The Impact of Classroom Scheduling on Student Nutrition in Full-Day Early Learning Kindergarten (ELK) versus Traditional Full-Day Junior/Senior Kindergarten Classes

by

Charley-Anne A. Horodziejczyk

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Human Kinetics (MHK)

Faculty of Graduate Studies

Laurentian University

Sudbury, Ontario, Canada

THESIS DEFENCE COMMITTEE/COMITÉ DE SOUTENANCE DE THÈSE
Laurentian Université/Université Laurentienne
Faculty of Graduate Studies/Faculté des études supérieures

Title of Thesis Titre de la thèse	The Impact of Classroom Scheduling on Student Nutrition in Full-Day Early Learning Kindergarten (ELK) versus Traditional Full-Day Junior/Senior Kindergarten Classes
Name of Candidate Nom du candidat	Dinnes, Charley-Anne
Degree Diplôme	Master of Human Kinetics
Department/Program Département/Programme	Human Kinetics
Date of Defence Date de la soutenance	December 16, 2014

APPROVED/APPROUVÉ

Thesis Examiners/Examinateurs de thèse:

Dr. Sandra Dorman
(Supervisor/Directeur(trice) de thèse)

Dr. Alain Gauthier
(Co-supervisor/Co-directeur(trice) de thèse)

Dr. Celine Larivière
(Committee member/Membre du comité)

Dr. Diana Urajnik
(Committee member/Membre du comité)

Dr. Jennifer Taylor
(External Examiner/Examinateur externe)

Approved for the Faculty of Graduate Studies
Approuvé pour la Faculté des études supérieures
Dr. David Lesbarrères
M. David Lesbarrères
Acting Dean, Faculty of Graduate Studies
Doyen Intérimaire Intérimaire, Faculté des études supérieures

ACCESSIBILITY CLAUSE AND PERMISSION TO USE

ABSTRACT

Background This thesis assessed the quality/quantity of student lunches amongst children using either the Early Learning Kindergarten (ELK) or full-day junior/senior kindergarten schedule; both of which differed in regards to school scheduling. ELK students were allotted two 40 minute nutrition breaks compared to the full day junior/senior kindergarten schedule who were allotted two 20 minute nutrition breaks.

Methods Data were collected over 5 days from eight classrooms at two schools. Food was photographed three times per-day: upon arrival to school; and after each nutrition break. Nutrient intakes (kilocalories, macronutrients, select micronutrients, and food groups) were determined and compared to standard dietary indices Mean scores for continuous variables were compared using independent-sample t tests.

Results A total of 135 kindergarten students participated in this study, representing an overall response rate of 71%. ELK lunches had more kilocalories, macronutrients, total food items, fruits/vegetables, and micronutrients packed. ELK students consumed a greater percentage of their packed lunches throughout the school day. Additionally 33% of the students permitted to access their lunch outside of nutrition breaks did so. All lunches, irrespective of schedule, were low in fibre, vitamin D, folate and potassium and high in sugar and sodium.

Conclusions Schools should implement policies that: a) provide younger students more time to eat; and b) allow children to access a healthy snack before first nutrition break for a greater consumption of essential nutrients. Parents should pack fewer non-food items to increase the likelihood that students will consume their packed fruit and vegetables servings.

Keywords

School scheduling, kindergarten, nutrition, school health, appetite, dietary intake

CO-AUTHORSHIP STATEMENT

Chapter III is presented as a manuscript for publication.

Author contributions:

Charley-Anne A. Horodziejczyk assisted with the conceptualization of the study, led the collection data, conducted all data analyses, and wrote the manuscript.

Dr. Sandra C. Dorman conceptualized the study, supervised the collection of data, assisted with data analyses and reviewed the manuscript.

Dr. Alain P. Gauthier conceptualized the study, assisted with data analyses and reviewed the manuscript.

Diana Urajnik assisted with the conceptualization of the study, assisted with data analyses and reviewed the manuscript.

Dr. Céline Larivière assisted with data analyses and reviewed the manuscript.

Laura J. Thirkill assisted with the conceptualized the study, co-led the collection of data, and assisted with data entry.

Michelle C. Laurence assisted with the conceptualized the study, collection of data, and assisted with data analyses.

Desiree Duguay assisted with data collection and data entry.

ACKNOWLEDGEMENTS

This thesis would not have been possible without the support and patience of many important people.

Firstly, I would like to express my sincere gratitude to my advisor Dr. Sandra Dorman for the continuous support throughout my graduate studies. I would like to thank-you for your patience, inspiration, and immense knowledge. I could not have imagined having a better advisor and mentor for my Master's studies.

I would like to thank my thesis committee members: Dr. Alain Gauthier, Dr. Diana Urajnik, and Dr. Celine Larivière and honorary committee member Michelle Laurence for your insightful comments and encouragement. It has been a pleasure to get to know you professionally and personally.

To my husband, Andrew: Planning a wedding while completing graduate studies was a challenge, but we did it! Our experiences together taught me that there is never a "good" time to dive into life's most significant events, and I could not have found a better partner to lean on during my aspirations of successfully completing graduate studies.

To my parents, Laura and Christopher Dinnes: Thank-you for always encouraging me to be fearless and to never settle for less. I love you *so* much.

To my peer and dear friend Laura Thirkill: You have provided me with an enormous amount of support over the last couple of years, and I am not sure I would have made it through without you! I can't wait to see the amazing things you do.

Lastly, thank-you to all of the research assistants who dedicated their time and efforts to this project; especially Desiree Duguay and Lindsay Leduc.

Table of Contents

List of Tables

List of Figures

CHAPTER 1

INTRODUCTION

1.1 Introduction

The early learning experiences of Ontario's children are undergoing a substantial reconfiguration. Not only has the curriculum of kindergarten been transformed with the intent to optimize student learning, but also, as of September 2014, all parents will have the option to enroll their child in a full day of kindergarten if they so choose (Cantalini-Williams & Telfer, 2010).

The full-day Early Learning Kindergarten (ELK) program began implementation across Ontario in 2011 and is a mandatory service in all elementary schools as of September 2014 (Cantalini-Williams & Telfer, 2010). The ELK program is a child-centered, developmentally appropriate, integrated, full-day program of learning for four and five-year-olds (Ontario Ministry of Education, 2010). The purpose of the program is to establish a strong foundation for learning in a safe and play-based environment that promotes physical, social, emotional and cognitive development for all children, and to improve student preparedness for grade one (Ontario Ministry of Education, 2010).

The ELK program significantly changes kindergarten programming and therefore requires careful scrutiny due to the large number of Canadian children who will participate in it, at a critical stage in their development. At the same time this program offers substantial opportunities to benefit the long-term health of Canadians.

Kindergarten lays the foundation for future school experiences. Early success in kindergarten predicts long-term educational success and adjustment outcomes (Kern & Friedman, 2008). In addition, kindergarten is one setting in which behaviour is learned, and would include food practices and physical activity while at school. Early, positive enforcement of health practices are more likely to become embedded behaviours, and schools provide an opportunity for interceptive strategies. Evidence also suggests that children who are hungry are significantly less attentive in the classroom (Taras, 2005) and tend to have behavioural difficulties (Murphy et al., 1998). Younger children may be the most vulnerable to nutritional changes in their food schedules. For example, Campbell et al. (2002) reported that approximately half of university-educated mothers claim their schedules impede their families' ability to eat breakfast and dinner meals together. This could have possible dietary intake implications, as Neumark-Sztainer et al. (2003) report that frequency of family meals is positively associated with intake of fruits, vegetables, grains, and calcium-rich foods, and negatively associated with soft drink consumption. Positive associations were also found between frequency of family meals and energy protein (percentage of total calories), calcium, iron, folate, fiber, and vitamins A, C, E, and B-6 (Neumark-Sztainer et al., 2003).

Despite potential dietary implications, the impact of school-scheduling on student nutrition has not been examined. The ELK eating schedule closely mirrors that of the Balanced School Day schedule (BSD), as the majority of schools in Ontario now employ the BSD schedule. The BSD schedule has two 40-minute breaks, each with twenty minutes to eat and twenty minutes for recess, separated by three 100-minute teaching blocks. The ELK schedule modifies this by giving students the full forty-minutes to consume food, during which time, the children can engage in quiet indoor play when they finish eating. Some schools have also chosen to allow kindergarten students to access their lunches outside of designated nutrition breaks if they are hungry. It is unclear why this adaptation was made, although it may have been in response to parental complaints of hunger amongst their children in full-day junior and senior kindergarten (JK/SK); parents believe that 20 minutes is not enough time for their children to eat their packed lunches. Several anecdotal reports on this topic can be found on school websites that explore implications of the shorter nutrition breaks associated with the BSD schedule in younger children (reviewed in Dorman et al., 2013).

Data regarding the relationship between school scheduling and nutrition is limited, and to date, there are no reports on kindergarten children. Dorman and colleagues (2013) previously found that with the exception of beverages, the BSD schedule did not impact 'what' parents packed for children's lunches for children in grades 3-to-6. However, parents report 'hunger' to be a common occurrence with younger children using the BSD schedule. It is hypothesized that this is because children do not seem capable of focusing their time during the 20-minute nutrition block to 'eat' their food. This is supported by Woehrle et al. (2001), who found that primary and junior students had decreased perceived "time to eat" after schools changed from traditional to BSD scheduling. This may be exacerbated in our youngest school students, i.e. kindergarten students.

1.2 Purpose

Given that classroom scheduling impacts time allocated for eating, this may have implications on children's overall health. However, no systematic evaluation of the nutritional impact of ELK scheduling on student nutrition has been completed. Therefore the purpose of this study was: i) to describe the nutritional quality and total amount of packed food consumed as well as food that children consumed during each break; ii) to examine the food choices that children made during first and second break in terms of amount and nutritional quality; and iii) to compare scheduling effects on student dietary intake (if any) between schools in the same geographic area: one using the Early Learning Kindergarten program and the other using the (now defunct) Full-Day Junior and Senior Kindergarten (JK/SK) program.

References for Chapter 1

Campbell, K., David, C., Cashel, K., Worsley, A., Gibbons, K., Birch, L. (2002). Family food environments of 5-6-year-old-children: Does socioeconomic status make a difference? Asia Pacific Journal of Clinical Nutrition. 11(Suppl):553-561

Cantalini-Williams, M., & Telfer, L. (2010). Successful Implementation of the Full-Day Early Learning-Kindergarten Program. *Early Years Education Ontario Network*, *14*(1). Retrieved from http://eyeonkids.ca/docs/files/canatlini-williams_full_day_leadership[1].pdf. Accessed August 26, 2014

Dorman, S. C., Gauthier, A. P., Laurence, M., Thirkill, L., & Kabaroff, J. L. (2013). Photographic Examination of Student Lunches in Schools Using the Balanced School Day Versus Traditional School Day Schedules. *ICAN: Infant, Child, & Adolescent Nutrition*, *5*(2), 78–84. http://doi.org/10.1177/1941406413476547

Murphy, J.M., Wehler, C.A., Pagano, M.E., Little, M., Kleinman, R.E., Jellinek, M.S. (1998). Relationship between hunger and psychosocial functioning in low-income American children. *Journal of the American Academy of Child and Adolescent Psychiatry*, *37*(2), 163–70. http://doi.org/10.1097/00004583-199802000-00008

Neumark-Sztainer, D., Hannan, P. J., Story, M., Croll, J., & Perry, C. (2003). Family meal patterns: Associations with sociodemographic characteristics and improved dietary intake among adolescents. *Journal of the American Dietetic Association*, *103*(3), 317–322. http://doi.org/10.1053/jada.2003.50048

Ontario Ministry of Education. (2010)[a]. The Full-Day Early Learning – Kindergarten Program. Retrieved October 5, 2013, from http://www.edu.gov.on.ca/eng/curriculum/elementary/kindergarten.html

Kern, M. L., & Friedman, H. S. (2008). Early educational milestones as predictors of lifelong academic achievement, midlife adjustment, and longevity. *Journal of Applied Developmental Psychology*, *30*(4), 419–430. http://doi.org/10.1016/j.appdev.2008.12.025

Taras, H. (2005). Nutrition and Student Performance at School. *Journal of School Health*, *75*(6), 199–213. http://doi.org/10.1111/j.1746-1561.2005.00025.x

Woehrle, T., Fox, S., & Hoskin, B. (2005). An Examination of the Balanced School Day Schedule. *Ontario Action Researcher*

CHAPTER II
REVIEW OF THE LITERATURE

2.1 Assessing Food and Nutrient Intakes

2.1.i Dietary Reference Intakes

The Dietary Reference Intakes (DRI) created by the Institute of Medicine between 1994 and 2005, are a comprehensive set of values for macronutrients (fats, proteins, carbohydrates and water) and micronutrients (vitamins and minerals) that are estimated to support a healthy diet for assumedly healthy individuals (Institute of Medicine, 2006). The values represent the most up to date data published by nutrition research experts, and are used by health professionals to assess dietary intake of individuals and groups (Institute of Medicine, 2006).

Depending on the amount of information available, each nutrient either has an Estimated Adequate Requirement (EAR) and a Recommended Daily Allowance (RDA), or an Adequate Intake (AI). Each DRI represents a clinically significant value, defined as follows: EAR represents the intake of a nutrient that is estimated to meet the needs of half of healthy individuals of a particular age and gender; RDA is the intake of a nutrient that is estimated to meet the needs of nearly all (97-98%) individuals of a particular age and gender; and AI is used when an RDA cannot be calculated. An AI is a recommended intake based on an estimation calculated by observations or experimentation on healthy individuals whose diets are assumed to be adequate (Institute of Medicine, 2006).

As a whole, each type of DRI is an estimation of what will be sufficient to meet the needs of healthy individuals. It is important to note that intakes may vary from day-to-day without significant effects on health. The Institute of Medicine recommends that to best assess the intakes of a group of individuals, the EAR should be used as the reference point, and that observed mean intakes should be used as the best indicator of usual intake (Institute of Medicine, 2006).

2.1.ii Acceptable Macronutrient Distribution Range

There is a growing body of evidence that disproportionate energy intake from macronutrients can increase the risk of certain chronic diseases, and may disrupt appropriate consumption of vitamins and minerals (Australian Ministry of Health, 2013). The Acceptable Macronutrient Distribution Ranges (AMDR) were developed by the Food and Nutrition Board of the Institute of Medicine, under consideration of the association between macronutrient intake, chronic diseases, and specific health outcomes, such as body weight management, Coronary Heart Disease, LDL oxidation, stroke, type II diabetes, cancer, osteoporosis, and child growth (Institute of Medicine, 2006), and are a subset of DRI’s.

Table I. Acceptable Macronutrient Distribution Ranges (AMDR).

Males and Females	Total Carbohydrate	Total Protein	Total Fat	n-6 polyunsaturated fatty acids (linoleic acid)	n-3 polyunsaturated fatty acids (α-linolenic acid)
	% Energy	% Energy	% Energy	% Energy	%Energy
1-3 years	45-65%	5-20%	30-40%	5-10%	0.6-1.2%
4-18 years	45-65%	10-30%	25-35%	5-10%	0.6-1.2%
19 +	45-65%	10-30%	25-35%	5-10%	0.6-1.2%

(Table adapted from Health Canada, 2011)

Divided into age groups, distribution ranges for specific macronutrients are given to estimate adequacy of energy sources based on scientific knowledge of reducing the risk of chronic disease while providing sufficient intakes of essential nutrients (See Table I). By definition, if an individual's intake of a particular energy source is above or below the AMDR, there is the potential of an increased risk of chronic disease and/or an inadequate intake of essential nutrients (Institute of Medicine, 2006).

2.1.iii Dietary Assessment Methods

The need to measure dietary behaviour and the implications of such habits on the risk of developing chronic diseases has been recognized by health professionals (Bingham et al., 1994). There are two major considerations for collecting nutrition information that can challenge such tasks: ensuring the assessment method is accurate, and feasibly extending the assessment method to reach large populations of people, (Bingham et al., 1994). Below, the most common methods for assessing dietary intake, and the evidence pertaining to each method will be detailed.

24-Hour Recall

The 24-hour recall is a retrospective method requiring participants to recollect all foods and beverages consumed either the previous day, or in the 24-hour period prior to the time of interview (Thomson & Subar, 2001). This method of assessing diet has one obvious limitation: one day is unlikely to represent habitual dietary intake. However, many national surveys utilize this method because it is less burdensome for participants, and often achieves a large response rate.

Food Frequency Questionnaire

Food frequency questionnaires (FFQ) is the most common method of collecting dietary habitual intake in epidemiological studies. FFQ are self-administered, and ask participants to report on the frequency of foods consumed and portion sizes over a given period of time (Thomson & Subar, 2001). For example, FFQs may ask how often the participant consumed a certain food item in the past month, past three months, or the past year.

FFQs have the same methodological concerns of surveys in general, including: i) reliance on recall over lengthy periods of time, which introduced measurement error; ii) the tendency for participants to exaggerate positive components of their diet over negative, or to respond in a way that they feel will 'please' the researcher by providing socially desirable information; iii) information gathered is limited to the questions asked and often can be minimal in scope; iv) cultural and language bias inherent in the way the survey was written, which either excludes possible answers or creates an inability to answer the question accurately and honestly; in general, research may never know if the respondent understood the question asked; v) potentially biased return rates, in that people who return a questionnaire may be those who have extremely positive or negative viewpoints and want their opinion heard; the most unbiased respondent is the person who typically does not respond because they do not care, which in and of itself can also bias the sample given that it will affect the complete rate of the survey; and vi) in the case of young children or incapacitated individuals, the use of secondary sources about food consumption (e.g. parental report) (Thompson & Subar 2001). However, FFQs are the most commonly used method because they are relatively inexpensive for large populations, do not require much effort to collect large amounts of data, and are easy to analyse (Thompson & Subar, 2001).

Three-Day Food Records:

Three-day food records require participants to record, in detail, all foods and beverages consumed during a three-day time period. It is recommended to record every second day; two during the week and one day during the weekend to capture variability (Goulet et al., 2004). Yang et al., (2010) found that compared to a nine-day food record, three-day food records showed higher correlations than did FFQ's. However, three-day food records are limited to capturing food intake at a specific point in time, and cannot capture the within-person variations of day-to-day dietary intake (Yang et al., 2010).

2.1.iv Photographic Examinations

Using photography to capture food intake is a relatively recent phenomenon compared to traditional assessment methods, (Sabinski, 2013). This method was developed to unobtrusively capture food intake and subsequently eliminate the need for self-reports. Advantages of this method include its low cost, limited participant burden, rapid data collection, and the possibility to extend the method to collect data on populations, (Sabinski, 2013). For example, in large-scale epidemiological studies, it is not recommended to use researcher-assisted three-day food records because of the large cost and resources needed. Using photographic captures of dietary intake instead could reduce participant involvement, reduce required training for research assistants, and eliminate the underreporting commonly seen during participant interviews, (Sabinski, 2013). Martin et al., (2007) measured the reliability and validity of assessing children's food intake using photography in a school cafeteria, and the method was reported to be reliable. Swanson 2008 also used this method during his study of children's food intake at two elementary schools. More specifically, lunch trays were photographed before and after eating periods and concluded that the method was cost-effective and reliable. Williamson et al., 2003 tested the validity of using photographs to collect dietary intake against the weighted foods of 60 test meals, and concluded that the method was reliable for estimating portion sizes.

