998). Effects of repletion with zinc and other micronutrients on neuropsychologic performance and growth of chinese children. *The American Journal of Clinical Nutrition, 68*(2 Suppl), 470S-475S.

Sahyoun, N., & Basiotis, P. P. (2000). *Food insufficiency and the nutritional status of the elderly population.* (No. 18).USDA Center for Nutrition Policy and Promotion.

Schinder, A. F., & Poo, M. (2000). The neurotrophin hypothesis for synaptic plasticity. *Trends in Neurosciences, 23*(12), 639-645.

Schluter G., L. C. (1999). Changing food consumption patterns: Their effects on the US food system.*22*(35-7), 1972-92.

Schoenthaler, S. J., Amos, S. P., Doraz, W. E., Kelly, M. A., & Wakefield, J. (1991). Controlled trial of vitamin-mineral supplementation on intelligence and brain function. *Personality and Individual Differences*,*12*(4), 343-350.

Schoenthaler, S. J., Bier, I. D., Young, K., Nichols, D., & Jansenns, S. (2000). The effect of vitamin-mineral supplementation on the intelligence of american schoolchildren: A randomized, double-blind placebo-controlled trial. *Journal of Alternative and Complementary Medicine (New York, N.Y.), 6*(1), 19-29.

Serra-Majem, L., Ribas, L., Perez-Rodrigo, C., Garcia-Closas, R., Pena-Quintana, L., & Aranceta, J. (2002). Determinants of nutrient intake among children and adolescents: Results from the enKid study. *Annals of Nutrition & Metabolism, 46 Suppl 1*, 31-38.

Sheppard, K. W., & Cheatham, C. L. (2013). Omega-6 to omega-3 fatty acid ratio and higher-order cognitive functions in 7- to 9-y-olds: A cross-sectional study. *The American Journal of Clinical Nutrition, 98*(3), 659-667. doi:10.3945/ajcn.113.058719; 10.3945/ajcn.113.058719

Shi, X., Tubb, L., Fingers, S. T., Chen, S., & Caffrey, J. L. (2013). Associations of physical activity and dietary behaviors with children's health and academic problems. *The Journal of School Health, 83*(1), 1-7.

Sibley, B., & Etnier, J. (2003). The relationship between physical activity and cognition in children: A meta-analysis. *Pediatr Exerc Sci*, *15*(3), 243-256.

Sigfusdottir, I. D., Kristjansson, A. L., & Allegrante, J. P. (2007). Health behaviour and academic achievement in icelandic school children. *Health Education Research, 22*(1), 70-80. doi:10.1093/her/cyl044

Simopoulos, A. P. (2011). Evolutionary aspects of diet: The omega-6/omega-3 ratio and the brain. *Molecular Neurobiology, 44*(2), 203-215.

Singh, A., Uijtdewilligen, L., Twisk, J., van Mechelen, W., & Chinapaw, M. (2012). Physical activity and performance at school. *Arch Pediatr Adolesc Med. 166*(1), 49-55.

Sofi, F., Cesari, F., Abbate, R., Gensini, G. F., & Casini, A. (2008). Adherence to mediterranean diet and health status: Meta-analysis. *BMJ (Clinical Research Ed.), 337*, a1344.

St Clair-Thompson, H. L., & Gathercole, S. E. (2006). Executive functions and achievements in school: Shifting, updating, inhibition, and working memory. *Quarterly Journal of Experimental Psychology (2006), 59*(4), 745-759

St John, M., Durant, M., Campagna, P. D., Rehman, L. A., Thompson, A. M., Wadsworth, L. A., & Murphy, R. J. (2008). Overweight nova scotia children and youth: The roles of household income and adherence to canada's food guide to healthy eating. *Canadian Journal of Public Health = Revue Canadienne De Sante Publique, 99*(4), 301-306.

Taras, H., & Potts-Datema, W. (2005). Obesity and student performance at school. *The Journal of School Health, 75*(8), 291-295.

Thomson, C. A., Giuliano, A., Rock, C. L., Ritenbaugh, C. K., Flatt, S. W., Faerber, S., . . . Marshall, J. R. (2003). Measuring dietary change in a diet intervention trial: Comparing food frequency questionnaire and dietary recalls. *American Journal of Epidemiology, 157*(8), 754-762.

Tobin, K. J. (2013). Fast-food consumption and educational test scores in the USA. *Child: Care, Health and Development, 39*(1), 118-124.

Tremarche, P. V., Robinson, E. M., & Graham, L. B. (2007). Physical education and its effect on elementary testing results. *Physical Education 64*, 58-64.

Trudeau, F., & Shephard, R. J. (2008). Physical education, school physical activity, school sports and academic performance. *The International Journal of Behavioral Nutrition and Physical Activity, 5*, 10-5868-5-10.

Veugelers, P. J., Fitzgerald, A. L., & Johnston, E. (2005). Dietary intake and risk factors for poor diet quality among children in nova scotia. *Canadian Journal of Public Health = Revue Canadienne De Sante Publique, 96*(3), 212-216.

Webb, K. L., Lahti-Koski, M., Rutishauser, I., Hector, D. J., Knezevic, N., Gill, T., . . . CAPS Team. (2006). Consumption of 'extra' foods (energy-dense, nutrient-poor) among children aged 16-24 months from western sydney, australia. *Public Health Nutrition, 9*(8), 1035-1044.