Gauthier et al., (2013) assessed the reliability of using digital photographs to estimate food and nutrient intake using the NutriBase Pro 10.0 nutrition software program. Both intra-rater (same rater) and inter-rater (two or more raters) reliability was measured, and overall, intra-rater coefficients were higher than the inter-rater reliability estimates. For kilocalories, carbohydrates, fat, and protein, the ICCs were strong (0.75-0.87) (Gauthier et al., 2013). For the micronutrients measured (sodium, calcium, vitamin C, vitamin A, and folate), some ICCs were found to be of moderate strength, and some fell below the level of acceptability. Specifically, the inter-rater reliability ICC for sodium and the intra-rater ICC for vitamin C were moderate, and the inter-rater ICC for folate and vitamin were below the level of acceptability (Gauthier et al., 2013). The authors recommend that those who use this method interpret micronutrient results with caution. As well, the authors recommend supplementing photographic images with diary log sheets to help identify items; for example, the contents of a sandwich or how many carrot sticks are in a container (Gauthier et al., 2013).

2.2 Schedule Changes in Ontario's Elementary Schools

2.2.i The Balanced School Day

The Traditional School Day (TSD) schedule for elementary students consists of two, 15 min recesses and a one-hour lunch. Newer to Canadian schools, the Balanced School Day (BSD) Schedule was introduced in 2003 (Woehrle, Fox, & Hoskin, 2001) and has since been adopted by approximately 1000 elementary schools in Ontario. The BSD schedule is a type of block scheduling that divides classroom instructional time into three 100-minute ‘learning blocks,’ separated by two ‘nutrition and physical activity’ breaks. These breaks are typically 40 minutes long, with 20 minutes allocated to both, often in a randomized order depending on the student’s grade. The rationale behind the BSD schedule was that having two breaks in contrast to three would reduce transition-time and give teachers a greater amount of uninterrupted instructional time (Woehrle et al., 2001), and therefore enhance classroom learning. However, given the fundamental alterations in patterns and times allotted for eating and playing, it is noted that the BSD also has significant implications for nutrition and physical activity levels in children.

The Halton District School Board in southern Ontario is one of Canada’s largest Boards, and was the first to examine the effects of implementing the BSD on school nutrition (HDSB, 2003). The Board distributed surveys to parents, students and staff asking how they felt about the BSD schedule compared to the school's former traditional schedule. Although not a peer-reviewed publication, this survey is available to view online (HDSB, 2003). Only two of the questions posed related to nutrition. One question, asked parents and students, if: ‘all of their food was consumed during lunch?’ Unfortunately due to design limitations, it was impossible to determine whether there was an increase or decrease in food consumption compared to the traditional schedule, or whether changes in eating habits were related to the BSD. The second question asked students: ‘Did you go home for lunch last year (i.e., prior to BSD implementation)?’ and ‘Do you go home for lunch now?’ Sixteen per cent of students reported going home for lunch with the traditional schedule whereas; 9% reported going home with the BSD schedule. Anecdotally, parents had reported through various Boards that they felt their children no longer had ‘enough time’ to eat. This contention was supported by a study conducted by Woehrle et al. (2001). Although the primary outcome for the study completed by Woehrle et al. was unrelated to nutrition, they did report results regarding eating time. Students, parents, and teachers were asked about their satisfaction with the amount of time allotted for eating and the results were mixed, (Woehrle et al., 2001). Intermediate and junior students following the TSD, and intermediate students following the BSD, were more likely to report that they had enough time to eat than junior students using the BSD. As well, only half (52%) of parents of children using the BSD schedule reported that their child had enough time to eat (Woehrle et al., 2001).

The only study to date that has specifically examined the nutrition and food-related effects of the BSD in comparison to the TSD, was completed by Dorman et al., in 2013. In this study, photographic examinations and diary logs were used to capture the food that parents packed for children at school, as well as the amount of food consumed by children while at school, in grades 3 and 6 at two schools; one using the BSD and the other using the TSD. No significant differences were found for kilocalories packed or consumed in student lunches between the two schedules. However, a significant difference between the number of beverages packed were noted. In particular, parents whose children were enrolled at a school using the BSD had a tendency to pack 2 beverages, rather than 1 as noted for the TSD, (Dorman et al., 2013). This study was the first of its kind to evaluate the effects of scheduling on student nutrition, and the literature continues to limited in this regard.

2.2.ii Full-Day Early Learning Kindergarten in Ontario

In 2004, before the development of full-day early learning kindergarten (ELK), the Ontario Ministry of Children and Youth Services devised the Best Start program (Ontario Ministry of Child and Youth Services, 2010). The goal of the Best Start program was to improve Ontario’s children’s preparedness to enter grade one. Since kindergarten was still only half-a-day, the Best

Start program aimed to provide children and parents with access to community resources, such as affordable childcare (Ontario Ministry of Children and Youth Services, 2010). Building upon the Best Start Program, the Special Advisor on Early Learning, Charles E. Pascal, began to advocate for province-wide access to full-day early learning kindergarten (Pascal, 2009). Full-day ELK was built around the goal to erase the historical divide between education and child-care by providing full-time education to all early learners (Pascal, 2009).

In September of 2010, the Ontario government began to integrate full-day kindergarten into Ontario`s schools. Other than select Catholic and French school boards, 2010 was the first year that full-day kindergarten was offered in Ontario (Pascal, 2009). Not since the implementation of junior kindergarten in 1944 has such a substantial change been made to the curriculum of early learners (Cantalini-Williams, & M. Telfer, 2010). In its first year, 35,000 four and five year old students participated in the first-phase, and since its implementation, full-day kindergarten is now offered in the majority of Ontario elementary schools. The Full-Day Early Learning Statute Law Amendment (2010) will give all Ontario elementary schools the mandatory responsibility to offer full-day early learning kindergarten by September, 2014 (Cantalini-Williams & Telfer, 2010).

According to the Ministry of Education, parents can expect their child to transition more smoothly into grade one, as participating in a full day of learning has the potential to improve kindergarten student reading, writing, and math skills (Ministry of Education, 2010). Additionally, some US and Canadian research has concluded that full-day kindergarten assists children in adapting to the more formal schedule of grade one and beyond (Ministry of

Education, 2010).

Besides changes to the curriculum, the ELK schedule also differs from traditional kindergarten with regards to scheduling. In our study, full-day JK/SK kindergarten classes followed the BSD schedule, wherein children were allotted two nutrition and physical activity breaks. The ELK schedule includes two 40-minute nutrition breaks and one 60-minute block for physical activity, called, “outdoor exploration time” (Ministry of Education, 2010). Additionally, in some school boards, children may be permitted to access their lunch at any point in time, if they so choose. There is no published research to date that has examined how these changes in policy will affect student dietary food and nutrient intake.

2.3 Nutrition for the Early Years

2.3.i Health Canada

According to Health Canada’s ‘Eating Well with Canada’s Food Guide’, children ages 4-8 years are recommended to consume 5 fruit and vegetable servings, 4 grain product servings, 2 milk and alternative servings, and 1 meat and alternative serving throughout the course of the day (Health Canada, 2011) (see Table II).

Table II Daily Food Guide Serving Recommendations

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

(Adapted from Health Canada 2011)

Health Canada divides their recommendations further as to what should be in a young student’s lunch, and what should be consumed for a morning and afternoon snack. They endorse 1 fruit, 1 vegetable, 1 grain product, a 0.5 milk serving, and a 0.3 meat-and-alternative serving for lunch, as well as, 1 grain and 1 fruit or vegetable serving for morning and afternoon snacks (Health Canada, 2011).

Since preschool and young children have small stomachs and smaller appetites, Health Canada (2011) recommends that children divide these servings into small meals and snacks consumed more often throughout the day. Specifically, it is recommended that children consume food six times a day, namely three meals and three snacks. Although Health Canada does not specifically recommend when students consume their small meals and snacks, they do recognize that children prefer to eat on a regular schedule and in familiar settings (Health Canada, 2011). They also recognize that the amount of food eaten at each meal and snack may vary daily depending on appetite fluctuations due to activity level and growth spurts. Lastly, Health Canada states that children easily lose interest in any single activity, including mealtimes. When hungry, young children will focus on eating, yet when satisfied they will turn their attention to a different activity (Health Canada, 2011).

The BSD and ELK schedules break from the recommendations made by Health Canada. Specifically, the replacement of a single lunch-break with two nutrition breaks decreases the number of meals consumed by children from three (i.e. breakfast, lunch & dinner) to two (i.e. breakfast & dinner), and increases the number of snacking opportunities.

Interestingly, as described above, the total amount of time provided to students for eating is double for the ELK schedule compared to the BSD. Health Canada (2011) states that children are able to self-regulate their kilocalorie needs, and will therefore adjust their food-intake as necessary. School boards that allow children to access their food outside of designated eating breaks are therefore implementing schedules that are consistent with Health Canada's recommendation to allow children to decide how much food they need.

2.3.ii Diet Quality and Academic Performance

The early academic performance of children often reflects their future academic achievement (McClelland et al., 2006). Similarly, early health behaviours and attitudes predict future health status (Gådin & Hammarstrom, 2002; Marmot & Wilkinson, 2005). Accordingly, a number of studies have highlighted the potential link between healthy eating habits and academic performance in early child development (Gunter and Daly, 2013), particularly hunger (Taras, 2005).

Due to the multidimensional relationship between food consumption and school performance, studies often use a Dietary Quality Index (DQI) to measure the association between nutrition and academic outcomes (Florence et al., 2008), and studies consistently show that children who have a healthy diet perform better academically, including performance on standardized tests (Gunter and Daly, 2013). For example, in Nova Scotia, students who had a lower DQI score were significantly more likely to perform poorly on standardized literacy tests after controlling for the socioeconomic status of parents and residential neighbourhoods (Florence et al., 2008). Additionally, it has been shown that children who consume fewer fruit and vegetables (Sigfusdottir, Kristjansson, &Allegrante, 2007), who come from food insecure homes (Jyoti, Frongillo, & Jones, 2005), and who have increased levels of sugary sweetened beverages

(Edwards, Mauch, &Winkelman, 2011), have lower grades and poorer scores on standardized tests.

2.3.iii Hunger in the Classroom

Taras (2005) published an article reviewing studies that reported on the association between nutrition, student school performance and cognitive functioning. The majority of the studies conducted in North America concluded that food insufficiency was associated with significantly decreased cognitive functioning, increased absenteeism, and a decrease in academic achievement, (Taras, 2005).

Breakfast consumption and performance outcome studies have highlighted the importance of nutrition in an effective classroom setting. In both elementary and secondary breakfast consumption has been associated with improved cognitive functioning tests, particularly tests that are more cognitively demanding (e.g. Mahoney et al., 2005; Cooper et al., 2011). These effects are even more pronounced in children whose nutritional status is compromised (Hoyland et al., 2009). As well, students who consume breakfast are more likely to report higher energy levels, lower levels of tiredness, and lower levels of hunger during morning class time (Mahoney et al., 2005). Students who consume breakfast also have blood glucose levels that remain significantly higher throughout the morning than those who do not (Pollitt & Mathews, 1998). It should be noted that glucose is a key substrate used by the brain for cognitive activity, and having a higher blood glucose level increases the delivery of glucose to the brain (Pollitt & Mathews, 1998), which could explain the increased cognitive functioning. Although breakfast consumption rates in Canada have been increasing in the past couple of decades, an unfortunate statistic from the Chief Public Health Officer's 2008 *Report on the State of Public Health in Canada*, states that an average of 31% of elementary students do not eat breakfast before school (Butler-Jones 2008).

The association between improved academic performance and breakfast consumption could also be explained by improved student attendance and decreased tardiness (Taras, 2005). Among schools that offer breakfast at school, students were more likely to be in attendance (Kleinman et al., 2002; Murphy et al., 1998).

2.3.iv Appetite Regulation

Evidence of appetite self-regulation has been demonstrated in infancy and has the potential to continue into early childhood, depending on parental influence (Birch & Fisher, 1998). In a series of experiments to examine whether or not infants as young as six weeks could self-regulate their formula intake, Fomon and colleagues (1993) manipulated the energy content of formula and removed maternal control. Study findings showed that infants who were fed a more energy-dilute formula consumed a greater volume than infants who were fed a more energy-rich formula, and total energy intake did not differ across conditions (Fomon, 1993).

Research conducted by Birch and colleagues from 1985 to 1993 extended this research further via similar investigations with children (Birch & Fisher, 1998). Children consumed a first meal that varied in energy content and were then offered a second course. Children who consumed a high-energy first meal, self-selected less food for the second course, compared to children who consumed a low-energy first meal (Birch & Deysher, 1985; Birch & Deysher, 1986; Birch et al., 1987; Kern et al., 1993).

More recently, an assessment of dietary intake of infants and toddlers showed evidence of energy self-regulation (Fox et al., 2006). Using data from 24-hour parental recalls of 3,022 infants and toddlers, a significant relationship was found between the number of eating times and volume of food intake. Infants and toddlers who ate less often throughout the day consumed larger-than-average portion sizes. The reverse was demonstrated as well, as children who had more feeding times during the day consumed smaller-than-average portion sizes (Fox et al., 2006). Unfortunately, a child's responsiveness to the energy content of food may diminish when adults use control strategies, specifically external cues to increase consumption (Birch & Fisher, 1998). This hypothesis was tested using two different food contexts: one in which the child chose how much to consume based on internal hunger cues, and one in which a reward was given for "cleaning your plate" (Birch et al., 1987). When rewards were given, evidence of self-regulation disappeared, and children ate significantly more (Birch et al., 1987). These results have been supported more recently in an evaluation of maternal feeding practice and children's appetite traits. Maternal "restriction" of foods was associated with over-responsiveness to such foods, and maternal pressure to eat was associated with food avoidance tendencies and fussiness (Webber et al., 2010).

2.4 Childhood Nutrition in Canada

Key physical, cognitive, language and social-emotional development occur during the early childhood years (Fomon, 1993). Examples of developments that have implications into adulthood children include the findings by Whittaker et al., 1997 that found that children who are obese between the ages of 6 and 9 years have a 55% chance of becoming an obese adult, which is 10 times the risk for children of normal weight. These facts are concerning as 2009 obesity-related illness in Ontario cost $4.5 million alone (Munter & Murumets, 2013). Increasing rates of obesity (Ebbeling et al., 2002) along with the fact that healthy childhood development is the eighth of twelve key social determinants of health (Marmot & Wilkinson, 2005), makes the growth and development of Canadian children a public health priority. Below, the current state of Canadian children in regards to food and nutrition will be discussed.

2.4.i Results from the Canadian Community Health Survey

In 2004, Statistics Canada published ‘Overview of Canadians’ Eating Habits’ findings from the Canadian Community Health Survey (CCHS) (Garriguet, 2004). This report was the first national survey to measure the eating habits of Canadians since the 1970’s (Garriguet, 2004). Over 3,500 Canadian citizens were asked to conduct 24-hour recalls, recollecting what they ate for breakfast, lunch, dinner, snacks, and whether or not foods were prepared at home, restaurants, or fast-food establishments. Results regarding Canadian children were divided into three major topics: fruit and vegetable consumption, energy intake and servings from food-groups, and macronutrient balance (Garriguet, 2004).

Fruit and Vegetable Consumption

Canada’s Food Guide recommends a minimum of five servings of fruit and vegetables daily for children between the ages of 4-8 (Health Canada, 2011). Average daily fruit and vegetable consumption for children and adolescents who participated in the CCHS was 4.5 servings daily. Seven out of 10 children did not meet Health Canada’s recommendation of five servings of fruit and vegetables (Garriuet, 2004).

Energy Intake and Servings from Food-Groups

The CCHS divided their sample's energy intake into the four food groups according to Canada's Food Guide. Grain products represented the largest energy source across the age span; specifically supplying 31% of total calories for children between the ages of 4-18 (Garriguet, 2004). Non-food group items represented the second highest calorie source, providing 22% of calories for children and adults (Garriguet, 2004). Non-food group items encompass items with high amounts of fat, oils, or sugar; high-fat and/or high-salt snack foods, beverages, and condiments (Health Canada, 2006). This is a concerning result, as the Canada's Food Guide recommends that Canadian's limit non-food group items (Health Canada, 2007).

Health Canada's Food Guide recommends between 2-3 milk products daily for children between the ages of 4-9 years (Health Canada, 2006). On average, children and adolescents sampled from the CCHS were achieving the recommendations for milk products (Garriguet, 2004). Although, they also saw that more than one third of children aged 4-9 do not meet the minimum two servings of milk products.

The number of meat and alternative servings consumed by children was not a concern. Regardless of age, Canadians' meat and alternative (e.g. eggs, beans, lentils) consumption met the recommendations (Garriguet, 2004).

Macronutrient Balance

As discussed above, the Institute of Medicine published percentage ranges for energy intake for the three macronutrients: carbohydrates, fat, and protein (Institute of Medicine, 2005).

The recommended energy intake from fat is between 25-35% for children and adolescents. The results of the 1970-1972 Nutrition Canada Survey saw that Canadians' were consuming above this recommendation at 40%, which initiated interventions to promote low-fat diets (Garriguet, 2004). The results of the 2004 CCHS saw vastly different results, as Canadian's on average were consuming 31% kilocalories from fat. Of children between the ages of 4-8 years, 7% consumed greater than 35% of their energy from fat. Canadian children are receiving almost equal amounts of their fat intake from dairy and meat products (Garriguet, 2004).

The AMDR for protein is between 10-35% for children and adolescents (Institute of Medicine, 2005). The CCHS reported that children within this age group obtained an average 14.7% of their energy from protein, which falls within the AMDR recommendation. Among children and adolescents, boys consumed a greater amount of calories from protein than females (Garriguet, 2004).

The AMDR for carbohydrates is between 45-65% for children and adolescents (Institute of Medicine, 2005). The average consumption was 55.4% for this age group in the CCHS. As well, for all age groups, females consumed a larger percentage of energy from carbohydrates than did males (Garriguet, 2004).

2.5 Nutrition Environment in Schools

2.5.i Canadian School Nutrition Policy

Comprehensive School Health (CSH) is a Canadian-born term used to describe the health promotion strategies being implemented across the country's schools to better understand and improve the health of Canada's youth (Canadian Journal of Public Health, 2010). Part of the CSH strategies includes school nutrition policies, which are designed to decrease the risk of developing chronic disease and increase student learning using current dietary recommendations. Of the school nutrition policies that exist, several components show the greatest evidence for effectiveness: food and beverages available, food environments, health education, health services and counselling, and family and community outreach (Canadian Journal of Public Health, 2010). Nutrition policies that change food and beverages available is arguably the most effective policy to date based on current health promotion research (Canadian Journal of Public Health, 2010). Food and beverages available refers to nutrition standards, which determine the types of foods available for sale in schools, or determine the nutrition quality of meal programs. Agencies such as the World Health Organization and the IOM recommend that schools develop strategies that encompass all foods available in schools to optimize student nutrient intake. Internationally, food and beverages available policies vary in rigor and adherence criteria and standards may vary in portion size, energy content, availability, and grade level (Canadian Journal of Public Health, 2010). Overall, the amount of research based on food and beverages is limited (Canadian Journal of Public Health, 2010), yet many are conclusive that nutrition standards impose positive results for food availability and student consumption (Lytle et al., 2003: Jyoti et al.,2005). For example, Howerton et al., conducted a review on seven school-based nutrition programs and concluded that for all programs, there was a moderate increase in fruit and vegetable consumption; results that may have future implications for a decrease in risk of chronic diseases (Howerton et al., 2007).

As of the 2011/2012 school year, all foods sold in Ontario’s publically-funded elementary and secondary schools must abide by the Ontario government’s Food and Beverage policy (EatRight Ontario, 2014). Under this policy, food and beverages fall under three different categories: sell most, sell less, and not permitted for sale (EatRight Ontario, 2014). Although the Ontario Food and Beverage Policy is a promising start for school nutrition, parents may still pack foods that fall under the ‘not permitted for sale’ category. The Healthy Kids Panel of the Ministry of Health and Long Term Care recommends a universal nutrition program for all primary and secondary schools to improve student nutrition (discussed below) (Munter & Murumets, 2013).

2.5.ii Nutrition in Full-Day Kindergarten

Prior to 2010, many Ontario parents began packing student lunches when their child entered grade one, as kindergarten students returned home for lunch after a half-day of schooling. Now that many kindergarten students have or will begin participating in a full-day of schooling, this may be the first opportunity that parents have to decide how much food their child needs to support them through a full-day of learning.

According to a recent Staff Report written by the General Manager of Children’s Services in Toronto, Ontario (2013), there is cause for concern regarding the new full-day kindergarten schedule on student nutrition. In Ontario, licensed day-care providers are obligated to provide a healthy lunch and snacks throughout the day to those under their care (Toronto Staff Report, 2013). The standards for foods provided are governed by the Ontario Ministry of Education, and follow Canada`s Food Guide to Healthy Eating (EatRight Ontario, 2013). There is currently no comprehensive and systematic approach to ensuring full-day kindergarten students receive adequate nutrition as there was when children were in day-care.

In a letter submitted to the Minister of Health and Long Term Care on May 2, 2013, the Healthy Kids Panel made several recommendations regarding the nutrition of early learners, one of which suggests a universal school nutrition program (Toronto Staff Report, 2013; Munter & Murumets, 2013). This recommendation is based upon reports that although parents appreciate food knowledge, education, and skills, it is not enough to change their current eating habits (Munter & Murumets, 2013). As well, there are disappointing statistics regarding child health, namely that 1 in 10 Canadian children live below the poverty line and that Canada is one of the few developed countries that do not have a national nutrition program (Munter & Murumets, 2013). Currently, Ontario has a limited amount of school-based nutrition programs, such as breakfast programs and fruit and vegetable supplementation programs. The main cause for the limited number is the high cost of operating such programs (Munter & Murumets, 2013). Because of the promising implications for increased child health, the Healthy Kids Panel recommends that these school-based programs build the foundation for a Canadian universal school nutrition program (Munter & Murumets, 2013).

Although the Ministry of Health and Long Term Care has expressed policy interest for a nutrition program for students, there are no government policies that dictate which Ministry is responsible for ensuring proper nutrition in full-day kindergarten, and through what standards (Toronto Staff Report, 2013).

2.6 Statement of the Problem

Kindergarten in Ontario is currently in the midst of a major transformation in many respects. Despite the reconfiguration of the traditional full-day kindergarten schedule, there has been no systematic evaluation as to how these changes affect student nutrition or physical activity. The new ELK schedule changes with regard to time-to-eat and access-to-food and significantly differs from traditional full-day kindergarten. Due to the growing body of literature linking diet quality and quantity with academic performance, schedule changes that affect student nutrition in a school setting warrant investigation.

References in Chapter II

Australian Ministry of Health. Nutrient Reference Values. Available from: http://www.nrv.gov.au/chronic-disease/macronutrient-balance. Accessed on July 28, 2014.

Benton, D., Jarvis, M. (2007). The role of breakfast and a mid-morning snack on the ability of children to concentrate at school. Physiology & Behavior. 90(2-3): 382-385.

Bingham, S.A., Gill, C., Welch, A., Day, K., Khaw, K.T., Sneyd, M.J., Key, T.J., Roe, L., Day, N.E (1994). Comparison of dietary assessment methods in nutritional epidemiology: weighted records v. 24 h recalls, food-frequency questionnaires and estimated-diet records. Br J Nutr. 72(4): 619-43.

Birch, L.L., Deysher, M (1985) Conditioned and unconditioned caloric compensation: evidence for self-regulation of food intake by young children. Learn Motiv 16:341–355.

Birch, L.L., Deysher, M (1986) Caloric compensation and sensory specific satiety: evidence for self- regulation of food intake by young children. Appetite 7:323–331

Birch, L.L., Fisher, J.O. (1998). Development of eating behaviors among children and asolescents. Pediatrics. (3 Pt 2): 539-49.

Birch, L.L., McPhee, L., Shoba. B.C., Steinberg, L., Krehbiel R. (1987) "Clean up your plate": effects of child feeding practices on the conditioning of meal size. Learn Motiv. 18:301–317.

Black, J.L., Billette, J.M. (2013). Do Canadians meet canada's food guide recommendations for fruit and vegetables? Appl Physiol Nutr Metab. 38(3): 234-42.

Butler-Jones, D. (2008). The chief public health officer;s report on the state of public health in Canada. Public Health Agency of Canada. http://www.phac-aspc.gc.ca/cphorsphc-respcacsp/2008/fr-rc/cphorsphc-respcacsp01-eng.php. Accessed on July 12, 2014.

Canadian Journal of Public Health. (2010). Supportive environments for learning: healthy eating and physical activity within comprehensive school health. 101(2).

Cantalini-Williams, M. Telfer, L. (2010). Successful implementation of the full-day early learning kindergarten program. Available from: http://www.cpco.on.ca/MembershipServices/documents/News/PrincipalConnections/PastIssues/Vol14/Issue1/FullDay.pdf. Accessed on October 5, 2013.

Cooper, H., Batts Allen, A., Pattall, E. A., Dent, A. L. (2010). Effects of full day kindergarten on academic achievement and social development. Review of educational research, 80(1), 34-70.

Dorman, S. C., Gauthier, A. P., Laurence, M., Thirkill, L., & Kabaroff, J. L. (2013). Photographic Examination of Student Lunches in Schools Using the Balanced School Day Versus Traditional School Day Schedules. ICAN: Infant, Child, & Adolescent Nutrition, 5(2), 78–84. http://doi.org/10.1177/1941406413476547

Dorman, S., Gauthier, A.P., & Thirkill, L. (2013). The impact of the balanced school day on student physical activity and nutrition. Phys Health Educ J, 78(4), 6–10.

EatRight Ontario. (2014) Learn more about what foods can be sold in schools with the school food and beverage policy. Available from: http://www.eatrightontario.ca/en/Articles/School-Health/Ontario-s-School-Food-and-Beverage-Policy/Learn-more-about-what-foods-can-be-sold-in-schools.aspx#.U9qp5PldWSo. Accessed on July 31, 2014.

Ebbeling, C.B., Pawlak, D.B., Ludwig, D.S. (2002). Childhood obesity: public health crisis, common sense cure. The Lancet. 360(9331): 473-482.

Edwards, J. U., Mauch, L., & Winkelman, M. R. (2011). Relationship of nutrition and physical activity behaviors and fitness measures to academic performance for sixth graders in a midwest city school district. Journal of School Health, 81(2), 65–73.

Florence, M. D., Asbridge, M., & Veugelers, P. J. (2008). Diet quality and academic performance. Journal of School Health, 78(4), 209–215.

Fomon SJ. Nutrition of Normal Infants. St Louis, MO: Mosby-Yearbook; 1993

Fox MK, Devaney B, Reidy K, Razafindrakoto C, Ziegler P. Relationship between portion size and energy intake among infants and toddlers: Evidence of self-regulation. J Am Diet Assoc. 2006;106:S77–S83

Gådin, K.G., Hammarstrom, A. (2002). Can school-related factors predict future health behaviour among young adolescents? Public Health. 116(1): 22-29

Garriguet, D. (2004). Overview of Canadians' eating habits. Finding from the Canadian Community Health Survey. Statistics Canada.

Gauthier, A. P., Jaunzarins, B. T., MacDougall, S.-J., Laurence, M., Kabaroff, J. L., Godwin, A. A., & Dorman, S. C. (2013). Evaluating the reliability of assessing home-packed food items using digital photographs and dietary log sheets. Journal of Nutrition Education and Behavior, 45(6), 708–712. http://doi.org/10.1016/j.jneb.2013.05.005

Goulet, J., Nadeau, G., Lapointe, A., Lamarche, B., Lemieux, S. (2004). Validity and reproducibility of an intervier-administered food frequency questionnaire for healthy french-canadian men and women. Nutrition Journal. 3:13

Gunter, W., Daly, K (2013). Health Behaviors and Standardized Test Scores: The Impact of School Health Climate on Performance, International Journal of School & Educational Psychology, 2013, 1, 3, 166.

Halton District School Board. (2003). The Balanced Day Surveys Report. Available from: http://www.hdsb.ca/schools/Balanced%20School%20Day%20Timetable/ExecSummBalancedDay.pdf. Accessed July 12, 2015.

Health Canada, (2012). Do Canadian adults meet their nutrient requirements through food intake alone? http://www.hc-sc.gc.ca/fn-an/alt_formats/pdf/surveill/nutrition/commun/art-nutr-adult-eng.pdf. Accessed August 1, 2014

Health Canada. (2011) Eating well with Canada's food guide - A resource for educators and communicators. Available from:http://www.hc-sc.gc.ca/fn-an/pubs/res-educat/res-educat-eng.php#a14. Accessed August 20, 2014.

Health Canada. (2011).Eating well with Canada's food guide. Available from: http://www.hc-sc.gc.ca/ fn-an/food-guide-aliment/index-eng.php/. Accessed October 5, 2013.

Horacio, JA, Madias, NE. (2007). Sodium and potassium in the pathogenesis of hypertension. New Engl J Med. 356(19): 1966-1978.

Howerton, M.W., Bell, B.S., Dodd, K.W., Berrigan, D., Stolzenberg-Solomon, R., Nebeling, L. School-based nutrition programs produced a moderate increase in fruit and vegetable consumption: meta and pooling analyses from 7 studies. Journal of Nutrition Education and Behavior. 39(4):186-196

Hoyland, A. Dye, L., Lawton, C.L. (2009). A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. Nutrition Research Reviews. 22: 220-243

Inchley J, Muldoon J, Currie C. Becoming a health promoting school: Evaluating the process of effective implementation in Scotland. Health Promot Int 2007;22(1):65-71.

Institute of Medicine. 2006. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington DC: National Academy Press.

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

Katamay, S.W., Esslinger, K.A., Vigneau;t, M., Johnston, J.L., Junkins, B.A., Robbins, L.G., Sirois, I.V., Jones-McLean, E.M., Kennedy, A.F., Bush, M.A., Brule, D., Martineau, C. (2007). Eating well with canada's food guide (2007): development of the food intake pattern. Nutrition Reviews. 65(4): 155-166.

Kern, D.L., McPhee, L., Fisher, J., Johnson, S., Birch, L.L. (1993) The postingestive consequences of fat condition preferences for flavors associated with high dietary fat. Physiol Behav 54:71–76.

Kern, M. L., & Friedman, H. S. (2008). Early educational milestones as predictors of lifelong academic achievement, midlife adjustment, and longevity. Journal of Applied Developmental Psychology, 30(4), 419–430. http://doi.org/10.1016/j.appdev.2008.12.025

Kleinman RE, Hall S, Green H, et al. Diet, breakfast, and academic performance in children. Ann Nutr Metab. 2002;46(suppl 1):24-30.

Kleinman, R. E., Murphy, J. M., Little, M., Pagano, M., Wehler, C. A., Regal, K., & Jellinek, M. S. (1998). Hunger in children in the United States: potential behavioral and emotional correlates. Pediatrics, 101(1), E3.

Kranz, S., Smiciklas-Wright, H., Siega-Riz, A.M., Mitchell, D. (2005). Adverse effect of high added sugar consumption on dietary intake in American preschoolers. The Journal of Pediatrics. 146(1):105-111

Lytle LA, Ward J, Nader PR, Pedersen S, Williston BJ. Maintenance of a health promoting programme in elementary schools: Results from the CATCH-ON study key information interviews. Health Educ Behav 2003;30(4):503-18.

Mahoney CR, Taylor HA, Kanarek RB, Samuel P. Effect of breakfast composition on cognitive processes in elementary school children. Physiol Behav 2005;85:635–45.

Marmot, M., Wilkinson, R. (2005). Social determinants of health. Oxford University Press.

Martin, C.K., Newton Jr, R.L., Anton, S.D., Allen, R., Alfonso, A., Han, A., Stewart, T., Sothern, Williamson, D.A (2007). Measurement of children's food intake with digital photography and the effects of a second serving upon food intake. Eat Behaviors. 8(2): 148-156.

McClelland, M.M., Acock, A.C., Morrison, F.J. (2006). The impact of kindergarten learning-related skills on academic trajectories at the end of elementary school. Early Childhood Research Quarterly. 21:471-490.

Micha R, Rogers PJ, Nelson M. Glycaemic potency of breakfast predicts cognitive function and mood in adolescent schoolchildren. Proc Nutr Soc 2008;67:E364.

Munter, A., Murumets, K.D. (2013). No Time to Wait: The Healthy Kids Strategy. Healthy Kids Panel. Available from: http://www.health.gov.on.ca/en/common/ministry/publications/reports/healthy_kids/healthy_kids.pdf. Accessed on July 12, 2015.

Murphy JM, Pagano ME, Nachmani J, Sperling P, Kane S, Kleinman RE. The relationship of school breakfast to psychosocial and academic functioning: cross-sectional and longitudinal observations in an inner-city school sample. Arch Pediatr Adolesc Med. (United States) 1998;152:899-907.

Nader, P. R., O'Brien, M., Houts, R., Bradley, R., Belsky, J., Crosnoe, R., … National Institute of Child Health and Human Development Early Child Care Research Network. (2006). Identifying risk for obesity in early childhood. Pediatrics, 118(3), e594–601. http://doi.org/10.1542/peds.2005-2801

Neumark-Sztainer, D., Hannan, P.J., Story, M., Croll, J., Perry, C. (2003). Family meal patterns: associations with sociodemographic characteristics and improved dietary intake among adolescents. Journal of the American Dietetic Association. 103(3): 317-322.

Pollitt E, Mathews R. Breakfast and cognition: an integrative summary. Am J Clin Nutr 1998;67:804S–13S.

Ontario Ministry of Education, (2010). *The Full-Day Early Learning – Kindergarten Program*, 1-162. Available from: http://www.edu.gov.on.ca/eng/curriculum/elementary/kindergarten.html. Acessed on October 5, 2013.

Ontario Ministry of Education, (2012). Full-Day Kindergarten for four and five year olds: time to learn, grow, and play. Available from: http://www.edu.gov.on.ca/kindergarten/EarlyLearnFS.pdf. Accessed on October 5, 2013.

Ontario Ministry of Health and Children's Services. The best start plan. Available from: http://www.children.gov.on.ca/htdocs/English/news/backgrounders/01292007.aspx. Accessed on October 5, 2013.

Pascal, C.E, (2009). With our best future in mind: implementing early learning in ontario. Available from: http://www.ontario.ca/education-and-training/early-learning-report Accessed on October 5, 2013.

Public Health Agency of Canada. (2013). Chief Public Health Officer's Reports on the State of Public Health in Canada. Available from: http://www.phac-aspc.gc.ca/cphorsphc-respcacsp/index-eng.php. Accessed on December 1, 2013.

Rampersaud, G., Pereira, M.A., Girard, B.L., Adams, J., Metzl, J.S. (2005). Breakfast habits, nutrition status, body weight, and academic performance in children and adolescents. Journal of the American Dietetic Association. 105(5): 743-760.

Sabinski, A. S., Toft, U., Klaus, A. K., Inge, T. (2013). Validation of a digital photographic method for assessment of dietary quality of school lunch sandwiches brought from home. Food and Nutrition Research. 57. Available from: http://www.foodandnutritionresearch.net /index.php/fnr/rt/printerFriendly/20243/28867. Accessed on June 05, 2015.

Sigfusdottir, I. D., Kristjansson, A. L., & Allegrante, J. P. (2007). Health behaviour and academic achievement in Icelandic school children. Health Education Research. 22, 70–80.

Swanson, M. Digital photography as a tool to measure school cafeteria consumption. Journal of School Health. 78(8): 432-437.

Taras, H. (2005) Nutrition and student performance at school. Journal of School Health. 75(6):199-213.

Thompson FE, Subar AF. Dietary assessment methodology. Nutrition in the Prevention and Treatment of Disease. San Diego, Calif: Academic Press; 2001:3-30.

Toronto Staff Report, (2013). Nutrition in full-day kindergarten. Available from: http://www.toronto.ca/legdocs/mmis/2013/cd/bgrd/backgroundfile-58283.pdf. Accessed on October 5, 2013.

Warren, J.M., Henry, C.J.K., Lightowler, H.J., Bradshaw, S.M., Perwaiz, S. (2003). Evaluation of a pilot school programme aimed at the prevention of obesity in children. Health Promotion International. 18(4): 287-296.

Webber L, Cooke L, Hill C, Wardle J. Associations between children's appetitive traits and maternal feeding practices. J Am Diet Assoc. 2010;110(11):1718-1722.

Williamson, D.A., Allen, H.R., Davis Martin, P., Alfonso, A.J., Gerald, B., Hunt, A (2003). Comparison of digital photography to weighted and visual estimation of portion sizes. Journal of the American Dietetic Association. 103(9); 1139-1145.

Woehrle, T., Fox, S., & Hoskin, B. (2005). An Examination of the Balanced School Day Schedule. Ontario Action Researcher.

Yang, J.Y., Mi, K.K., Se, H.H., Younjhin, A., Jae, E.S., Dong, H.K (2010). Relative validities of 3-day food records and the food frequency questionnaire. Nutr Res Pract. 4(2): 142-148.

CHAPTER III

PHOTOGRAPHIC EXAMINATION OF KINDERGARTEN STUDENT LUNCHES AND THE IMPACT OF THE EARLY LEARNING KINDERGATEN (ELK) SCHEDULE ON FOOD CONSUMPTION

Chapter III is presented as a manuscript for publication. The manuscript is under review with the Journal of Nutrition Education and Behavior

Horodziejczyk, C. A., Duguay. D. D., Urajnik, D., Gauthier, A. P., Thirkill, L. J., Larivière, C., & Dorman, S.C. (2014). Photographic examination of kindergarten student lunches and the impact of the early learning kindergarten (ELK) schedule on food consumption. Submitted to *Appetite*.