Willett, W. (2013). *Nutritional epidemiology* (3rd ed.). New York, NY: Oxford University Press.

Wood, M. (2001). Studies probe role of minerals in brain function. *Agriculture Research*, 49.10.

Yamada, K., Mizuno, M., & Nabeshima, T. (2002). Role for brain-derived neurotrophic factor in learning and memory. *Life Sciences, 70*(7), 735-744.

Youdim, M. B., & Yehuda, S. (2000). The neurochemical basis of cognitive deficits induced by brain iron deficiency: Involvement of dopamine-opiate system. *Cellular and Molecular Biology (Noisy-Le-Grand, France), 46*(3), 491-500.

Yehuda, S., Rabinovitz, S., & Mostofsky, D. I. (2006). Nutritional deficiencies in learning and cognition. *Journal of Pediatric Gastroenterology and Nutrition, 43 Suppl 3*, S22-5.

Yeung, R. R. (1996). The acute effects of exercise on mood state. *Journal of Psychosomatic Research, 40*(2), 123-141.

Zhang, J., Hebert, J. R., & Muldoon, M. F. (2005). Dietary fat intake is associated with psychosocial and cognitive functioning of school-aged children in the united states. *The Journal of Nutrition, 135*(8), 1967-1973.

APPENDIX A Dietary Intake Analysis

Table 12 Quantitative amounts for YAQ responses.

Response	Frequency/day
Never/less than 1 per month	0.02
Once per month	0.03
1-3 times per month	0.07
2-3 times per month	0.08
1 time per week or less	0.14
1 time per week	0.14
Once per week or more	0.2
2 or more per week	0.3
1-4 per week	0.35
2-4 times per week	0.43
2-6 times per week	0.61
5 or more times per week	0.71
5-7 times per week	0.85
1 time per day	1
1-2 times per day	1.5
2 or more times per day	2
2-3 times per day	2.5
2-4 times per day	3
3 or more times per day	3
4+ times per day	4
5 or more per day	5

Table 13 **List of numbered YAQ questions divided by core and non-core food.**

Core Food Variable List	Non-core Food Variable List
Q. 23	Q. 16
Q. 24	Q. 17
Q. 25	Q. 18
Q. 27	Q. 19
Q. 28	Q. 26
Q. 29	Q. 32
Q. 30	Q. 33
Q. 43	Q. 36
Q. 44	Q. 37
Q. 45	Q. 38
Q. 47	Q. 41
Q. 48	Q. 42
Q. 50	Q. 46
Q. 51	Q. 49
Q. 52	Q. 62
Q. 53	Q. 63
Q. 54	Q. 64
Q. 55	Q. 67
Q. 56	Q. 68
Q. 57	Q. 69
Q. 58	Q. 70
Q. 59	Q. 86
Q. 60	Q. 121
Q. 61	Q. 122
Q. 65	Q. 123
Q. 66	Q. 124
Q. 73	Q. 125
Q. 74	Q. 126
Q. 75	Q. 127
Q. 76	Q. 128
Q. 77	Q. 129
Q. 79	Q. 130
Q. 80	Q. 131
Q. 81	Q. 132
Q. 82	Q. 133
Q. 83	Q. 134
Q. 84	Q. 135

Core Food Variable List	Non-core Food Variable List
Q. 85	Q. 136
Q. 86	Q. 137
Q. 87	Q. 138
Q. 88	Q. 139
Q. 89	Q. 140
Q. 90	Q. 141
Q. 91	Q. 142
Q. 92	Q. 143
Q. 93	Q. 144
Q. 94	Q. 145
Q. 95	Q. 146
Q. 96	
Q. 97	
Q. 99	
Q. 100	
Q. 101	
Q. 102	
Q. 103	
Q. 104	
Q. 105	
Q. 106	
Q. 107	
Q. 108	
Q. 109	
Q. 110	
Q. 111	
Q. 112	
Q. 113	
Q. 114	
Q. 115	
Q. 116	
Q. 117	

APPENDIX B Harvard Youth/Adolescent Questionnaire

MARKING INSTRUCTIONS

- Use a **NO. 2 PENCIL** only.
- Do not use ink or ballpoint pen.
- Darken in the circle completely.
- Erase cleanly any marks you wish to change.
- Do not make any stray marks on this form.

The RIGHT way to mark your answer! ●

The WRONG way to mark your answers! ✓ ✗

USE A NO. 2 PENCIL ONLY

1. What is your AGE?

- ◯ Less than 9
- ◯ 9
- ◯ 10
- ◯ 11
- ◯ 12
- ◯ 13
- ◯ 14
- ◯ 15
- ◯ 16
- ◯ 17
- ◯ 18 or older

2. Are you:

- ◯ Male
- ◯ Female

Questionnaire refers to what you ate over the past year.

3. Do you now take vitamins (like Flintstones, One-A-Day, etc.)?

◯ No ◯ Yes → **If yes)**

a) How many vitamin pills do you take a week?

- ◯ 2 or less
- ◯ 3 - 5
- ◯ 6 - 9
- ◯ 10 or more

b) For how many years have you been taking them?