Title: Photographic Examination of Kindergarten Student Lunches and the Impact of the Early Learning Kindergarten (ELK) Schedule on Food Consumption.

Authors: CA Dinnes*, LJ Thirkill, DU Urajnik, C Larivière, AP Gauthier, DD Duguay, M Laurence, and SC Dorman.

School of Human Kinetics, Laurentian University, 935 Ramsey Lake Road, Sudbury, ON, P3E 2C6

Journal Submission: Appetite

***Corresponding Author**: Charley-Anne Dinnes (charleydinnes@gmail.com)

ABSTRACT

Students spend approximately one third of their waking hours at school. Therefore, the school environment and schedule has the capacity to influence children's health habits and eating patterns. Different eating and instructional timetables could affect the children's dietary intakes. The purpose of this study was to assess the quality/quantity of student lunches amongst children using either the Early Learning Kindergarten (ELK) or full-day junior/senior schedule.

Data were collected over 5 days from eight classrooms at two schools. Food was photographed three times per-day: upon arrival to school; and after each nutrition break. A total of 135 kindergarten students participated in this study, representing an overall response rate of 71%. Nutrient intakes (kilocalories, macronutrients and select micronutrients) were determined and compared to standard dietary indices. The number of fruit/vegetables servings and non-food items packed and consumed were also enumerated. Mean scores for continuous variables were compared using independent-sample *t* tests. Overall, ELK lunches had more kilocalories, macronutrients, total food items, fruits/vegetables, and micronutrients. ELK students consumed a greater percentage of their packed lunches throughout the school day. All lunches, irrespective of schedule, were low in fibre, vitamin D, folate and potassium and high in sugar and sodium.

The results of this study demonstrate that schools should implement policies that: a) provide younger students more time to eat; and b) allow children to access a healthy snack before first nutrition break for a greater consumption of essential nutrients. Parents should pack fewer non-food items.

Keywords: School, child, nutrition, schedule, health

INTRODUCTION

The kindergarten experience of Canadian children is undergoing substantial changes. In Ontario full-day kindergarten is now a mandatory service provided by publically-funded elementary schools (Cantalini-Williams & Telfer, 2010). In 2011, kindergarten programs in Ontario were to begin implementing the Early Learning Kindergarten (ELK) program, with all schools adopting it by September 2014. Accordingly, children as young as three will now spend approximately one third of their waking hours in school and will be subject to the eating schedules of the school. This may present challenges for parents who will have to prepare packed lunches for their young children to eat at school.

The ELK program is a child-centered, developmentally appropriate, integrated, full-day program of learning for four and five-year-olds (Ontario Ministry of Education, 2010[a]). The purpose of the ELK is to establish a strong foundation for learning in a safe and play-based environment that promotes physical, social, emotional and cognitive development for all children and to improve student preparedness for grade one (Ontario Ministry of Education, 2010[b]). This program is thought to offer substantial opportunities to benefit the long-term health of Canadians. Nevertheless, careful scrutiny of the ELK program is still warranted. It is well established that key physical, cognitive, language and social-emotional development occurs during the early years of child development (National Research Council and Institute of Medicine, 2000). For example, an unappealing statistic published by Nader et al., 2008 saw 60% of children who were overweight at any time during the preschool period, and 80% of children who were overweight at any time during the elementary period were also overweight at the age of 12 (Nader et al., 2006). This suggests that health interventions implemented in daycares and kindergarten programs prior to grade 1 play a pivotal role in mitigating health concerns later in development.

Kindergarten lays the foundation for future school experiences: early success predicts long-term educational success and adjustment outcomes (Kern & Friedman, 2008). Likewise, schools provide opportunity for interceptive strategies to promote healthy food and physical activity behaviours, which are then more likely to become embedded behaviours later in life. Evidence also suggests that children who are well-fed are significantly more attentive in the classroom (Taras, 2005) and tend to have less behavioural difficulties (Murphy et al., 1998; Kleinman et al., 1998) Younger children may be the most vulnerable to nutritional changes in their food schedules (Neumark-Sztrainer et al., 2003). Despite this, the impact of school schedule on kindergarten student nutrition has never been examined.

The ELK schedule closely mirrors that of the Balanced School Day schedule (BSD), the latter being employed, for all ages, in the majority of schools in Ontario. The BSD has two 40-minute breaks, each with twenty minutes to eat and twenty minutes for recess separated by three 100-minute teaching blocks. In comparison, the ELK schedule provides students the full 40-minutes to consume food, during which time, the children can engage in quiet indoor play, when they finish eating. Some schools allow kindergarten students to access their lunches outside of designated nutrition breaks if they are hungry; it is unclear why this adaptation was made, although it may be in response to parental concerns about children complaining of ‘not having enough time to eat’ their packed lunches. Several anecdotal reports on this matter are available on school websites that explore implications of the shorter nutrition breaks associated with the BSD schedule in younger children (reviewed in Dorman, Gauthier, & Thirkill, 2013).

With the exception of beverages, the BSD schedule has not been shown to impact 'what' parents packed for children's lunches in grades 3-to-6 (Dorman et al., 2013). However, parents report 'hunger' to be a common occurrence with younger children using the BSD schedule (Woehrle, Fox, & Hoskin, 2001). It is hypothesized that this is because children do not seem capable of focusing their time during the 20-minute nutrition block to 'eat' their food. This is supported by, Woehrle et al. (2001) who found that primary and junior students had less perceived "time to eat" after schools changed implemented BSD scheduling. This may be exacerbated in kindergarten students.

Classroom scheduling impacts time allocated for eating which may affect children's nutritional status and overall health. To our knowledge, no systematic evaluation of the effects of ELK scheduling on student nutrition has been completed. Therefore the purpose of this study was: i) to qualify and quantify the food that parents packed and that children consumed during each break; ii) to examine the food choices that children made during the first and second break; and iii) to compare food choices and intake of children using the ELK versus the JK/SK (now defunct) kindergarten programs.

METHODS

STUDY DESIGN

Data were collected in May 2013 at two elementary schools. Participating schools were selected for use of different kindergarten programs and matched for: geographic proximity (2.5 km apart); population size; and socioeconomic status. See Table I.

Table I DEMOGRAPHICS BY SCHEDULE N=189

	School A	**School B**
Schedule	Early Learning Kindergarten	Full-Day JK/SK
Total Kindergarten population	108	81
Percentage of students who live in lower-income households	7%*	17%*
Percentage of students whose parents have some university education	54%**	53%**

(Ministry of Education, 2013)

* Provincial average: 16.5%

** Provincial average: 36.9%

Note: ELK class sizes are larger (maximum of 30 students); compared to JK/SK class sizes (maximum 20 students).

All students in kindergarten at these schools were asked to participate in the study (N=189). Parental consent was obtained prior to data collection. No child was excluded for any reason, except lack of parental consent or verbal expression from the child that they did not wish to participate. Ethics approval was granted from the University's Research and Ethics Board as well as the participating school board and the local District Health Unit.

Data were collected over the same, five, consecutive days (Monday-Friday) at both school; predicted to be ‘regular’ days by the administration. Gerosovitz et al. (1978) recommend a minimum of three days of food data to adequately reflect normal food consumption patterns.

Each participant was assigned an identification number and an in-class researcher recorded attendance. Each classroom had an in-class researcher and each school had a photography team. All lunches were photographed digitally, three times each day: 1) when participants arrived at school, 2) after the first nutrition break (mid-morning), and 3) after the second nutrition break (mid-afternoon). These photos showed what parents packed, what children chose to consume at first and second break and the food left uneaten after the second break. Children were instructed not to discard any food. An in-class researcher monitored each class throughout.

PHOTOGRAPHY PROCESS

Student's lunch bags were numbered with a sticker on Day 1, which corresponded to their assigned participant numbers. Participants with food allergies were also identified and clearly labelled. Each day the in-class researcher organized lunches for photography team collection thrice daily. A photo station arranged, student lunches were unpacked and aligned on tables, with placards displaying: participant number and study day. Food was arranged to allow for full content capture. Food in clear containers were placed upside down for optimum visual examination and food in opaque containers had the lids removed and placed with the inside facing up to reduce contamination. The photography team wore non-latex, sterile gloves, food was arranged on parchment paper and gloves and paper were changed in between each class photo. Lunches from children with food allergies were handled separately and fresh parchment and gloves were used. Every lunch at was photographed twice: showing the nutrition labels in the first photo, and name brands in the second photo (Figure 1).

To supplement the photographic data, parents provided a daily log sheet, listing all of the food items packed.

Both schools participated in pizza and milk programs and one school participated in a pasta program. School records were accessed to identify students participating in these programs.

The in-class researcher also noted throughout any students in the ELK program who accessed their lunches outside of nutrition break, as well as recording the time of access.

NUTRIENT COMPOSITION ANALYSIS

For each participant and each day, food and beverage data packed and consumed during break one and two were analysed by viewing the photos for details on portion size, content and any identifiable product and nutritional information labels. Details were corroborated with parent logs and the information was entered into a nutritional analysis software program (NutriBase 11.0). Data was summarized into: total food packed, food remaining after morning break, and food remaining after afternoon break. Daily consumption averages were calculated for each participant.

Two evaluators entered the nutrition data using Nutribase 11.0, as described by Dorman et al. (2013) and validated by Gauthier et al. (2013).

FOOD CHOICE ANALYSIS

Photos were also examined and food was categorized into: total packed food items, non-food group items, and fruit/vegetable food items. See Figure 1. Food items were identified using Health Canada's Food Guide to Healthy (Health Canada, 2011). Non-food items were so identified, if they were not included in the Health Canada's Food Guide. After each break, fruit/vegetable and non-food items consumed were also counted and compared between schedules.

STATISTICAL ANALYSES

Data were expressed as means ± standard error of the mean (SE). Descriptive statistics were generated for all measures, including the sample as a whole and by schedule type (ELK vs JK/SK using BSD). Mean scores were calculated for continuous variables and compared using independent-sample *t* tests (e.g. kilocalories) between groups (e.g. schedule). For all analyses, statistical significance is reported at levels less than alpha 0.05 using SPSS 16.0.

Figure 1. Illustrating the three photos captured for one student lunch on one day.

RESULTS

Eight classrooms (four from each school) with a total of 135 kindergarten students participated in this study, representing an overall response rate of 71%. Note: ELK class sizes are larger (maximum of 30 students); compared to JK/SK class sizes (maximum 20 students).

After removing students for absenteeism (absent three days or more), the sample size was 121 students. Seventy-eight (64%) students were from the school using the ELK schedule and forty-three (36%) students were from the school using the full-day JK/SK with BSD schedule

Fifty-six (46%) students were boys and 65 (54%) students were girls.

KILOCALORIE AND MICRONUTRIENT CONSUMPTION

Total kilocalories and macronutrients packed were significantly higher for children using the ELK schedule. See Table II. See Figure I for changes in kilocalories between schedules throughout the school day.

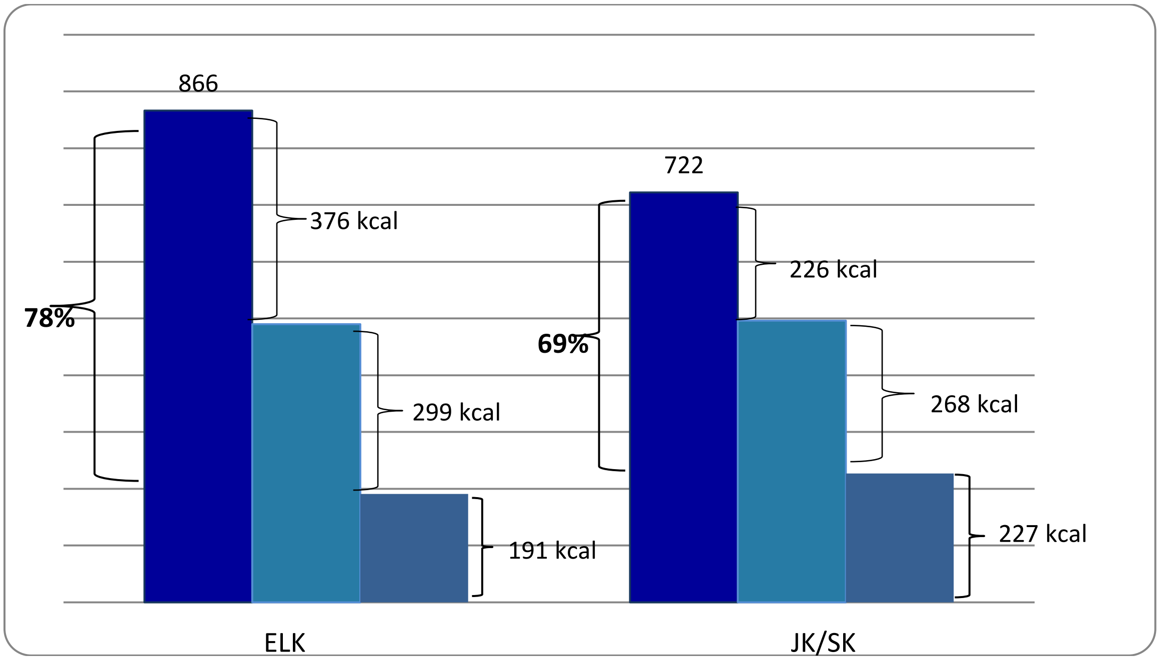
Table II KCAL/MACRONUTRIENT CONSUMPTION N=121

Nutrients	**Packed**		**Remaining after break one**		**Remaining after break one**		**Estimated daily consumption**	
	ELK	JK/SK	ELK	JK/SK	ELK	JK/SK	ELK	JK/SK
Kilocalories	858±25.4**	722±27.7**	489±25.6	495±25.4	191±17.6	227±24.8	667kcal	495kcal *
Carbohydrates(g)	138g±4.1**	116g ±4.9**	78±4.3	79±4.5	31g±3.0	37g±4.1	107g	79g
Sugar(g)	76g±2.8*	65g±3.5*	40 ±2.6	41±2.9	14g±1.6	18g±2.1	62g	47g
Fibre(g)	8.7g±0.36*	6.5g±0.41*	4.9±0.30	4.6±0.36	2.2g±0.23	2.4g±0.27	6.5g	4.1g
Fat(g)	24g±1.1*	21g±1.0*	14±0.9	15±0.9	6g ± 0.6	7g ± 0.8	18g	14g
Protein(g)	29g±1.1**	23g±1.0**	17±1.0	17±0.8	6g±1.0	6g±0.7	23g	17g

* = p<0.05

** = p<0.001

Figure 2. ELK student lunches had significantly more kilocalories and were also eating more of their lunch.



AMDR Carbohydrates

For both ELK and JK/SK schedules, calories packed and consumed from carbohydrates fell within the upper margin of the AMDR, which recommend that energy from carbohydrates contribute 45-65% of total energy, (Institute of Medicine, 2006) (ELK packed: 64%, JK/SK packed: 64%; ELK: consumed, 64%, JK/SK consumed: 64%). Children in this study consumed an average of 62g of sugar and 5g of fibre at school, per day.

AMDR Fats

For both ELK and JK/SK schedules, the percentage of calories packed and consumed from fat fell within the lower range of the AMDR, which recommends energy from fats provide between 25-35% of total energy, (Institute of Medicine, 2006) (ELK packed: 25%, JK/SK packed: 26%; ELK consumed: 24%, JK/SK consumed: 25%).

AMDR Protein

For both schedules, the percentage of energy packed and consumed from protein were within the lower range of the AMDR which recommend energy from protein provide between 10-30% of total energy, (Institute of Medicine, 2006) (ELK packed: 14%, JK/SK packed: 13%; ELK consumed: 14%, JK/SK consumed: 14%).

VITAMIN AND MINERAL CONSUMPTION

Of the vitamins and minerals measured, a significantly greater amount was present in the packed lunches of students using the ELK schedule. See Table III.

Table III VITAMIN AND MINERAL CONSUMPTION N=121

Vitamin/ Mineral (EAR or AI)	**Packed**		**Remaining by end-of-day**		**Estimated Daily Consumption/ %DRI**	
	ELK	JK/SK	ELK	JK/SK	ELK	JK/SK
Vit.A µg (275µg)	161±168.5*	79±110.7*	70±14.0	41±12.1	91/ 33%	38/ 14%
Vit. C mg (22mg)	59±33.6*	40±32.5*	15±2.2	14±2.6	44/ 200%	26/ 118%
Vit.D µg (400 IU)	63±5.3*	13±3.7*	5±0.7	3±0.7	58/ 15%	10/ 3%
Calcium mg (800mg)	452±215.3**	215±99.4**	60±6.5	60±9.5	391/ 49%	155/ 13%
Folate µg (160µg)	71±30.5**	44±28.4**	23±2.3	18±2.9	48/30%	26/16%
Iron mg (4.1mg)	3.5±1.2**	2.4±1.1**	0.9±0.1	0.9±0.1	2.6/63%	1.5/37%
Potassium mg (3800mg)	622±240.9**	375±204.7**	161±17.9	146±21.7	461/12%	228/6%
Sodium mg (1200mg)	1178±398.2*	991±276.03*	277±27.4	310±37.4	901/75%	681/57%

* = p<0.05

** = p<0.001

*EAR = Estimated Average Recommendation

*AI – Adequate intake

Note: EAR is recommended for assessing the nutrient intake of groups by the Institute of Medicine. The EAR is estimated to meet the needs of half of assumedly healthy individuals.

FOOD ITEM CONSUMPTION

Children in the ELK schedule had a significantly greater amount of food items packed. Since there was no difference in the number of food items remaining at the end-of-day, it is estimated that students in the ELK schedule were consuming a more food items packed. See table IV.

Table IV FOOD ITEMS PACKED AND CONSUMED N=121

	Packed Food Item		**Remaining after first break**		**Remaining after second break**		**Estimated food items consumed**	
	ELK	JK/SK		JK/SK	ELK	JK/SK	ELK	JK/SK
Total Food Items	8.2±0.23**	6.6±0.30**	3.8±0.21	3.5±0.21	1.8±0.21	2.0±0.23	6.4	4.6
Fruit/Vegetable Items	3.3±0.12*	2.1±0.12*	1.6±0.11	1.1±0.12	0.9±0.10	0.7±0.12	2.4	1.4
Non-Food Items	1.7±0.14	1.7±0.23	1.1±0.13	1.0±0.21	0.5±0.08	0.6±0.12	1.2	1.1

* = p<0.05

** = p<0.001

FOOD ACCESS OUTSIDE OF NUTRITION BREAKS

Of the four ELK classes, three implemented a policy that allowed students to access their lunch outside of nutrition breaks if they were hungry. In these classes, approximately 26% or 33% of students utilized this policy, and accessed at least one food item from their lunch, all within the morning time block prior to the first nutrition break.

DISCUSSION

QUALITY AND QUANTITY

The quality of student lunches can be discussed using three guidelines: 1) Acceptable Macronutrient Distribution Ranges (AMDR); 2) Dietary Reference Intake values (DRI); and 3) Health Canada's Guide to Healthy Eating.

AMDR Carbohydrates. For both ELK and JK/SK schedules, calories packed and consumed from carbohydrates fell within the upper margin recommended, suggesting that carbohydrates contributed 45-65% of total calories (ELK packed: 62%, JK/SK packed: 63%; ELK: consumed, 63%, JK/SK consumed: 64%). However, sub-analyses of carbohydrates identify two areas of concern: the proportion of sugar and fibre contained within these foods. Canada's food guide recommends a maximum daily consumption of 100g of sugar and minimum of 25g of fibre. Children in this study consumed an average of 62g of sugar and 5g of fibre at school, per day. These findings are unsettling given the known health detriments of elevated sugar consumption including: obesity, cardiovascular disease; and type II diabetes (Johnson et al., 2007) and benefits of adequate fibre, including: regular bowel movements; healthy gastrointestinal microbiomes; blunting sugar absorption; reducing low-density lipoproteins and increasing high-density lipoproteins (Anderson et al., 2009). In addition, Anderson et al. (2009) suggests that insufficient fibre consumption is linked to obesity.

AMDR Fats. The percentage of calories consumed from fat fell within the lower range of recommended (25-35% of total calories) for both ELK and JK/SK schedules (ELK packed: 25%, JK/SK packed: 25%; ELK consumed: 24%, JK/SK consumed: 25%). However, it is likely that children are meeting recommendations for fat when meals consumed at home are included. We hypothesize that repeated messages to the public about reducing fat consumption, compounded by industry responses, which highlight foods with reduced fats for children, have prompted parents to make low-fat or fat-free food choices for their children.

AMDR Protein. For both schedules the number of kilocalories packed and consumed were within the lower end of the recommended (10-30% of total calories) (Institute of Medicine, 2006) (ELK packed: 13%, JK/SK packed: 12%; ELK consumed: 14%, JK/SK consumed: 14%). Protein's RDA for children are 0.95g/kg of body weight per day or approximately 19g/day (Institute of Medicine, 2005). On average, children in the present study consumed 20.7g at school. Therefore daily protein intake for the majority of children is adequate, this reflects Canadian statistics for adults, which show protein consumption within the AMDR (Health Canada, 2012).

DRI. Given that kindergarten students spend approximately one-third of their day in school, they should consume one third of their daily vitamins and minerals during this time. The following micronutrients: potassium, sodium, folate, calcium, and vitamin D were highlighted. Of particular concern was the low amount of potassium representing 16% and 12% of the daily DRI value for lunches from students using the ELK and JK/SK schedule respectively. In contrast, alarmingly high amounts of sodium were present: the average sodium content of packed foods represented 98% of the DRI in the ELK schedule and 83% in the JK/SK schedule. These values are not surprising and reflect general under- and over consumption of potassium and sodium respectively in Canadian society (Health Canada, 2012). These values are consistent with the distribution and consumption of fruit/vegetable and non-food items that tended to be lower for the first and higher for the latter. For instance, the majority of potassium is found in fruit and vegetables, whereas the majority of sodium comes from processed food items. Furthermore, as lunches are not refrigerated, there is likely a perceived need to pack non-perishable food items; this contributes to elevated sodium levels. It is important to note that low potassium and high sodium dietary levels increase the risk for developing hypertension (Adrogu**é** & Madias, 2007), which in turn, is a risk factor for cardiovascular disease and type II diabetes (Cheung & Li, 2012).

In the present study, folate, calcium and vitamin D were lower than recommended levels. Children in our study were consuming approximately 1/10 of recommended folate. Given that folate and other B vitamins are required nutrients for cell division, proliferation and metabolism which are critical processes for growing children the low levels of folate are concerning (Bailey & Gregory, 1999). Similarly low calcium and vitamin D consumption, needed for adequate bone growth and strength, requires attention. (Vitamin D: ELK 15%, JK/SK 3%; Calcium: ELK 49%, JK/SK 19%). This may reflect the perception by parents that milk is unhealthy (Johansen et al., 2011). Given that dairy and vegetables are the best sources of calcium for children, regular consumption of these foods should be strongly encouraged.

Food Choices and the Canada Food Guide. The number of fruit and vegetable servings in the packed lunches in the present study were encouraging. On average lunches comprised 2.8 fruit/vegetable servings or half of the minimum daily recommended (5), as per the Canada Food Guide (Health Canada, 2011). However, irrespective of schedule, students left one serving of fruit/vegetable uneaten after second break. Importantly, when parents packed more fruit and vegetables (ELK schedule), children consumed more. Therefore, parents should continue to pack more servings of fruit/vegetables and educators must continue to encourage the consumption of these foods as a priority. Scheduling may also affect consumption of fruit/vegetable, by providing students with more time to eat these food items, as was given in the ELK schedule.

Lunches showed an average of 1.7 non-food items packed. Such items are listed as "others" within the Canada Food Guide and examples include: cookies, candy, chips, and pudding. After second break, students consumed an average of 1.2 non-food items. We found no significant differences in the non-food items packed between schedules, and there was also no significant difference in the amounts consumed. This suggests that children have a preference for non-food items over other food items. Accordingly, we recommend that parents avoid packing non-food group items, or pre-packaged, energy-dense food items and rather to increase the availability of other food-group items, particularly packed vegetable and fruit servings. This recommendation would dramatically all aspects of the children's diets, highlighted in the present study.

Scheduling effects. The primary finding we report in relation to scheduling effects is that children need more time to eat their lunches. Children enrolled in the Full-day JK/SK which follows the Balanced School Day Schedule, consumed 172 fewer kcal than children in the ELK schedule. On average they consumed 495kcal during the school day. If we estimate that the average child aged 4-5 engaging in moderate physical activity requires 1600kcal/day, then these children are consuming less than 1/3 of their daily energy requirements. This is critical, because it suggests that these children are likely hungry throughout the school day, and hunger has many impacts, including academic performance and behaviour (Murphy et al., 1998). Although parents from the JK/SK school packed fewer total kilocalories, we believe that this was in response to the food consumption of their children. That is, there was no difference in the amount of food that children left uneaten at the end-of-day, between schools. We hypothesize that over the school year (this data was collected in May), parents adapted the amount of food that they packed based upon what their children were eating, i.e. based on foods uneaten by the end of the school-day. Given that children of this age are less capable of predicting outcomes from choices

(Atance & Meltzoff, 2005), it seems reasonable that they are also less capable of ensuring that they eat adequate amounts of food to meet their needs and to sustain themselves over a separate time-period where they will be unable to access their lunches.

Limitations. Despite the many strengths of this study, a few limitations do merit discussion. First, while the reliability of the data entry method described in this study has been deemed acceptable, Gauthier et al. (2013) did report that inter-rater results for certain micronutrients were not as strong as others (i.e., Vitamin A and folate fell below the acceptable range) and the method was not evaluated for the actual accuracy of item selection in the nutrient software program. Thus, the complexities associated with identifying items in photographs and accurately selecting them in the nutritional analysis software can lead to errors. While our results give us no reason for concern, actual values from this study should be interpreted as estimates.
A second limitation is that we cannot know for certain what children actually consumed; we photographed the food that was packed and that was remaining after each break. We requested that students not dispose of any uneaten food, but we did not actively monitor for this. We therefore reported unconsumed foods, and estimated food consumption. Having said this, to our knowledge, we believe our methodology is currently the most accurate available method.
Third, although schools/children were matched to the best of our ability, inherent differences likely exist which we were unable to control for, however, we believe there is reason for concern regarding any impact from these differences in our interpretation of the results.

While not presented in the results, there were no statistically significant differences between boys and girls in consumption or food choice patterns; however, further study on gender differences is warranted.

Recommendations. Based upon the findings from this study we make three specific recommendations for parents, educators and decision makers respectively: 1) Parents need to pack more fruit and vegetables in lunches, to avoid packing non-food items and to participate in milk programs. 2) Government agencies should consider instituting a daily milk program and/or snack program for children in kindergarten. Snacks should include fruit, vegetables and school-safe foods high in essential fats (e.g. seeds). These should be offered before first nutrition break; given that 33% of children accessed their lunch at this time during the school day. This would largely ensure that the majority of Canadian children are consuming more calcium, more potassium, more fibre, more Vitamin D and more fruit and vegetables daily, providing many health benefits for both the children themselves and Canadian Society at large. 3) Schools need to modify schedules for younger children to allow them longer periods of time to eat their packed lunches. We would recommend 30 minutes for each break, based upon anecdotal experiences and the results of this study. Furthermore, children should be allowed to access their lunches as needed before the first nutrition break. We would recommend communicating this information to parents suggesting they pack a healthy early-morning snack for this time period.

REFERENCES

Adrogué, H. J., & Madias, N. E. (2007). Sodium and Potassium in the Pathogenesis of Hypertension. *New England Journal of Medicine*, *356*(19), 1966–1978. http://doi.org/10.1056/NEJMra064486

Anderson, J. W., Baird, P., Davis, R. H., Ferreri, S., Knudtson, M., Koraym, A., … Williams, C. L. (2009). Health benefits of dietary fiber. *Nutrition Reviews*, *67*(4), 188–205. http://doi.org/10.1111/j.1753-4887.2009.00189.x

Atance, C. M., & Meltzoff, A. N. (2005). My future self: Young children's ability to anticipate and explain future states. *Cognitive Development*, *20*, 341–361.

Bailey, L. B., & Gregory, J. F. (1999). Folate metabolism and requirements. *The Journal of Nutrition*, *129*(4), 779–782.

Cheung, B. M. Y., & Li, C. (2012). Diabetes and hypertension: is there a common metabolic pathway? *Current Atherosclerosis Reports*, *14*(2), 160–166. http://doi.org/10.1007/s11883-012-0227-2

Dorman, S. C., Gauthier, A. P., Laurence, M., Thirkill, L., & Kabaroff, J. L. (2013). Photographic Examination of Student Lunches in Schools Using the Balanced School Day Versus Traditional School Day Schedules. *ICAN: Infant, Child, & Adolescent Nutrition*, *5*(2), 78–84. http://doi.org/10.1177/1941406413476547

Dorman, S., Gauthier, A.P., & Thirkill, L. (2013). The impact of the balanced school day on student physical activity and nutrition. *Phys Health Educ J*, *78*(4), 6–10.

Gauthier, A. P., Jaunzarins, B. T., MacDougall, S.-J., Laurence, M., Kabaroff, J. L., Godwin, A. A., & Dorman, S. C. (2013). Evaluating the reliability of assessing home-packed food items using digital photographs and dietary log sheets. *Journal of Nutrition Education and Behavior*, *45*(6), 708–712. http://doi.org/10.1016/j.jneb.2013.05.005

Gersovitz, M., Madden, J. P., & Smiciklas-Wright, H. (1978). Validity of the 24-hr. dietary recall and seven-day record for group comparisons. *Journal of the American Dietetic Association*, *73*(1), 48–55.

Government of Canada, H. C. (2011). Eating Well with Canada's Food Guide - Main Page - Health Canada [landing page]. Retrieved May 22, 2015, from http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/index-eng.php

Health Canada (2012). Do Canadian Adults Meet their Nutrient Requirements through Food Intake Alone? [Health Canada, 2012] [statistics]. Retrieved August 1, 2014, from http://www.hc-sc.gc.ca/fn-an/surveill/nutrition/commun/art-nutr-adult-eng.php

Institute of Medicine. (2006) Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients). Washington, DC: National Academy Press.

Johansen, S. B., Næs, T., & Hersleth, M. (2011). Motivation for choice and healthiness perception of calorie-reduced dairy products. a cross-cultural study. *Appetite*, *56*(1), 15–24. http://doi.org/10.1016/j.appet.2010.11.137

Johnson, R. J., Segal, M. S., Sautin, Y., Nakagawa, T., Feig, D. I., Kang, D.-H., … Sánchez-Lozada, L. G. (2007). Potential role of sugar (fructose) in the epidemic of hypertension, obesity and the metabolic syndrome, diabetes, kidney disease, and cardiovascular disease. *The American Journal of Clinical Nutrition*, *86*(4), 899–906.

Kleinman, R. E., Murphy, J. M., Little, M., Pagano, M., Wehler, C. A., Regal, K., & Jellinek, M. S. (1998). Hunger in children in the United States: potential behavioral and emotional correlates. *Pediatrics*, *101*(1), E3.

Nader, P. R., O'Brien, M., Houts, R., Bradley, R., Belsky, J., Crosnoe, R., … National Institute of Child Health and Human Development Early Child Care Research Network. (2006). Identifying risk for obesity in early childhood. *Pediatrics*, *118*(3), e594–601. http://doi.org/10.1542/peds.2005-2801

National Research Council and Institute of Medicine. (2000). *From Neurons to Neighborhoods: The Science of Early Childhood Development.* Washington, DC: National Academy Press.

Neumark-Sztainer, D., Hannan, P. J., Story, M., Croll, J., & Perry, C. (2003). Family meal patterns: Associations with sociodemographic characteristics and improved dietary intake among adolescents. *Journal of the American Dietetic Association*, *103*(3), 317–322. http://doi.org/10.1053/jada.2003.50048

Ontario Ministry of Education. (2010)[b]. Full-day early learning kindergarten program for four and five year olds: a reference guide for educators. Retrieved October 5, 2013, from http://www.edu.gov.on.ca/eng/curriculum/elementary/kinder2010.pdf.

Woehrle, T., Fox, S., & Hoskin, B. (2005). An Examination of the Balanced School Day Schedule. *Ontario Action Researcher*

CHAPTER IV

GENERAL DISCUSSION

4.1 Discussion

In the past, Ontario's kindergarten students attended school for a half-day of learning, followed by lunch either at home or at day-care. The full-day ELK schedule that is now mandatory in all Ontario's publically funded elementary schools as of September 2014 will have students eating their lunch regularly at school (Cantalini-Williams & Telfer, 2010). The impacts of a full school-day on the diets of early learners has yet to be examined, therefore the purpose of this study was three-fold: i) to qualify and quantify the food that parents packed and the food that children consumed during each break; ii) to examine the food choices that children made during first and second break; and iii) to compare scheduling effects (if any) between schools in the same geographic area: one using the ELK program and the other using the (now defunct) Full-Day JK/SK program.

The data and literature related to the quality and quantity of students' packed lunches is very limited. As well, research regarding the packed foods that Canadian students consume throughout the school day is non-existent to the authors' knowledge. Seeing as the early years are a critical period in the growth and development of children, ‘what?’ and ‘how much?’ children consume at school at an early age deserves examination. Below, the sample size, demographics, and the results to address the three research questions as they compare to Canadian statistics of dietary intake will be discussed in further detail.

4.1.i Sample and Demographics

The total sample can be broken down into schedule, grade, and gender as demonstrated in the following table.

Table III Breakdown of Participants by Schedule and Gender

ELK		JK/SK	
78 students		43 students	
Male	**Female**	**Male**	**Female**
34	44	22	21
JK	**SK**	**JK**	**SK**
51	27	23	20

Participation was higher among the ELK sample, representing a total response rate of 78% whereas students from the ELK sample had a 61% response rate. As well, class sizes are larger in the ELK schedule, as there is both a Certified Ontario Teacher as well as an Early Childhood Educator present in each classroom, allowing for a maximum of 26 students in comparison to a 21 student maximum for JK/SK sample.

4.2 Quality of Packed and Consumed Foods

The quality of student lunches refers specifically to the foods that students bring to school. Quality of foods, specifically for Canadian students, can be discussed using three guidelines; 1) Acceptable Macronutrient Distribution Ranges (AMDR); 2) Dietary Reference Intake values (DRI); and 3) Canada's Food Guide recommendations.

4.2.i Acceptable Macronutrient Distribution Range (AMDR)

As stated in the introduction, the AMDRs give distribution ranges for specific macronutrients in order to estimate adequacy of energy sources. In conjunction with the DRI amounts for macronutrients, health professionals use these tools to determine intake adequacy.

The following tables outline the grams of packed and consumed macronutrients, and the percentage of the RDA and total energy intake, by schedule.

Table IV Packed Macronutrients vs. Recommended Daily Allowance

Macronutrient	RDA	ELK	%RDA	JK/SK	%RDA
CARBOHYDRATES	**130 g**	138 g	106%	116 g	89%
Sugar	**Maximum: 100g**	76g	76%	65g	65%
Fibre	**Minimum: 25g**	9g	36%	7g	28%
PROTEIN	**19 g**	29 g	153%	23 g	121%
FAT	**30 g**	24 g	80%	21 g	70%

Table V Packed Macronutrients vs. Acceptable Macronutrient Distribution Ranges

Macronutrient	AMDR	ELK	JK/SK
CARBOHYDRATES	**45-65%**	64%	64%
PROTEIN	**10-30%**	14%	13%
FAT	**25-35%**	25%	26%

Table VI Consumed Macronutrients vs Recommended Daily Allowance

Macronutrient	RDA	ELK	%RDA	JK/SK	%RDA
CARBOHYDRATES	**130 g**	107 g	82%	79 g	61 %
Sugar	**Maximum:100g**	62 g	62%	47 g	47%
Fibre	**Minimum: 25g**	7 g	26%	4 g	16%
PROTEIN	**19 g**	23 g	121 %	17 g	89%
FAT	**30 g**	18 g	60%	14 g	47%

Table VII Consumed Macronutrients vs Acceptable Macronutrient Distribution Ranges

Macronutrient	AMDR	ELK	JK/SK
CARBOHYDRATES	**45-65%**	64%	64%
PROTEIN	**10-30%**	14%	14%
FAT	**25-35%**	24%	25%

Carbohydrates

The requirements for carbohydrates are based upon the average minimum amount of glucose utilized by the brain (Institute of Medicine, 2006). After 12 months of age, the EAR and RDA for carbohydrates (100 and 130g respectively), remain constant for both age and gender groups, excluding pregnant and lactating women. For both ELK and full-day JK/SK schedules, grams of carbohydrates present in student lunches appear adequate. ELK packed lunches contained an average of 138 grams of carbohydrates, and full-day JK/SK lunches contained an average of 116 grams of carbohydrates. Although both values are well above 1/3 of the DRI values for carbohydrates, there has been insufficient evidence to set a Upper Limit for carbohydrates (Institute of Medicine, 2006).

Children in the ELK schedule consumed 107g of the 138g carbohydrates in the packed lunch, and students in the JK/SK schedule consumed 79g of the 116g packed.

Calories packed from carbohydrates fell within the upper margin of the AMDR, which suggests that carbohydrates contribute between 45 to 65% of total calories (see Table III). Children in the ELK schedule had packed foods that contained 64% of total energy as carbohydrates, and children in the full-day JK/SK schedule contained 64%.

Sugar

When we sub-analyze these carbohydrates, we identify two areas of concern. First, the large proportion of sugar contained within these foods, and secondly, the low levels of fibre.