- ◯ 0 - 1 years
- ◯ 2 - 4
- ◯ 5 - 9
- ◯ 10+ years

4. How many teaspoons of sugar do you ADD to your beverages or food each day?

- ◯ None/less than 1 teaspoon per day
- ◯ 1 - 2 teaspoons per day
- ◯ 3 - 4 teaspoons per day
- ◯ 5 or more teaspoons per day

5. Which cold breakfast cereal do you usually eat?

- ◯ Never eat cold breakfast cereal

6. Where do you usually eat breakfast?

- ◯ At home
- ◯ At school
- ◯ Don't eat breakfast
- ◯ Other

7. Which of the following best describes your lunch on a school day?

- ◯ I bring a prepared lunch from home
- ◯ I buy my lunch at school
- ◯ I eat my lunch at home
- ◯ I don't eat lunch
- ◯ Other

30962

8. How many times each week (including weekdays and weekends) do you usually eat at a fast food restaurant, or eat food taken out from a fast food restaurant?

- ◯ Never/less than once per week
- ◯ 1 - 2 times per week
- ◯ 3 - 4 times per week
- ◯ 5 or more times per week

9. How many times each week (including weekdays and weekends) do you usually eat supper at the table with other people?

- ◯ Never/less than once per week
- ◯ 1 - 2 times per week
- ◯ 3 - 4 times per week
- ◯ 5 or more times per week

10. How many times each week (including weekdays and weekends) do you usually eat supper in front of the TV?

- ◯ Never/less than once per week
- ◯ 1 - 2 times per week
- ◯ 3 - 4 times per week
- ◯ 5 or more times per week

11. How many times each week (including weekdays and weekends) do you usually eat supper at a friend's house?

- ◯ Never/less than once per week
- ◯ 1 - 2 times per week
- ◯ 3 - 4 times per week
- ◯ 5 or more times per week

12. How often do you have supper that is ready made, like frozen dinners, Spaghetti-O's, microwave meals, etc.

- ◯ Never/less than once per week
- ◯ 1 - 2 times per week
- ◯ 3 - 4 times per week
- ◯ 5 or more times per week

13. How many times each week (including weekdays and weekends) do you usually eat supper alone?

- ◯ Never/less than once per week
- ◯ 1 - 2 times per week
- ◯ 3 - 4 times per week
- ◯ 5 or more times per week

14. How often do you eat food that is fried at home, like fried chicken?

- ◯ Never/less than once per week
- ◯ 1 - 3 times per week
- ◯ 4 - 6 times per week
- ◯ Daily

15. How often do you eat fried food away from home (like french fries, chicken nuggets)?

- ◯ Never/less than once per week
- ◯ 1 - 3 times per week
- ◯ 4 - 6 times per week
- ◯ Daily

DIETARY INTAKE

How often do you eat the following foods:

Example If you drink one can of diet pop 2 - 3 times per week, then your answer should look like this:

E1. Diet pop (1 can or glass)

- ◯ Never
- ◯ 1 - 3 cans per month
- ◯ 1 can per week
- ● 2 - 6 cans per week
- ◯ 1 can per day
- ◯ 2 or more cans per day

BEVERAGES

FILL OUT ONE BUBBLE FOR EACH FOOD ITEM

16. Diet pop (1 can or glass)

- ○ Never/less than 1 per month
- ○ 1 - 3 cans per month
- ○ 1 can per week
- ○ 2 - 6 cans per week
- ○ 1 can per day
- ○ 2 or more cans per day

17. Pop - not diet (1 can or glass)

- ○ Never/less than 1 per month
- ○ 1 - 3 cans per month
- ○ 1 can per week
- ○ 2 - 6 cans per week
- ○ 1 can per day
- ○ 2 or more cans per day

18. Hawaiian Punch, lemonade, Koolaid or other non-carbonated fruit drink (1 glass)

- ○ Never/less than 1 per month
- ○ 1 - 3 glasses per month
- ○ 1 glass per week
- ○ 2 - 4 glasses per week
- ○ 5 - 6 glasses per week
- ○ 1 glass per day
- ○ 2 or more glasses per day

19. Iced Tea - sweetened (1 glass, can or bottle)

- ○ Never/less than 1 per month
- ○ 1 - 3 glasses per month
- ○ 1 - 4 glasses per week
- ○ 5 - 6 glasses per week
- ○ 1 or more glasses per day

20. Tea (1 cup)

- ○ Never/less than 1 per month
- ○ 1 - 3 cups per month
- ○ 1 - 2 cups per week
- ○ 3 - 6 cups per week
- ○ 1 or more cups per day

21. Coffee - not decaf. (1 cup)

- ○ Never/less than 1 per month
- ○ 1 - 3 cups per month
- ○ 1 - 2 cups per week
- ○ 3 - 6 cups per week
- ○ 1 or more cups per day

Example If you eat:

3 teaspoons of margarine on toast
1 - 2 teaspoons of margarine on sandwich
1 teaspoon of margarine on vegetables