Canada's food guide has recently announced a proposed maximum daily consumption of 100g of sugar. Although this value is still above the recommendation by the World Health Organization of 10% of total kilocalories derived from sugar (World Health Organization, 2014), it is the first time the Canadian government has formally tried to limit the intake of sugars, in particular refined sugars. In parallel, Health Canada is revising food packaging to include the amount of refined sugars contained in food on Nutrient Content labelling, and to collapse sugar names under one heading in the ingredient list to better inform consumers about actual sugar content. The present study underlines the need for these changes: the packed lunches of children in the ELK schedule contained an average of 76g of sugar and lunches from children in the full-day JK/SK program contained an average of 65g of sugar, or 76% and 65% of the daily maximum, respectively. Of packed sugar, ELK children consumed 62g and full-day JK/SK children consumed 47g. As a whole, children from our study were consuming an average of 62g of sugar per day or 62% of the daily-recommended maximum. Given that these values exclude sugar consumption outside of school, we estimate that sugar intake by children far exceeds the maximum daily-recommended levels for the majority of students, regardless of school schedule. Of our total sample, 15 students or 12% had packed lunches containing over the daily-recommended amount of sugar. Additionally, 100 students, or 83% of our total sample had packed lunches containing over one half of the daily-recommended amount of sugar. This is an unsettling finding given the known health effects of elevated sugar consumption which may include obesity, cardiovascular disease and the development of type II diabetes (Johnson et al., 2007).

Three food item groups explain the high amounts of sugar present in student lunches. The first and largest contributor of sugar was juice boxes and sugar-sweetened beverages. The average juice box provides 20g of sugar, and in some cases, parents are packing two; one for each nutrition break. These results are consistent with those found by Dorman et al. (2013), who reported that parents packed significantly more sugar-sweetened beverages when nutrition breaks were increased from one to two daily. As well, in the study ‘Do Canadians meet Canada's Food Guide's recommendations for fruits and vegetables?’, Black & Billette (2013) found that juice was a major contributor to fruit and vegetable intake for children, contributing 32-41% of their daily fruit and vegetable servings as juice. The second largest contributor of sugar was pre-packed non-food items, which were often high in sugar, such as pudding cups, cookies, gummy fruit snacks, and jello. These non-food group items represented, on average, 2 items out of 8 (ELK) and out of 6 (full-day JK/SK) in every lunch packed.

The third major contributor was fruit. As young children are known to preferentially eat fruit over vegetables, parents tend to pack more fruit than vegetable items, in general. Fruit has notably more sugar than vegetables do. Having said this, we would not recommend decreasing fruit consumption amongst children. These results are in line with those found by Kranz et al., (2005) who report three main sources of sugar for preschool children: soft drinks, desserts, and fruit.

There are serious implications for high dietary intake of sugar. Dubois et al., (2007) compared frequency of sugar sweetened beverages to BMI classifications at age 2.5, 3.5, and 4.5 years of age. Overall, 6.9% of children who did not consume sugar-sweetened beverages were overweight by age 4.5, compared to 15.4% of children who regularly consumed sugar-sweetened beverages (four to six times or more per week) (Dubois et al., 2007). According to their multivariate analysis, sugar-sweetened beverage consumption between meals more than doubled pre-school children's odds of being overweight (Dubois et al., 2007).

Kranz et al. (2005) have also reported that increases in added sugar consumption is paralleled with a decrease of nutrient and food group intakes, and an increased risk of achieving vitamin and mineral intake below the DRI. Interestingly, calcium intake was insufficient in large proportions of children consuming 16% or more of total energy intake from sugar (Kranz et al., 2005). Last, an increase in sugar consumption in early childhood can be linked to an increase in dental caries (Karjalainen et al., 2001), poor eating habits (Linardakis et al., 2008), and an increase in health concerns later in life (Ebbeling et al., 2002) such as obesity, cardiovascular disease, and diabetes. Human infants are born with a preference for sweet taste (Beauchamp & Moran, 1982), thus parents play an integral role of helping their children regulate their sugar intake.

Fibre

The current minimum daily-recommended amount of fibre for children (AI) is 25g (Institute of Medicine, 2006). The AI for total fibre is based upon the intake level epidemiological studies have shown to protect against CHD (Institute of Medicine, 2006). Packed lunches of children in the ELK sample contained an average of 9 grams of fibre, and children in the full-day JK/SK sample contained an average of 7 grams, 36% and 28% of the AI, respectively. Of the grams of fibre packed, ELK students consumed 6.5 grams and students in the full-day JK/SK schedule consumed 4.1 grams, 26% and 16% of the daily-recommended amount of fibre, respectively.

Adequate dietary fibre intake is essential for regular bowel movements, is linked to healthy gastrointestinal microbiomes, is believed to blunt sugar absorption, and is associated with reduced levels of low-density lipoproteins and increased levels of high-density lipoproteins, which are both predictors of good cardiovascular health (Institute of Medicine, 2006). In contrast, insufficient fibre consumption is linked to obesity (Anderson et al., 2009). Careful consideration of sugar and fibre levels in young children's lunches is clearly warranted.

Total Fat

Fats, a major energy source of the body, also aid in the absorption of fat-soluble vitamins A, D, E, K and carotenoids, (Institute of Medicine, 2006). Children's EAR for fat is 30 grams. Students in the ELK and JK/SK schedule had packed foods that totalled 24 and 21 grams of fat, or 80 and 70% of the EAR respectively. Of the packed grams of fat, children in the ELK schedule consumed 18g and students in the JK/SK schedule consumed 14g, 60% and 47% of the EAR respectively.

The suggested AMDR for fat is between 25-35% of total daily calories (Institute of Medicine, 2006). In the present study, the percentage of calories from the packed and consumed fat fell within the lower range of this recommendation for both the ELK of the JK/SK schedule. Lunches of children in the ELK schedule had 25% of total energy derived from fat, and 26% for children in the JK/SK schedule. Of the total energy consumed throughout the school day, ELK students consumed 24% as fat, and students in the full-day JK/SK schedules consumed 25% as fat. We hypothesize that repeated messages to the public about reducing fat consumption to combat obesity, compounded by industry responses which highlight foods with reduced fats for children, have prompted parents to make low-fat or fat-free food choices for their children. For example, as mentioned in the introduction, the results of the 1970-1972 Nutrition Canada Survey showed that Canadians were consuming above the recommended AMDR at 40%, and thus began the initiation of several interventions to promote low-fat diets (Garriguet, 2004). These particular low-fat foods are potentially problematic in that essential fats, which are critical for nervous system development particularly during the first 5 years of life, may not be consumed in sufficient quantities to ensure optimal brain development. Unfortunately we were unable to distinguish essential fats from non-essential fats in this study. However, given our understanding of the predominant foods that contain essential fats, we can anecdotally say that this was not the predominant fat in children's lunches. Governing bodies need to make renewed efforts to encourage the consumption of essential fats. School-friendly food options that are not nut-based need to become mainstream to achieve this objective.

Protein

Proteins form the major structural components of all cells in the body, and function as enzymes, membrane components, transport carriers, and as hormones (Institute of Medicine, 2006). Daily protein requirements were set based on analyses of available nitrogen balance studies (Institute f Medicine, 2006). Children in the ELK schedule had packed foods with an average of 29 grams of protein, and children in the JK/SK schedule had an average of 23 grams, 10 and 4 grams above the RDA, respectively. ELK students consumed 23g of protein, and full-day JK/SK students consumed 17g of protein, or 120% and 89% of the RDA, respectively. Again, there is no tolerable upper limit set for protein due to insufficient evidence (Institute of Medicine, 2006).

For both school schedules, the amount of calories packed from protein was within the lower end of the suggested AMDR for protein, which is 10-30% of total calories. ELK students had packed foods with 13% of total energy from protein, and JK/SK students had 12%. Of the total energy consumed throughout the school day, ELK students consumed 14% as protein, and students in the JK/SK schedule consumed an equal 14% as protein. The RDA for protein for children is 0.95g/kg of body weight per day or approximately 19g/day. It is therefore highly likely that the daily protein intake for the majority of children is adequate, and this corresponds with Canadian statistics for adults showing that protein consumption falls within the AMDR (Health Canada, 2012).

4.2.ii Dietary Reference Intakes

Assuming full-day kindergarten students spend approximately one third of their waking hours in the school setting, we assumed that they should be consuming approximately one third of their daily vitamin and mineral intake during this time. For the majority of the vitamins and minerals measured, the average amounts present in children's packed lunches were a third or over the DRI value for children between the ages of 4-8 years. We scrutinized particularly the levels of the following micronutrients: vitamin A, potassium, sodium, folate, calcium, and vitamin D, and iron. These select micronutrients are imperative for healthy growth and development for children (Institute of Medicine 2006).

As seen in chapter 3, the following table lists the measured micronutrients of students' packed foods, and the percentage of each micronutrient to their corresponding DRI value. To measure vitamin and mineral adequacy of groups, it is recommended to compare intake to the EAR value (or AI when an EAR cannot be calculated).

Table VII Packed and Consumed Micronutrients vs. DRI

Vitamin/ Mineral (EAR or AI)	**Packed**		**Remaining by end-of-day**		**Estimated Daily Consumption/ %DRI**	
	ELK	JK/SK	ELK	JK/SK	ELK	JK/SK
Vit.A µg (275µg)	161±19.07*	79±16.1*	70±14.0	41±12.1	91/ 33%	38/ 14%
Vit. C mg (22mg)	59±3.80*	40±4.95*	15±2.2	14±2.6	44/ 200%	26/ 118%
Vit.D µg (400 IU)	63±5.3*	13±3.7*	5±0.7	3±0.7	58/ 15%	10/ 3%
Calcium mg (800mg)	452±24.5 **	215±15.51**	60±6.5	60±9.5	391/ 49%	155/ 13%
Folate µg (160µg)	71±30.5**	44±28.4**	23±2.3	18±2.9	48/30%	26/16%
Iron mg (4.1mg)	3.5±1.2**	2.4±1.1**	0.9±0.1	0.9±0.1	2.6/63%	1.5/37%
Potassium mg (3800mg)	622±27.2**	375±31.2**	161±17.9	146±21.7	461/12%	228/6%
Sodium mg (1200mg)	1178±45.09*	991±42.09*	277±27.4	310±37.4	901/75%	681/57%

* = p>0.05

** = p>0.001

*EAR = Estimated Average Recommendation

*AI – Adequate intake

Note: EAR is recommended for assessing the nutrient intake of groups by the Institute of Medicine. The EAR is estimated to meet the needs of half of assumedly healthy individuals.

Of particular concern was the low amount of potassium both packed and consumed throughout the school day. Potassium represented 16% (608mg) and 12% (456mg) of the daily EAR value for lunches from students using the ELK and JK/SK schedule, respectively. When examining our student population as a whole, only two students, or 1% of our total sample, was arriving at school with a lunch that contained at least one third of the EAR for potassium. Average potassium consumption of ELK students by the end of the school day was 461mg and 229 mg for JK/SK students, representing 12% and 6% of the EAR, respectively.

As well, packed lunches of children in the ELK schedule contained 98% of the daily sodium EAR of 1200 mg and 83% in the JK/SK schedule. As a whole, the average sodium content of packed foods ranged from 400mg to 2100mg.Unfortunately, 39 students, or 32% of our total sample lunches contained sodium above the *daily* Estimated Average Recommendation of 1200mg. Consumption of sodium throughout the school day was also alarming, as students in the ELK schedule consumed an average of 901mg of sodium, and JK/SK students consumed an average of 681mg of sodium, representing 75% and 57% of the EAR, respectively.

Low amounts of potassium combined with the high amounts of sodium present in students' lunches, and thus consumed throughout the school day, should be of concern to health professionals. Even small changes in the concentration of extracellular potassium can greatly affect the ratio between extracellular and intracellular potassium, thus affecting neural transmission, muscle contraction, and vascular tone (Institute of Medicine, 2006). An excess of sodium and a deficit of potassium are typical of the modern Western diet, and over time, an excess of cellular sodium and a deficit in cellular potassium increases peripheral vascular resistance and ultimately establishes hypertension (Horacio et al., 2007). Furthermore, hypertension in turn is a risk factor for cardiovascular disease and type II diabetes.

These values are not surprising and reflect general under- and over consumption of potassium and sodium respectively in Canadian society (Health Canada, 2012). These numbers are also in alignment with the distribution and consumption of fruit/vegetable items and packed non-food items that tended to be lower for the first and higher for the latter. For instance, the majority of potassium is found in fruit and vegetables, whereas the majority of sodium comes from processed food items. Furthermore, as lunches are not stored in refrigerators, there is likely a perceived need to pack non-perishable food items that remain edible for the entire school day. This in turn contributes to elevated sodium levels in children's lunches.

In the present study, the levels of folate appear to be lower than the recommended intake levels. The RDA value, expected to meet the needs of 97-98% of healthy children, is 200μg, (Institute of Medicine, 2006). Packed lunches in the ELK schedule contained an average of 70μg of folate, and packed lunches in the JK/SK schedule contained an average of 43μg, or 35% and 22% of the RDA, respectively. As a whole, the packed lunches of our sample was divided almost equally between containing and not containing at least one-third of the EAR value for folate of 160μg, as 55 students or 45% of the total population did not have packed foods that contained at least one-third of the EAR for folate. Given that folate and other B vitamins are required nutrients for cell division, proliferation and metabolism, which are critical processes for growing children (Bailey & Gregory 1999), the low levels of folate are alarming. More alarming is the low amounts of consumed folate by the end of the school day, especially those in the JK/SK schedule. Students in the ELK schedule consumed only 48mg, and students in the JK/SK schedule consumed 26mg, 30% and 16% of the EAR, respectively. The richest sources of folate include fortified grain products, dark green vegetables, and beans and legumes, and the consumption of these items should be encouraged, as epidemiological studies suggest that folate may protect against vascular disease, cancer, and mental disorders (Institute of Medicine 2006).

In 2011, the Institute of Medicine revised the DRI values for calcium and vitamin D in a public health report, building upon the prior values published in 1997 (Ross et al., 2011). The process involved identifying 'indicators' causally linked to meeting the needs of at least 97.5% of the population. It is important to note that The Institute of Medicine further specified, because of the unique feature of cutaneous synthesis of vitamin D, and the variation in synthesis due to sun exposure, skin pigmentation, genetic factors, the use of sunscreen, latitude, as well as concerns linking sun exposure and skin cancer risk, that the DRI's for vitamin D be based on an assumption of minimal or no sun exposure (Ross et al., 2011). Accordingly, scientific evidence for both skeletal and extraskeletal chronic disease outcomes was examined in order to determine: 1) which health outcomes are related to calcium/vitamin D intake; 2) how much calcium and vitamin D is required to achieve desirable health outcomes; and 3) How much is too much (Ross et al., 2010). Skeletal outcomes considerations included bone mineral content and density, fracture risk, rickets/osteomalacia, and extraskeletal outcomes included CVD, hypertension, diabetes, fall and performance, autoimmune disorders, infectious diseases, pregnancy disorders, and neuropsychological functioning. After scrutinizing the evidence, the Institute of Medicine concluded that skeletal health was the only outcome that could be used as an 'indicator', whereby causality was established and a dose-response was sufficient to support its use for DRI development (Ross et al., 2011).

The growth of one's skeleton determines the size and proportion of one's body. Throughout early childhood until early adolescence, the bony skeleton undergoes a substantial increase in size

(Martini et al., 2006). The process of replacing other tissues with bone, or ossification, requires the deposition of calcium salts, or calcification (Martini et al., 2006). In order for calcification to occur, a constant dietary source of calcium is required (Martini et al., 2006). Additionally, vitamin D is required for the absorption of calcium, and is especially required during rapid growth (Institute of Medicine, 2006). The hormone calcitrol, synthesized in the kidneys, is also essential for normal calcium absorption in the digestive tract. Calcitrol synthesis is dependent upon the availability of a related steroid, cholecalciferol, or vitamin D_3, which may be synthesized through the skin or absorbed from dietary intake (Martini et al., 2006).

Low calcium and vitamin D were identified in the lunches of the children in the present study. The EAR for calcium is 800mg. Although children in the ELK schedule had packed foods containing 56% of the EAR for calcium, (452mg) students in our JK/SK sample were arriving at school with only 27%, (215mg). As a whole, 44 students or 36% of our total sample did not have at least of the daily EAR for calcium present in their packed foods. Students in the ELK schedule consumed 391mg, or 49% the EAR for calcium, and students in the JK/SK schedule consumed 155mg, or 19%.

Similarly, vitamin D levels were below recommended levels of 400 IU. Children in the ELK schedule had packed foods containing 16% (63 IU) of the EAR for vitamin D, and students in our JK/SK sample had 3% (13 IU). As a whole, only 6 students, or 5% of our total sample were arriving at school with at least one-third of the total EAR for vitamin D. Vitamin D consumption was even less, as ELK students consumed an average of 58 IU, or 15% of the EAR, and JK/SK students consumed an average of 10 IU, or 2% of the EAR for vitamin D.

Low amounts of calcium and vitamin D seen in this study could be reflective of the decrease in milk consumption per capita in Canada, (Government of Canada, 2014). The Canadian Dairy Information Centre of the Government of Canada, 2014 has tracked such statistics that indicate a steady decrease of 3.25%, 2%, and skim milk consumption between 1997 and 2014, (Government of Canada, 2014). 1% milk appears to have peaked in 2012 and has been gradually decreasing since. Annual fluid milk consumption was measured in litres and took into account cross-border shipping, (Government of Canada, 2014). See Table IX for select statistics.

Table IX Canadian per Capita Milk Consumption Statistics from 1997 - 2014

Year	3.25%	2%	1%	Skim	Total
2014	13.35	37.82	12.52	3.90	72.91
2013	13.33	40.05	12.93	4.16	75.53
2012	13.51	43.65	13.49	4.50	80.27
2005	15.51	47.09	12.74	5.24	83.97
2000	18.77	49.97	11.88	4.82	88.37
1997	20.91	53.31	10.95	4.48	92.40

* in Litres

(Government of Canada, 2014)

The decrease in milk consumption has been similarly documented by the United States Department of Agriculture. In their report, “Why are Americans Consuming Less Fluid Milk? A Look at Generational Differences in Intake Frequency”, it is reported that the portion sizes of fluid milk consumed has remained constant, although the frequency of consumption has declined, (Stewart et al., 2013). Disappointingly, children are not excluded from these statistics. Between the years 1977-1978 children aged 2-12 were consuming an average of 1.7 eight ounce servings of milk per day which since decreased to 1.2 eight ounce servings between the years of

2007-2008, (Stewart et al., 2013). The decreases of fluid milk consumption over time can be in part explained by the increasing cost of fluid milk, and the increase in competing products that displace fluid milk, such as sports drinks, sugar-sweetened fruit juices, energy drinks, and vitamin enriched water. The report recognizes that children may be the key to mitigating the decreasing fluid milk consumption, as early habit formation has the strongest influence on long-term dietary choices, (Stewart et al., 2013).

Additionally, Jay-Russell (2010) reported that in the midst of trends toward choosing less processed foods, there is a growing consumer demand for raw (unpasteurized) dairy products from local dairies despite the significant health risks associated with raw milk consumption. Weber et al., 2008 used qualitative data to demonstrate the movement of consumers towards exclusively grass-fed meat and dairy products without the use of antibiotics, and discovered that beginning in 1990 consumers in the United States have become concerned with the mass farming of corn-fed cattle. Although there is an increased demand for dairy and meat products from grass-fed animals these specific food items only represent 0.2 percent of the U.S meat and dairy sector and they are sold in high-end restaurants, at a premium by ranchers, and at health food stores (Weber et al., 2008). Overall, it is clear that consumers are concerned with current dairy farming practices, and this may deter them from purchasing dairy products.