5 - 6 teaspoons total all day

then answer this way →

E2. Margarine (1 teaspoon) - not butter

- ○ Never
- ○ 1 - 3 teaspoons per month
- ○ 1 teaspoon per week
- ○ 2 - 6 teaspoons per week
- ○ 1 teaspoon per day
- ○ 2 - 4 teaspoons per day
- ● 5 or more teaspoons per day

DAIRY PRODUCTS

22. What TYPE of milk do you usually drink?

- ○ Whole milk
- ○ 2% milk
- ○ 1% milk
- ○ Skim/nonfat milk
- ○ Don't know
- ○ Don't drink milk

23. Milk (glass or with cereal)

- ○ Never/less than 1 per month
- ○ 1 glass per week or less
- ○ 2 - 6 glasses per week
- ○ 1 glass per day
- ○ 2 - 3 glasses per day
- ○ 4+ glasses per day

24. Chocolate milk (glass)

- ○ Never/less than 1 per month
- ○ 1 - 3 glasses per month
- ○ 1 glass per week
- ○ 2 - 6 glasses per week
- ○ 1 - 2 glasses per day
- ○ 3 or more glasses per day

30962

25. Instant Breakfast Drink (1 packet)

- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

26. Whipped cream

- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

27. Yogurt (1 cup) - Not frozen

- ○ Never/less than 1 per month
- ○ 1 - 3 cups per month
- ○ 1 cup per week
- ○ 2 - 6 cups per week
- ○ 1 cup per day
- ○ 2 or more cups per day

28. Cottage or ricotta cheese

- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

29. Cheese (1 slice)

- ○ Never/less than 1 per month
- ○ 1 - 3 slices per month
- ○ 1 slice per week
- ○ 2 - 6 slices per week
- ○ 1 slice per day
- ○ 2 or more slices per day

30. Cream cheese

- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

31. What TYPE of yogurt, cottage cheese & dairy products (besides milk) do you use mostly?

- ○ Nonfat
- ○ Lowfat
- ○ Regular
- ○ Don't know

32. Butter (1 teaspoon) - NOT margarine

- ○ Never/less than 1 per month
- ○ 1 - 3 teaspoons per month
- ○ 1 teaspoon per week
- ○ 2 - 6 teaspoons per week
- ○ 1 teaspoon per day
- ○ 2 - 4 teaspoons per day
- ○ 5 or more teaspoons per day

33. Margarine (1 teaspoon) - NOT butter

- ○ Never/less than 1 per month
- ○ 1 - 3 teaspoons per month
- ○ 1 teaspoon per week
- ○ 2 - 6 teaspoons per week
- ○ 1 teaspoon per day
- ○ 2 - 4 teaspoons per day
- ○ 5 or more teaspoons per day

34. What FORM and BRAND of margarine does your family usually use?

- ○ None
- ○ Stick
- ○ Tub
- ○ Squeeze (liquid)

WHAT SPECIFIC BRAND AND TYPE (LIKE "PARKAY CORN OIL SPREAD")?

Leave blank if you don't know.

35. What TYPE of oil does your family use at home?

- ○ Canola oil
- ○ Corn oil
- ○ Safflower oil
- ○ Olive oil
- ○ Vegetable oil
- ○ Don't know

0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9

MAIN DISHES

36. Cheeseburger (1)

- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 - 4 per week
- ○ 5 or more per week

37. Hamburger (1)

- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 - 4 per week
- ○ 5 or more per week

38. Pizza (2 slices)

- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

39. Tacos/burritos (1)

- ○ Never/less than 1 per month
- ○ 1 - 3 per month
- ○ One per week
- ○ 2 - 4 per week
- ○ 5 or more per week

40. Which taco filling do you usually have:

- ○ Beef & beans
- ○ Beef
- ○ Chicken
- ○ Beans

41. Chicken nuggets (6)

- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

42. Hot dogs (1)
- Never/less than 1 per month
- 1 - 3 per month
- One per week
- 2 - 4 per week
- 5 or more per week

43. Peanut butter sandwich (1) (plain or with jelly, fluff, etc.)
- Never/less than 1 per month
- 1 - 3 per month
- One per week
- 2 - 4 per week
- 5 or more per week

44. Chicken or turkey sandwich (1)
- Never/less than 1 per month
- 1 - 3 per month
- One per week
- 2 or more per week

45. Roast beef or ham sandwich (1)
- Never/less than 1 per month
- 1 - 3 per month
- One per week
- 2 or more per week

46. Salami, bologna, or other deli meat sandwich (1)
- Never/less than 1 per month
- 1 - 3 per month
- One per week
- 2 or more per week

47. Tuna sandwich (1)
- Never/less than 1 per month
- 1 - 3 per month
- One per week
- 2 or more per week

48. Chicken or turkey as main dish (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

49. Fish sticks, fish cakes or fish sandwich (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

50. Fresh fish as main dish (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

51. Beef (steak, roast) or lamb as main dish (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

52. Pork or ham as main dish (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

53. Meatballs or meatloaf (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

54. Lasagna (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

55. Macaroni and cheese (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

56. Spaghetti with tomato sauce (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

57. Eggs (1)
- Never/less than 1 per month
- 1 - 3 eggs per month
- One egg per week
- 2 - 4 eggs per week
- 5 or more eggs per week

58. Liver: beef, calf, chicken or pork (1 serving)
- Never/less than 1 per month
- Less than once per month
- Once per month
- 2 - 3 times per month
- Once per week or more

59. Shrimp, lobster, scallops (1 serving)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

30962

60. French toast (2 slices)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

61. Grilled cheese (1)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

62. Eggrolls (1)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

MISCELLANEOUS FOODS

63. Brown gravy
- Never/less than 1 per month
- Once per week or less
- 2 - 6 times per week
- Once per day
- 2 or more times per day

64. Ketchup
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

65. Clear soup (with rice, noodles, vegetables) 1 bowl
- Never/less than 1 per month
- 1 - 3 bowls per month
- 1 bowl per week
- 2 or more bowls per week

66. Cream (milk) soups or chowder (1 bowl)
- Never/less than 1 per month
- 1 - 3 bowls per month
- 1 bowl per week
- 2 - 6 bowls per week
- 1 or more bowls per day

67. Mayonnaise
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 6 times per week
- Once per day

68. Low calorie/fat salad dressing
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 6 times per week
- Once or more per day

69. Salad dressing (not low calorie)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 6 times per week
- Once or more per day

70. Salsa
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 6 times per week
- Once or more per day

71. How much fat on your beef, pork, or lamb do you eat?
- Eat all
- Eat some
- Eat none
- Don't eat meat

72. When you have chicken or turkey, do you eat the skin?
- Yes
- No
- Sometimes

BREADS & CEREALS

73. Cold breakfast cereal (1 bowl)

- Never/less than 1 per month
- 1 - 3 bowls per month
- 1 bowl per week
- 2 - 4 bowls per week
- 5 - 7 bowls per week
- 2 or more bowls per day

74. Hot breakfast cereal, like oatmeal (1 bowl)

- Never/less than 1 per month
- 1 - 3 bowls per month
- 1 bowl per week
- 2 - 4 bowls per week
- 5 - 7 bowls per week
- 2 or more bowls per day

75. White bread, pita bread, or toast (1 slice)

- Never/less than 1 per month
- 1 slice per week or less
- 2 - 4 slices per week
- 5 - 7 slices per week
- 2 - 3 slices per day
- 4+ slices per day

76. Dark bread (1 slice)

- Never/less than 1 per month
- 1 slice per week or less
- 2 - 4 slices per week
- 5 - 7 slices per week
- 2 - 3 slices per day
- 4+ slices per day

77. English muffins or bagels (1)

- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 4 per week
- 5 or more per week

78. Muffin (1)

- Never/less than 1 per month
- 1 - 3 muffins per month
- 1 muffin per week
- 2 - 4 muffins per week
- 5 or more muffins per week

79. Cornbread (1 square)

- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more per week

80. Biscuit/roll (1)

- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 4 per week
- 5 or more per week

81. Rice

- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

82. Noodles, pasta

- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

83. Tortilla - no filling (1)

- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 4 per week
- 5 or more per week

84. Other grains, like kasha, couscous, bulgur

- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

85. Pancakes (2) or waffles (1)

- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

86. French fries (large order)

- Never/less than 1 per month
- 1 - 3 orders per month
- 1 order per week
- 2 - 4 orders per week
- 5 or more orders per week

87. Potatoes - baked, boiled, mashed

- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

FRUITS & VEGETABLES

88. Raisins (small pack)
- Never/less than 1 per month
- 1 - 3 times per month
- 1 per week
- 2 - 4 times per week
- 5 or more times per week

89. Grapes (bunch)
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

90. Bananas (1)
- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 4 per week
- 5 or more per week

91. Cantaloupe, melons (1/4 melon)
- Never/less than 1 per month
- 1 - 3 times per month
- 1 per week
- 2 or more times per week

92. Apples (1) or applesauce
- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 6 per week
- 1 or more per day

93. Pears (1)
- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 6 per week
- 1 or more per day

94. Oranges (1), grapefruit (1/2)
- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 6 per week
- 1 or more per day

95. Strawberries
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 or more times per week

96. Peaches, plums, apricots (1)
- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 or more per week

97. Orange juice (1 glass)
- Never/less than 1 per month
- 1 - 3 glasses per month
- 1 glass per week
- 2 - 6 glasses per week
- 1 glass per day
- 2 or more glasses per day

98. Apple juice and other fruit juices (1 glass)
- Never/less than 1 per month
- 1 - 3 glasses per month
- 1 glass per week
- 2 - 6 glasses per week
- 1 glass per day
- 2 or more glasses per day

99. Tomatoes (1)
- Never/less than 1 per month
- 1 - 3 per month
- 1 per week
- 2 - 6 per week
- 1 or more per day

100. Tomato/spaghetti sauce
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

101. Tofu
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

102. String beans
- Never/less than 1 per month
- 1 - 3 times per month
- Once per week
- 2 - 4 times per week
- 5 or more times per week

30962

103. Beans/lentils/soybeans
- ○ Never/less than 1 per month
- ○ Once per week or less
- ○ 2 - 6 times per week
- ○ Once per day

104. Broccoli
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

105. Beets (not greens)
- ○ Never/less than 1 per month
- ○ Once per week or less
- ○ 2 or more times per week

106. Corn
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

107. Peas or lima beans
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

108. Mixed vegetables
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

109. Spinach
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once a week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

110. Greens/beet greens
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

111. Green/red peppers
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once a week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

112. Yams/sweet potatoes (1)
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once a week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

113. Zucchini, summer squash, eggplant
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

114. Carrots, cooked
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

115. Carrots, raw
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

116. Celery
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 4 times per week
- ○ 5 or more times per week

117. Lettuce/tossed salad
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 - 6 times per week
- ○ One or more per day

118. Coleslaw
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

119. Potato salad
- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

Think about your usual snacks. How often do you eat each type of snack food.