Given that dairy and vegetables are the best sources of calcium for children, regular consumption of these foods should be strongly encouraged, as in addition to bone development, calcium is also involved in vascular, neuromuscular, and glandular functions (Institute of Medicine, 2006). Specifically, many schools have implemented a school milk program, which makes intake of milk throughout the school day a feasible and easily accessible option. Cow's milk offered in school milk programs is a source of both calcium and vitamin D. One 250ml carton of milk provides 300 mg calcium and 100 IU vitamin D equivalent to 38% and 25% of the EAR respectively. Parents are encouraged to participate in milk programs to increase their child's likelihood of meeting the EAR of 800mg of calcium and 100 IU of vitamin D.

The different milk programs provided by the individual schools likely explain the differences between the two schedules. In the school that housed our JK/SK sample, the milk program had a mandatory policy that participation required receiving milk all five days of the school week. If parents are not able to choose the days in which their child receives milk, it may deter them enrolling their child in a milk program. Participation in a milk program was greater among our ELK sample, (60%) than our JK/SK sample (51%).

Iron levels fell within expected ranges. Children in the ELK schedule had packed foods containing 84% of the EAR for iron, or 3.5 mg and students in the JK/SK schedule had foods with 58% of EAR for iron, or 2.4 mg. As a whole, only 10 students, or 8% of our total population did not arrive at school with at least one-third of the EAR for iron. Likewise, iron consumption remained adequate, as students in the ELK schedule consumed an average of 2.6 mg, or 63% the EAR, and JK/SK students consumed an average of 1.5 mg, or 37% of the EAR. Given that iron is essential for normal red blood cell levels, and iron-induced anemia is notorious for creating poor learning outcomes (Halterman et al.; 2001; Oski 1993), it is reassuring to see that these children were estimated to receive adequate amounts.

Complementing adequate iron levels was adequate vitamin C content of packed foods, as vitamin

C enhances iron uptake from the gut, (Institute of Medicine, 2006). Children in the ELK schedule had packed foods containing 269% of the EAR for vitamin C (59mg), and JK/SK students had 183% (20mg). As well, only 4% of our total sample arrived at school with less than one-third of the EAR for vitamin C. Also of interest, 98 students or 81% of our total sample had lunches containing above the daily EAR for vitamin C of 22mg. Consumption throughout the school day was also high, as ELK students consumed an average of 44mg, or 200% the EAR, and JK/SK students consumed an average of 26 mg, or 118%. Even though vitamin C content in the student lunches and vitamin C consumption was well above the EAR, toxicity is highly unlikely given that vitamin C is a water-soluble vitamin (Institute of Medicine, 2006). Unfortunately, the predominance of this vitamin is believed to be from fortified beverages packed in the lunches rather than fruit servings. This is problematic predominantly because these drinks also provide high amounts of sugar as outlined above, and recommending their removal may cause a decline in vitamin C consumption.

4.3 Quantity of Foods Packed and Consumed

4.3.i The Canada Food Guide

Last revised in 2007, Canada's Food Guide aims to assist people in making food choices to promote health and reduce the risk of nutrition-related chronic diseases as a reflection of what is available in Canada, and what food choices Canadians make (Katamay et al, 2007). The food intake patterns and amounts recommended by Canada's Food Guide are based upon current nutritional science, and have been designed to meet nutrition standards, such as the Dietary Reference Intakes and Acceptable Macronutrient Distribution Ranges (Katamay, 2007). In the present study, Canada's Food Guide was used to classify the food items packed in student lunches, and consumed throughout the school day.

All food items were divided into three categories using Canada's Food Guide as a reference: fruit and vegetable servings, non-food group items, and other food group items. Fruit and vegetable servings were defined as a serving according Canada's Food Guide. Non-food group items were defined as pre-packaged food items not recognized by Canada's Food Guide or if they were food items not permitted for sale in Ontario schools as determined by Ontario's School Food and Beverage Policy. Last, other food-group items were defined as items in the three remaining food groups; milk and alternative products, meat and alternatives, and grain products. Overall, children in the ELK schedule were arriving at school with an average of 8.2 food items compared to 6.6 in the JK/SK schedule.

Fruits and Vegetables

The number of fruit and vegetable servings in the packed lunches in the present study was encouraging. Children in the ELK schedule averaged 3.3 servings of fruit and vegetables in packed lunches, and JK/SK students averaged 2.1 servings. It is important to note that 100% fruit juice was considered a fruit and vegetable serving. On average, our lunch samples comprised 2.8 servings or half of the minimum daily recommended 5 servings of fruit and vegetables as per Canada's Food Guide. It is important to note that 100% fruit juice was classified as a fruit and vegetable serving during our data entry and analysis. Unfortunately, on average and irrespective of schedule, students left 1 serving of fruit/vegetable uneaten by the end of the day. However, when parents packed more fruit and vegetables (ELK schedule), children consumed more of these items. Therefore, parents and educators should continue to pack more servings of fruit and vegetables in lunches, and educators must continue to encourage the consumption of these foods as a priority while children are at school. Scheduling may also affect consumption of fruit and vegetables, by providing students with more time to eat these food items (e.g. the ELK students).

Non-food Group Items

Health professionals in 2004 revised Canada's Food Guide's 1992 definition of an "other" food guide item. The previous definition was considered too vague, thus the 2004 revision includes stricter guidelines as to what does not fit within the four food groups (Katamay et al., 2007). These definitions were used as guidance when classifying food items. Although the 2007 revision eliminated the 'other group' classification, the guidelines proposed assisted in our classification as to which items do not fall within the Canada Food Guide.

Additionally, Ontario's School Food and Beverage Policy divides commonly consumed foods into "Sell Most", "Sell Least" and "Not Permitted for Sale" categories, (EatRight Ontario, 2014). Food items found in student lunches that fell within the "Not Permitted for Sale" were considered non-food group items during data analyses.

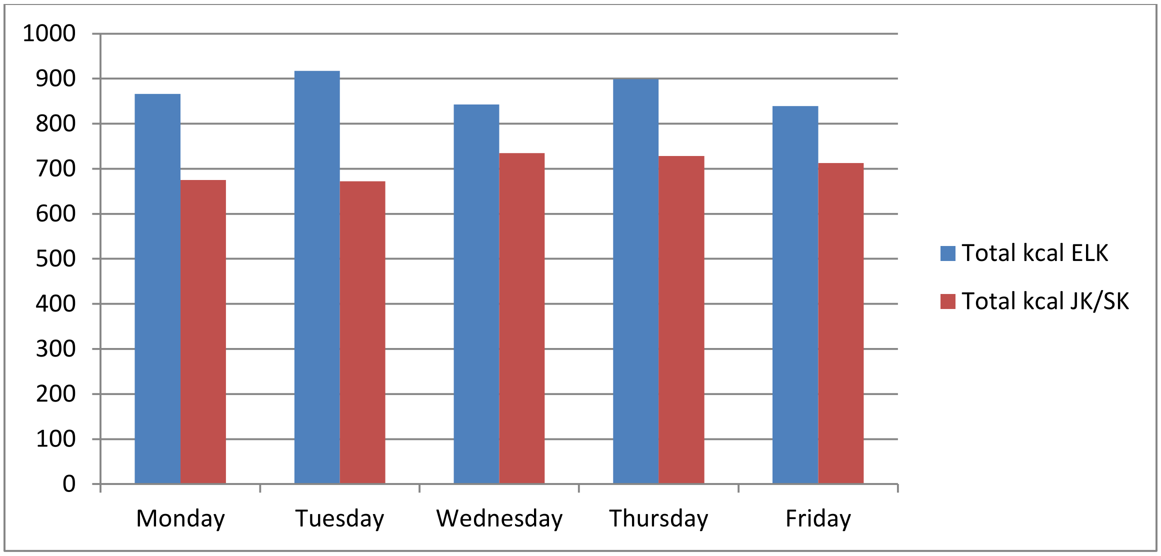
Irrespective of schedule, children were arriving at school with an average of 1.7 non-food group items in their lunches. By the end of the day, students consumed an average of 1.2 of these items. However, we found no significant difference in the non-food group items packed between schedules, and there was also no significant difference in the amounts of consumed non-food items, leaving an average of 0.5 of 1.7 servings remaining at the end of the school day. This suggests that children possibly chose to eat non-food items over fruits/vegetables. Accordingly, we recommend that parents avoid packing non-food group items, or pre-packaged, energy-dense food items, and rather, to increase the availability of other food-group items, particularly packed vegetable and fruit servings. This recommendation would dramatically curtail the elevated daily sugar consumption at school that was found in the present study, and increase the amount of consumed vitamins and minerals.

4.3.ii Kilocalories Packed and Consumed

One unexpected result of this study was the significantly different kilocalorie content of student lunches between the ELK and JK/SK schedules. After best matching for socioeconomic status, geographic proximity and school-population size, we hypothesized that there would be no significant difference between the amounts of kilocalories packed in student lunches. However, children in the ELK schedule had packed lunches containing a significantly greater amount of kilocalories compared to JK/SK students (ELK: 858 kcal; JK/SK: 722 kcal).

To better understand why, we examined food programs offered by both schools. In the school that housed our ELK sample, Tuesday and Thursday of every week were ‘pizza days’, where parents had the option or ordering x number of servings of pizza for their child to consume during the second nutrition break. Additionally, Wednesday of every week was ‘pasta day’, where parents had the option of ordering their child approximately three-quarters of a cup of pasta with butter, tomato sauce, or a Bolognese sauce, again, to be consumed during the second nutrition break. This differs significantly from the school that housed our JK/SK sample. Pizza days were allotted to one day a week, Wednesday, and pasta days were not an option.

Figure I Kilocalories by days of the week, by schedule

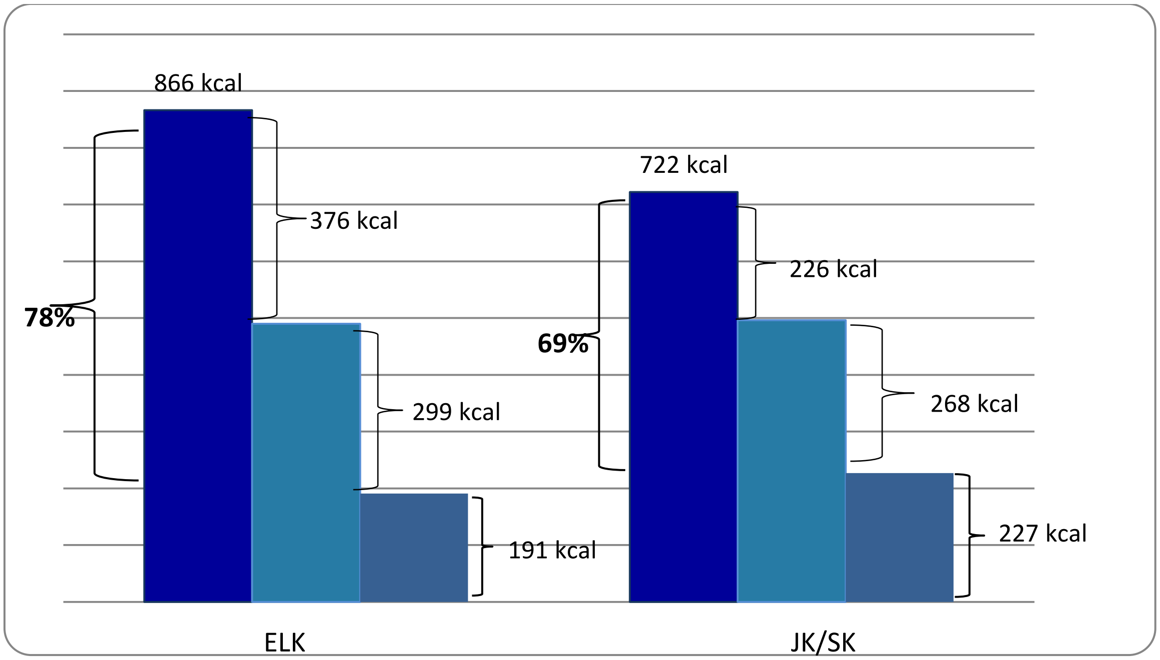


As illustrated by in Figure I, Tuesdays and Thursdays (pizza days) for the ELK sample had significantly higher total kilocalories than Monday, Wednesday, and Friday. Pasta day on Wednesdays for the ELK sample did not appear to affect total kilocalorie amounts in student lunches. Also of interest, pizza day for the JK/SK sample (Wednesday) also resulted in the highest kilocalorie lunch day of the week. Therefore, the increase in pizza days from one to two days per week could in part explain the increase in kilocalorie content of student lunches in the ELK sample in comparison to the JK/SK sample.

Although pizza days are representing the highest kilocalorie days of the week, I do not intend to convey the message that parents should not participate in pizza programs at school. Current school nutrition standards police the type of pizza that can be offered in schools (EatRight Ontario, 2014). In order for an Ontario school to sell pizza that does not follow the nutrition standards outlined by the 'sell most' category, principals could only allow a maximum of 10 pizza days to be offered a year (EatRight Ontario, 2014). This was not the case in either of our two schools; pizza sold in these schools are required to fall within the "sell most category". This category requires pizza dough to have whole grain as the first ingredient, and all major ingredients such as cheese and pepperoni must fall within the "sell most" category (e.g. skim milk cheese, turkey pepperoni, (EatRight Ontario, 2014). Pizza provided in both of school sampled comply within the Ontario School and Beverage Policy (personal verification).

Not only were children in the ELK schedule provided with a significantly greater amount of kilocalories in their lunches, but they were also consuming a greater percentage of their lunches throughout the school day (see Figure II).

Figure II Consumed Kilocalories by Schedule



However, despite the greater amount of kilocalories packed, students in the ELK schedule had less kilocalories remaining by the end of the school day (191 kcal) than did children in the JK/SK schedule (227 kcal). Children in the ELK schedule consumed 78% of their packed kilocalories, and student in the JK/SK schedule only consumed 69% of their packed kilocalories. These results are similar to those found by Woerhle et al. (2001) and MacDougal et al. (unpublished findings) that state young children in the BSD schedule (as seen by our JK/SK schedule) do not have enough time to eat throughout the school day.

4.3.iii Food Choice Analysis

Table X summarizes which food items children were choosing to eat during the first break, and what they were choosing to eat during the second break.

Table X Consumption of Food Items

Schedule/Food Item	Total Packed Food Items	Consumed During First Break 1	Consumed During Second Break 2	Consumed Total/Percentage Packed
ELK: Total Food Items	8.2	4.4	2.0	6.4 / 78%
JK/SK: Total Food Items	6.6	3.1	1.5	4.6 / 70%
ELK: Fruit/Vegetable	3.3	1.7	0.7	2.4 / 73%
JK/SK: Fruit/Vegetable	2.1	1.0	0.4	1.4 / 67%
ELK: Non-Food Items	1.7	0.6	0.6	1.2 / 71%
JK/SK: Non-Food Item	1.7	0.7	0.4	1.1 / 65%

Interestingly, children were eating the majority of their lunch during the first break and the predominant food items where milk and dairy products, meat and alternatives, and grain products. This supports our belief that children are hungry before the first break and would benefit from either access to their packed lunch during the first period of the day, or implementation of a national food program offered during the first break.

Promisingly, children in the ELK schedule consumed 1.7 fruit and vegetable servings and children in the JK/SK schedule consumed 1 fruit and vegetable servings, followed by 0.7 and 0.4 fruit and vegetable servings during the second break, respectively. These results are in accordance with Canada's Food Guide, which recommends 1 fruit or vegetable serving for morning and afternoon snacks. It is important to note that when classifying food group items, fruit juice boxes fell under the category of fruit and vegetable servings. To decrease the sugar content of lunches and increase the vitamin and mineral content, we recommend parents pack more fresh fruit and vegetable servings and less fruit juices.

Data regarding non-food group items was similar between schedules. In the first nutrition break, children in the ELK schedule consumed an average of 0.6 non-food group items, and children in the JK/SK schedule consumed an average of 0.7 non-food group items, followed by 0.6 and 0.4 items during the second break, respectively. Over the course of the school day, ELK children consumed 1.2 non-food group items and JK/SK children consumed 1.1 non-food group items. Given that these food items are often high in kilocalories, and include refined sugar, yet few nutrients, and they may displace the consumption of packed fruits and vegetables, we recommend parents do not pack non-food group items on a daily basis.

4.4 Scheduling effects.

The primary finding we report in relation to scheduling effects is that children within our sample need more time to eat their lunches. Children enrolled in the full-day JK/SK using the BSD schedule consumed 172 fewer kcal than children in the ELK schedule. On average, they consumed 495kcal/day during the school day, or 69% of the total kcal provided in their packed foods. If we estimate that the average child aged 4-5 years engaging in moderate physical activity requires 1600kcal/day, then JK/SK children are consuming less than one-third of their daily energy requirements. On the other hand, children in the ELK schedule consumed 667kcal/day, or 78% of the total kcal provided in their packed foods. This is critical, because it suggests that children who are only given two 20-minute time blocks to consume food are likely hungry throughout the school day, and hunger has many impacts on the child, including academic performance and behaviour, (Taras, 2005).

Although parents of students in the JK/SK schedule packed fewer total kilocalories, we suggest that this was in response to the food consumption by their children. That is, there was no difference in the amount of food that children left uneaten at the end-of-day, between schedules. Likely, over the school year (this data was collected in May), parents adapted the amount of food that they packed based upon what their children were eating. This belief is supported by previous work in our research group, which has shown that significantly more children in grade 3 reported 'not having enough time to eat' during the 20-minute nutrition break, compared to grade 6 students who felt they did have enough time to eat (MacDougall et al.). Woehrle et al. reported similar findings in 2001. Given that children of this age are less capable of predicting outcomes from choices (Atance & Meltzoff 2005), it seems reasonable that they are also less capable of ensuring that they eat adequate amounts of food to meet their needs and to sustain themselves over a subsequent time-period where they will be unable to access their lunches.

4.4.i Access outside Nutrition Breaks

A policy implemented in the ELK classrooms that allowed students to access their packed foods outside of designated nutrition breaks had major implications on dietary intake. Of the four ELK classrooms we studied, three teachers adopted this policy change. It was evident that students were utilizing this policy to their advantage, as 26 students, or 33% accessed at least one food item from their lunch outside of nutrition breaks. Furthermore, it is important to note that children accessed their packed foods during the morning instruction block, prior to the first nutrition break. No child accessed their lunch between first and second nutrition breaks, nor the period between the second nutrition break and the end of the school day. This suggests that students are most hungry during morning instruction time. There are many reasons for this, including: they did not consume breakfast, they did not consume sufficient breakfast to maintain satiety or consumed a breakfast with a low satiety level, or they consumed breakfast at an earlier time-period (e.g. 6am), which led to hungry earlier in the school day.