Example If you eat poptarts rarely (about 6 per year) then your answer should look like this:

E3. Poptarts (1)

- ● Never/less than 1 per month
- ○ 1 - 3 per month
- ○ 1 - 6 per week
- ○ 1 or more per day

SNACK FOODS/DESSERTS

120. Fill in the number of snacks (food or drinks) eaten on school days and weekends/vacation days.

Snacks	School Days					Vacation/Weekend Days				
	NONE	1	2	3	4 OR MORE	NONE	1	2	3	4 OR MORE
Between breakfast and lunch	○	○	○	○	○	○	○	○	○	○
After lunch, before dinner	○	○	○	○	○	○	○	○	○	○
After dinner	○	○	○	○	○	○	○	○	○	○

121. Potato chips (1 small bag)

- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ One small bag per week
- ○ 2 - 6 small bags per week
- ○ 1 or more small bags per day

122. Corn chips/Doritos (small bag)

- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ One small bag per week
- ○ 2 - 6 small bags per week
- ○ 1 or more small bags per day

123. Nachos with cheese (1 serving)

- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ Once per week
- ○ 2 or more times per week

124. Popcorn (1 small bag)

- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ 1 - 4 small bags per week
- ○ 5 or more small bags per week

125. Pretzels (1 small bag)

- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ 1 small bags per week
- ○ 2 or more small bags per week

126. Peanuts, nuts (1 small bag)

- ○ Never/less than 1 per month
- ○ 1 - 3 small bags per month
- ○ 1 - 4 small bags per week
- ○ 5 or more small bags per week

127. Fun fruit or fruit rollups (1 pack)

- ○ Never/less than 1 per month
- ○ 1 - 3 packs per month
- ○ 1 - 4 packs per week
- ○ 5 or more packs per week

128. Graham crackers

- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ 1 - 4 times per week
- ○ 5 or more times per week

129. Crackers, like saltines or wheat thins

- ○ Never/less than 1 per month
- ○ 1 - 3 times per month
- ○ 1 - 4 times per week
- ○ 5 or more times per week

30962

130. Poptarts (1)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 poptarts per month
- ◯ 1 - 6 poptarts per week
- ◯ 1 or more poptarts per day

131. Cake (1 slice)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 slices per month
- ◯ 1 slice per week
- ◯ 2 or more slices per week

132. Snack cakes, Vachon Cakes (1 package)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 per month
- ◯ Once per week
- ◯ 2 - 6 per week
- ◯ 1 or more per day

133. Danish, sweetrolls, pastry (1)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 per month
- ◯ 1 per week
- ◯ 2 - 4 per week
- ◯ 5 or more per week

134. Donuts (1)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 donuts per month
- ◯ 1 donut per week
- ◯ 2 - 6 donuts per week
- ◯ 1 or more donuts per day

135. Cookies (1)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 cookies per month
- ◯ 1 cookie per week
- ◯ 2 - 6 cookies per week
- ◯ 1 - 3 cookies per day
- ◯ 4 or more cookies per day

136. Brownies (1)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 per month
- ◯ 1 per week
- ◯ 2 - 4 per week
- ◯ 5 or more per week

137. Pie (1 slice)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 slices per month
- ◯ 1 slice per week
- ◯ 2 or more slices per week

138. Chocolate (1 bar or packet) like Hershey's or M & M's
- ◯ Never/less than 1 per month
- ◯ 1 - 3 per month
- ◯ 1 per week
- ◯ 2 - 6 per week
- ◯ 1 or more per day

139. Other candy bars (Milky Way, Snickers)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 candy bars per month
- ◯ 1 candy bar per week
- ◯ 2 - 4 candy bars per week
- ◯ 5 or more candy bars per week

140. Other candy without chocolate (Skittles) (1 pack)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 times per month
- ◯ Once per week
- ◯ 2 - 4 times per week
- ◯ 5 or more times per week

141. Jello
- ◯ Never/less than 1 per month
- ◯ 1 - 3 times per month
- ◯ Once per week
- ◯ 2 - 4 times per week
- ◯ 5 or more times per week

142. Pudding
- ◯ Never/less than 1 per month
- ◯ 1 - 3 times per month
- ◯ Once per week
- ◯ 2 - 4 times per week
- ◯ 5 or more times per week

143. Frozen yogurt
- ◯ Never/less than 1 per month
- ◯ 1 - 3 times per month
- ◯ Once per week
- ◯ 2 - 4 times per week
- ◯ 5 or more times per week

144. Ice cream
- ◯ Never/less than 1 per month
- ◯ 1 - 3 times per month
- ◯ Once per week
- ◯ 2 - 4 times per week
- ◯ 5 or more times per week

145. Milkshake or frappe (1)
- ◯ Never/less than 1 per month
- ◯ 1 - 3 per month
- ◯ 1 per week
- ◯ 2 or more per week

146. Popsicles
- ◯ Never/less than 1 per month
- ◯ 1 - 3 popsicles per month
- ◯ 1 popsicle per week
- ◯ 2 - 4 popsicles per week
- ◯ 5 or more popsicles per week

147. **Please list any other foods that you usually eat at least once per week that are not listed (for example, coconut, hummus, falafel, chili, plantains, mangoes, etc. . .)**

FOODS	HOW OFTEN?
a) __________	a) __________
b) __________	b) __________
c) __________	c) __________
d) __________	d) __________

THANK YOU FOR COMPLETING THIS SURVEY!

Mark Reflex® forms by NCS Pearson EM-247495-2:654321 Printed in U.S.A.

30962

APPENDIX C Student Survey

CLASS II

Children's Lifestyle And School-performance Study

STUDENT SURVEY

This survey asks questions about the food that you eat, the types of activities that you take part in and how you feel about your health. We will also measure your growth and development in private (height, weight, and arm span). Your answers will help us learn more about children in Nova Scotia.

Your answers will be kept PRIVATE. They will not be shown to anyone from your school or your family.

Your participation is voluntary.

I understand the information given to me about the research.

I agree to take part in this research.

○ Yes ○ No

Your signature: ______________________ **Date:** __________

There are no right or wrong answers. Take your time and answer each question with the response that best describes you. If you need help or have any questions please ask the researcher who is visiting your class.

Please place this survey in the envelope when you are finished. Thank you for your help!

Please use the CLASS II pencil provided in the envelope to mark your responses.

The right way to mark your answer	The wrong way to mark your answer
●	

DO NOT WRITE IN THIS AREA

SERIAL #

1) How often do you do the following at your school?

	Not available at my school	Never	About once a month	About once a week	2–3 times per week	4 or more times per week
a) Buy food to eat as a snack	○	○	○	○	○	○
b) Buy food to eat for lunch	○	○	○	○	○	○
c) Buy something to drink	○	○	○	○	○	○
d) Eat at the breakfast program	○	○	○	○	○	○

2) When you eat food or drink a beverage provided by your school, what do you usually have?

	Not available at my school	Never	About once a month	About once a week	2–3 times per week	4 or more times per week
a) White milk	○	○	○	○	○	○
b) Flavoured milk (like chocolate)	○	○	○	○	○	○
c) Bottled water	○	○	○	○	○	○
d) Juice	○	○	○	○	○	○
e) Snacks, like cookies, candy, chocolate	○	○	○	○	○	○
f) Snacks, like baked chips or crackers, plain granola bars	○	○	○	○	○	○
g) Snacks, like fruit, vegetables and yogurt	○	○	○	○	○	○

3) How much do you care about...

	Not at all	A little bit	Quite a lot	Very much
a) being healthy?	○	○	○	○
b) being physically active at school?	○	○	○	○
c) being physically active outside of school?	○	○	○	○
d) eating healthy food at school?	○	○	○	○
e) eating healthy food outside of school?	○	○	○	○

4) How often do you do the following:

	Never	About once a month	About once a week	2–3 times per week	4 or more times per week
a) help prepare or cook food in your home (e.g., make lunch or snack)?	○	○	○	○	○
b) help make family meal choices?	○	○	○	○	○
c) help with family grocery shopping?	○	○	○	○	○

DO NOT WRITE IN THIS AREA

SERIAL #

5) **Have you done any of the following activities in the last 7 days (last week)?**
If yes, how many times? *(Choose only one circle per row.)*

	No	1–2	3–4	5–6	7 times or more
Skipping	○	○	○	○	○
Rowing/canoeing	○	○	○	○	○
In-line skating	○	○	○	○	○
Tag	○	○	○	○	○
Walking for exercise	○	○	○	○	○
Bicycling	○	○	○	○	○
Jogging or running	○	○	○	○	○
Aerobics	○	○	○	○	○
Swimming	○	○	○	○	○
Baseball, softball	○	○	○	○	○
Dance	○	○	○	○	○
Football	○	○	○	○	○
Badminton	○	○	○	○	○
Skateboarding	○	○	○	○	○
Soccer	○	○	○	○	○
Street hockey	○	○	○	○	○
Volleyball	○	○	○	○	○
Basketball	○	○	○	○	○
Ice skating	○	○	○	○	○
Cross-country skiing	○	○	○	○	○
Ice hockey/ringette	○	○	○	○	○
Other: ______	○	○	○	○	○
Other: ______	○	○	○	○	○

6) **In the last 7 days (last week), during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)?** *(Choose one only)*

- ○ I don't do PE. Why? ______
- ○ Hardly Ever
- ○ Sometimes
- ○ Quite often
- ○ Always

7) **This question is about what you do at <u>recess and lunch time</u>.**
In the last <u>7 days</u> (last week), what did you <u>usually</u> do… *(Choose one option per row)*

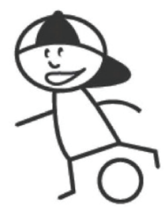
	Sat down *(talking, reading, doing school work)*	Stood or walked around	Ran or played a little bit	Ran around and played quite a bit	Ran around and played hard most of the time	I do not have recess
At morning recess	○	○	○	○	○	○
At lunch recess *(besides eating lunch)*	○	○	○	○	○	○
At afternoon recess	○	○	○	○	○	○

8) **This question is about what you do <u>outside of school time</u>.**
In the last 7 days (last week) how often did you do sports, dance, or play games in which you were <u>very active</u>? *(Choose one option per row)*

	None	1 time last week	2 to 3 times last week	4 or 5 times last week	6 or more times last week
Right after school?	○	○	○	○	○
In the evenings?	○	○	○	○	○
Last weekend?	○	○	○	○	○

9) **Which *one* of the following describes you best for the last <u>7 days</u> (last week)?**
Please read all five statements before deciding on the one answer that describes you.

○ <u>All or most</u> of my free time was spent doing things that involve little physical effort
○ I <u>sometimes</u> (1–2 times last week) did physical things in my free time
○ I <u>often</u> (3–4 times last week) did physical things in my free time
○ I <u>quite often</u> (5–6 times last week) did physical things in my free time
○ I <u>very often</u> (7 or more times last week) did physical things in my free time



10) **Please choose how often you did physical activity (like playing sports, games, dancing, or any other physical activity) for each day last week.** *(Choose only one per row)*

	None	Little bit	Medium	Often	Very often
Monday	○	○	○	○	○
Tuesday	○	○	○	○	○
Wednesday	○	○	○	○	○
Thursday	○	○	○	○	○
Friday	○	○	○	○	○
Saturday	○	○	○	○	○
Sunday	○	○	○	○	○

11) **Were you sick in the last 7 days (last week), or did anything prevent you from doing your normal physical activities?**

- ○ No
- ○ Yes *What prevented you?* ______________________________

Please choose the answer that best describes you for each of the following questions.

12) **If you wanted to, how confident are you that you could...**

	Not at all confident	A little bit confident	Quite confident	Very confident
a) be physically active no matter how tired you may be?	○	○	○	○
b) be physically active even if you have a lot of homework?	○	○	○	○
c) ask your parent or other adult to play a physical activity or sport with you?	○	○	○	○
d) be physically active for at least 60 minutes on 5 or more days per week?	○	○	○	○
e) eat healthy food at school?	○	○	○	○
f) choose a healthy snack between school and dinner time?	○	○	○	○
g) eat healthy food if you are alone at home?	○	○	○	○
h) choose a healthy snack when you are bored?	○	○	○	○
i) choose a healthy snack when you are sad?	○	○	○	○

13) **Please read the following statements and choose the answer that best describes you.**

	Never or almost never	Sometimes	Often or almost always
a) My future looks good to me	○	○	○
b) I like the way I look	○	○	○
c) I like myself	○	○	○
d) I feel like I do not have any friends	○	○	○
e) I feel unhappy or sad	○	○	○
f) I worry a lot	○	○	○
g) I am in trouble with my teacher(s)	○	○	○
h) I have trouble paying attention	○	○	○
i) I have trouble enjoying myself	○	○	○
j) If I have problems there is someone I trust to go to for advice	○	○	○

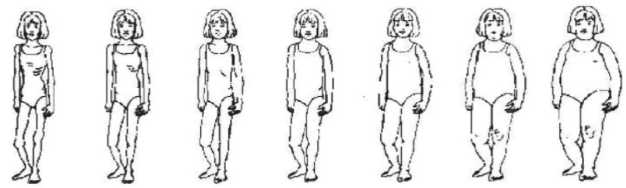
DO NOT WRITE IN THIS AREA

SERIAL #

3/8" PERF

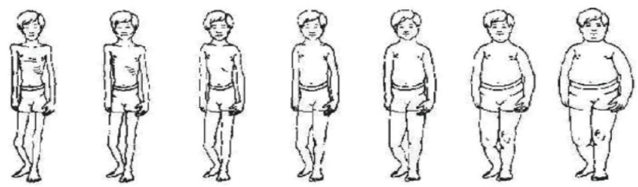
14) **Fill in the bubble below the picture that best matches to <u>what you look like now</u>.**

Girls



○ ○ ○ ○ ○ ○ ○

Boys



○ ○ ○ ○ ○ ○ ○

15) **For each question, fill in one circle that best describes your health TODAY.**

a) Walking

- ○ I have no problems walking around
- ○ I have some problems walking around
- ○ I have a lot of problems walking around

b) Looking after myself

- ○ I have no problems washing or dressing myself
- ○ I have some problems washing or dressing myself
- ○ I have a lot problems washing or dressing myself

c) Doing usual activities (e.g., going to school, hobbies, sports, playing, doing things with family or friends)

- ○ I have no problems doing my usual activities
- ○ I have some problems doing my usual activities
- ○ I have a lot of problems doing my usual activities

d) Having pain or discomfort

- ○ I have no pain or discomfort
- ○ I have some pain or discomfort
- ○ I have a lot of pain or discomfort

e) Feeling worried, sad or unhappy

- ○ I am not worried, sad or unhappy
- ○ I am a bit worried, sad or unhappy
- ○ I am very worried, sad or unhappy

Thanks for completing this survey!