These results could have important implications for children's academic success. Early studies have documented the impact of hunger on academic performance, particularly when children miss breakfast (Mahoney et al., 2005; Rampersaud et al., 2005). However, even small breakfasts, which leave children hungry, can negatively influence performance. Benton and Benton & Jarvis (2007) conducted a study examining the effects of breakfast quality and midmorning snacks on children's ability to concentrate in school. Children who had consumed a small breakfast (average 61 kcal) spent significantly less time focusing on required tasks than those who had consumed a larger breakfast. Fortunately, consuming a midmorning snack mitigated the effect of a small breakfast, and significantly improved concentration on assignments. Related to this, is macronutrient content of breakfast foods. Warren et al (2003) have also shown that 'what' children eat for breakfast impacts satiety. Foods containing higher protein, fats, whole grains and fibre keep children feeling fuller longer (Warren et al., 2003). Given that many Canadian children consume cereal as the primary choice for breakfast (Rampersaud et al., 2005) it is easy to imagine that these same children might report being hungry prior to the first nutrition break, as many “ready-to-eat cereals” are low in whole grains and high in added sugars.

Overall, our findings support wide-spread adoption of school policies that would allow children, particularly younger children, to access their food prior to first nutrition break. The results also suggest that government agencies should consider implementing a school-wide food program, wherein children are provided with healthy snacks in the morning. At the same time, messages to parents must continue to highlight the importance of breakfast for children, including healthy options.

4.5 Recommendations

Based upon the findings of this study, we make three specific recommendations for parents, educators and decision makers.

1) First, parents should pack more fruit and vegetables in lunches, they should avoid packing non-food items, and they should be encouraged to participate in student milk programs.
2) Second, government health units should consider implementing daily milks and/or snack programs for children in kindergarten. Snacks should include fruit, vegetables and “school-safe” foods high in essential fats (e.g. seeds) and dairy products. These snacks should be offered before the first nutrition break given that 33% of children accessed

their lunch at this time during the school day. This would ensure that the majority of Canadian children are consuming more calcium, more potassium, more fibre, more vitamin D and more fruit and vegetables on a daily basis, which would provide many health benefits for both the children themselves and Canadian society at large.

3) Third, schools should to modify schedules for younger children to allow them longer periods of time to eat their packed lunches. We would recommend 30 minutes for each break, based upon our results, other evidence discussed above, and anecdotal experiences. Furthermore, in the case where a government-supported breakfast program does not exist, children should be allowed to access their lunches as needed before the first nutrition break. We would recommend communicating this information to parents, and suggest that they pack a healthy early-morning snack for this time period.

References for Chapter IV

Beauchamp, G. K., & Moran, M. (1982). Dietary experience and sweet taste preference in human infants. Appetite, 3, 139–152

Black, J.L., Billette, J.M. (2013). Do Canadians meet canada's food guide recommendations for fruit and vegetables? Appl Physiol Nutr Metab. 38(3): 234-42.

Cantalini-Williams, M. Telfer, L. (2010). Successful implementation of the full-day early learning kindergarten program. Available from: http://www.cpco.on.ca/MembershipServices/documents/News/PrincipalConnections/PastIssues/Vol14/Issue1/FullDay.pdf. Accessed on October 5, 2013.

Dorman, S.C., Gauthier, A.P., Laurence, M., Thirkill, L.J., Kabaroff, J.L. (2013). Photographic examination of student lunches in schools using the balanced school day versus traditional school day schedules. Infant, Child, & Adolescent Nutrition, 5(2), 78-84.

Dubois, L., Farmer, A., Girard, M., Peterson, K. (2007). Regular sugar-sweetened beverage consumption between meals increases risk of overweight among pre-school-aged children. Journal of the American Dietetic Association. 107(6): 924-934.

EatRight Ontario. (2014) Learn more about what foods can be sold in schools with the school food and beverage policy. Available from: http://www.eatrightontario.ca/en/Articles/School-Health/Ontario-s-School-Food-and-Beverage-Policy/Learn-more-about-what-foods-can-be-sold-in-schools.aspx#.U9qp5PldWSo. Accessed on July 31, 2014.

Ebbeling, C.B., Pawlak, D.B., Ludwig, D.S. (2002). Childhood obesity: public health crisis, common sense cure. The Lancet. 360(9331): 473-482.

Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington DC: National Academy Press.
Garriguet, D. (2004). Overview of Canadians' eating habits. Finding from the Canadian Community Health Survey. Statistics Canada.

Gunter, W., Daly, K (2013). Health Behaviors and Standardized Test Scores: The Impact of School Health Climate on Performance, International Journal of School & Educational Psychology, 2013, 1, 3, 166.

Health Canada, (2012). Do Canadian adults meet their nutrient requirements through food intake alone? http://www.hc-sc.gc.ca/fn-an/alt_formats/pdf/surveill/nutrition/commun/art-nutr-adult-eng.pdf. Accessed August 1, 2014

Health Canada. (2011) Eating well with Canada's food guide - A resource for educators and communicators. Available from:http://www.hc-sc.gc.ca/fn-an/pubs/res-educat/res-educat-eng.php#a14. Accessed August 20, 2014.

Health Canada. (2014). Improving nutrition information of food labels: better understanding the sugar content of our foods. Available from: http://www.hc-sc.gc.ca/fn-an/label-etiquet/sugars-sucres-fs-fr-eng.php. Accessed on August 20, 2014.

Howerton, M.W., Bell, B.S., Dodd, K.W., Berrigan, D., Stolzenberg-Solomon, R., Nebeling, L. School-based nutrition programs produced a moderate increase in fruit and vegetable consumption: meta and pooling analyses from 7 studies. Journal of Nutrition Education and Behavior. 39(4):186-196

Institute of Medicine. 2006. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Jay-Russell, M.T. (2010). Raw (unpasteurized) milk: are health-conscious consumers making an unhealthy choice? Clinical Infectious Diseases, 51(12): 1418-1419.

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

Karjalainen, S., Söderling, E., Sewón, L., Lapinleimu, H. and Simell, O. (2001), A prospective study on sucrose consumption, visible plaque and caries in children from 3 to 6 years of age. Community Dentistry and Oral Epidemiology, 29: 136–142.

Katamay, S.W., Esslinger, K.A., Vigneau;t, M., Johnston, J.L., Junkins, B.A., Robbins, L.G., Sirois, I.V., Jones-McLean, E.M., Kennedy, A.F., Bush, M.A., Brule, D., Martineau, C. (2007). Eating well with canada's food guide (2007): development of the food intake pattern. Nutrition Reviews. 65(4): 155-166.

Klaus, W., Keinze, K.L., DeSoucey, M. (2008) Forage for thought: mobilizing codes for grass-fed meat and dairy products. Administrative Science Quarterly. 53: 529-567.

Kranz, S., Smiciklas-Wright, H., Siega-Riz, A.M., Mitchell, D. (2005). Adverse effect of high added sugar consumption on dietary intake in American preschoolers. The Journal of Pediatrics. 146(1):105-111

Linardakis, M., Sarri, K., Pateraki, M.S., Sbokos, M., Kafatos, A. (2008). Sugar-added beverages consumption among kindergarten children of Crete: effects on nutritional status and risk of obesity. BMC Public Health. 8:279.

Lytle LA, Ward J, Nader PR, Pedersen S, Williston BJ. Maintenance of a health promoting programme in elementary schools: Results from the CATCH-ON study key information interviews. Health Educ Behav 2003;30(4):503-18.

MacDougall, S, A. Gauthier, B. Jaunzarins, S.C. Dorman. A Survey study on school scheduling: student perceptions of hunger, physical activity and learning engagement. *Submitted Infant, Child and Adolescent Nutrition.*

Mahoney CR, Taylor HA, Kanarek RB, Samuel P. Effect of breakfast composition on cognitive processes in elementary school children. Physiol Behav 2005;85:635–45.

Marmot, M., Wilkinson, R. (2005). Social determinants of health. Oxford University Press.
Oski FA.(1993). Iron deficiency in infancy and childhood. New England Journal of Medicine. 329:190–193.

Martini, F, et al. (2006). Fundamentals of Anatomy & Physiology, 7th edition. Pearson. San Francisco.

Public Health Agency of Canada. (2013). Chief Public Health Officer's Reports on the State of Public Health in Canada. Available from: http://www.phac-aspc.gc.ca/cphorsphc-respcacsp/index-eng.php. Accessed on December 1, 2013.

Rampersaud, G., Pereira, M.A., Girard, B.L., Adams, J., Metzl, J.S. (2005). Breakfast habits, nutrition status, body weight, and academic performance in children and adolescents. Journal of the American Dietetic Association. 105(5): 743-760.

Ross, C.A., et al. (2011). The 2011 report on dietary intakes for calcium and vitamin D from the institute of medicine: what clinicians need to know. Journal of Clin Endocrinol Metab. 96(1): 53-58.

Sabinski, A. S., Toft, U., Klaus, A. K., Inge, T. (2013). Validation of a digital photographic method for assessment of dietary quality of school lunch sandwiches brought from home. Food and Nutrition Research. 57. Available from: http://www.foodandnutritionresearch.net /index.php/fnr/rt/printerFriendly/20243/28867. Accessed on June 05, 2015.

Stewart, H., Dong, D., Carlson, A. (2013). United States Department of Agriculture. Why Are Americans Consuming Less Fluid Milk? A Look at Generational Differences in Intake Frequency. Available from: http://www.ers.usda.gov/media/1118789/err149.pdf. Accessed on July 07, 2015).

Sudbury and District Health Unit. (2014). Fruit and veggies welcomes into sudbury area schools.

Available from: http://sdhu.com/content/news/details.asp?n=1339&lang=0. Accessed on September 30, 2014.

Taras, H. (2005) Nutrition and student performance at school. Journal of School Health. 75(6):199-213.

Warren, J.M., Henry, C.J.K., Lightowler, H.J., Bradshaw, S.M., Perwaiz, S. (2003). Evaluation of a pilot school programme aimed at the prevention of obesity in children. Health Promotion International. 18(4): 287-296.

Weber, K., Heinze, K.L., DeSoucey, M. (2008). Forage for thought: mobilizing codes in the movement for grass fed meat and dairy products. Administrative Science Quarterly. (53): 529-567.

Woehrle, T. Fox, S. Hoskin, B. (2001). An examination of the balanced school day schedule. Available from: http://oar.nipissingu.ca/PDFS/V831E.pdf. Accessed on October 5, 2012.

World Health Organization. (2014). WHO opens public consultation on draft sugar guideines. Available from: http://www.who.int/mediacentre/news/notes/2014/consultation-sugar-guideline/en/. Accessed on August 20, 2014.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

5.1 Conclusion

The implications of this thesis comprise two main subjects: school scheduling and the quality of home-packed lunches, as the effects of different schedules on dietary intake, as well as the quality of student lunches. Implications may impact public health interventions, school decision-making by school-boards, principals, and teachers, as well as parents, guardians, providers, and ultimately, packed food and student consumption.

School Scheduling

Major changes to the daily routines of early learners have resulted from the new ELK schedule, yet evidence-based justifications for this new schedule are lacking. In particular, the current curriculum recognizes that children require ample opportunities to eat throughout the day, although they do not explain how the decision came about allowing kindergarten children double the time to consume food than students in grade one onwards.

We sought to understand if this change had any implications on kindergarten students' dietary intake, and the results were in favour of the ELK schedule. Of the students that attended our ELK school, a greater proportion of their packed foods were consumed throughout the school day. This translated into an increased consumption of all macronutrients, vitamins, and minerals. We argue that two twenty minute breaks to consume food are not enough time for adequate energy intake, and may have physiological and academic consequences. If children experience hunger while completing academic-related tasks, memory, concentration, and classroom behaviour may be compromised, and negatively affect academic performance.

Students using the ELK schedule were allowed to access their packed foods throughout the school-day if they were hungry. This additional schedule change may have contributed to the increased lunch consumption for the students using the ELK schedule, as many students took advantage of this policy between the beginning of the day and the first nutrition break. We recommend that this policy be extended to students in grade 3 based on our results and the results of MacDougall et al. (unpublished findings), which showed that students in grade 3 are significantly more likely to report being hungry at the start of the school day than students in grade 6, and are more likely to report that they do not have enough time to eat. By allowing children to access their packed foods when they feel hungry, decision-makers may foster childrens' innate ability to regulate dietary intake.

Our findings can inform public health interventions that aim to decrease student hunger in the classroom, and increase students' academic performance. We recommend parents be educated as to what constitutes a healthy snack to be consumed as a mid-morning snack.

Last, our results indicate that children are choosing to consume a greater proportion of their packed foods during the first nutrition break than the second nutrition break. It is clear that students are hungry during this time. These results support the current mid-morning snack interventions that have been applied to qualifying schools in Northern Ontario, (Sudbury and District Health Unit, 2014) called the Northern Fruit and Vegetable Program. We recommend that such interventions be applied to all junior students in elementary schools, and provide one whole grain product and a fruit or vegetable serving as recommended by Health Canada (2011).

Diet Quality of Student Lunches

The results of the overall diet quality of student lunches can support public health interventions targeting macro and micronutrients. In the present study, AMDRs, DRIs, and Canada's Food Guide assisted us in identifying areas of concern, specifically sugar, fibre, calcium, vitamin D, potassium, and sodium.

Of the total carbohydrates packed in student lunches, we saw an over-representation of sugar, and an underrepresentation of fibre. Interventions should educate parents as to what "school-safe" products are high in whole grains and fibre, and low in sugar. Additionally, we would recommend parents avoid packing pre-packaged treat items such as cookies, pudding cups, and sugar-sweetened beverages to increase the likelihood that children will consume the fibre packed in their lunch.

The calcium and vitamin D content of student lunches was also very low. Participation in a school milk program could help alleviate this issue, and parents should be encouraged to participate in milk programs if available and financially feasible. If not, school nutrition supplementation programs should consider providing milk and milk alternatives to students. Last, the high sodium and low potassium levels found our study are alarming due to their integral role in the pathogenesis of hypertension, CVD, and diabetes, (Horacio & Madias, 2007; Cheung & Li, 2012). Interventions should target low sodium and potassium rich foods (such as vegetables, fruits, and legumes) for school supplementation programs to increase student dietary intake. Again, parents should be advised to decrease pre-packed food items in student lunches to help alleviate this issue.

Future Directions

Although our research questions have been answered, our study is one of the very few to evaluate not only what foods Canadian children bring and consume during the school day, but how school scheduling affects dietary intake. We encourage future studies to build upon our findings and evaluate if Canadian students of all ages are meeting dietary guidelines during the school day. Using our photographic methodology for recording dietary intake, future studies should extend data collection to encompass a full day. As well, when schedule changes are inevitably introduced in schools in the future, we recommend that future studies investigate how such changes affect student dietary intake. Last, quantitative data should be combined with qualitative data, so as to better understand how parents decide what and how much to pack in their child's lunch.

References of Chapter V

Cheung, B. M. Y., & Li, C. (2012). Diabetes and hypertension: is there a common metabolic pathway? *Current Atherosclerosis Reports*, *14*(2), 160–166. http://doi.org/10.1007/s11883-012-0227-2

Health Canada. (2011) Eating well with Canada's food guide - A resource for educators and communicators. Available from:http://www.hc-sc.gc.ca/fn-an/pubs/res-educat/res-educat-eng.php#a14. Accessed August 20, 2014.

Horacio, JA, Madias, NE. (2007). Sodium and potassium in the pathogenesis of hypertension. New Engl J Med. 356(19): 1966-1978.

MacDougall, S, A. Gauthier, B. Jaunzarins, S.C. Dorman. A Survey study on school scheduling: student perceptions of hunger, physical activity and learning engagement. *Submitted Infant, Child and Adolescent Nutrition.*

Sudbury and District Health Unit. (2014). Fruit and veggies welcomes into sudbury area schools. Available from: http://sdhu.com/content/news/details.asp?n=1339&lang=0. Accessed on September 30, 2014.

APPENDICES

List of Appendices:

Appendix A: Data Management Methodology

i. Data Entry Declaration

Charley-Anne A. Horodziejczyk conceptualized the data entry methods and entered student lunch data

Laura J. Thirkill co-led data entry and entered student lunch data.

Desiree D. Duguay assisted with the management of data entry.

ii. NutriBase 11.0 software.

NutriBase 11.0 software is a food and nutrition management program that allows for comparison between individual food items or entire meals with regards to macro and micronutrients. NutriBase 11.0 provides the latest USDA Nutrient Database for Standard Reference, the latest Canadian Nutrient Files, and a proprietary listing of Brand Names foods. It allows for the addition of new food items as well as the management of "personal food items PFI; a function that allowed for common food items to be saved into a separate database that could be accessed conveniently. NutriBase 11.0 also provided the ability to view nutrient data in a spreadsheet view to view data for many food items simultaneously.

iii. Data Management

Within the NutriBase 11.0 program, individual participants were tracked using their participant number as their personal profile. Each student had a total of three profiles for each day of the week: 1. Food items they arrived the school with 2. Food items left-over after break one and 3. Food items left-over after break two. Student lunches were entered into the software by adding each individual food item as indicated by the digital photographs by searching NutriBase 11.0 Canadian Nutrient File; i.e. chocolate chip Bear Paw®, one stalk celery (35g), or 125ml Allens® apple sauce. If the food item was not available in the software's database, the food item's nutrition label was researched and added as a PFI within the software program. Common foods entered frequently were also saved within the PFI file as to be accessed conveniently by research assistants. Any food item that could not be identified via the digital photographs was not entered into the NutriBase 11.0 software.

Data was exported using the NutriBase 11.0 report function and created a profile for each student's Monday – Friday food consumption. Means could then be calculated and compared within and between subjects.

iv. Data Entry

Two researchers entered food items into the software simultaneously allowing for constant communication and to ensure inter-rater reliability. Before entering food items, agreements were made between the two researchers as to which food item would be chosen from the available items from the Canadian Nutrient File. To ensure intra-rater reliability, previously entered data was regularly audited by lead investigator.

Appendix B: Laurentian University Research Ethics Approval

LaurentianUniversity
UniversitéLaurentienne

APPROVAL FOR CONDUCTING RESEARCH INVOLVING HUMAN SUBJECTS
Research Ethics Board – Laurentian University

This letter confirms that the research project identified below has successfully passed the ethics review by the Laurentian University Research Ethics Board (REB). Your ethics approval date, other milestone dates, and any special conditions for your project are indicated below.

TYPE OF APPROVAL / New X / Modifications to project / Time extension	
Name of Principal Investigator and school/department	Laura Thirkill (SHK) Charley-Anne Dinnes (SHK) Supervisors: Sandra Dorman, Alain Gauthier
Title of Project	The Impact of Classroom Scheduling on Student Health
REB file number	2013-02-13
Date of original approval of project	March 8, 2013
Date of approval of project modifications or extension *(if applicable)*	
Final/Interim report due on	March 8, 2014
Conditions placed on project	Final report due on May 31, 2014

During the course of your research, no deviations from, or changes to, the protocol, recruitment or consent forms may be initiated without prior written approval from the REB. If you wish to modify your research project, please refer to the Research Ethics website to complete the appropriate REB form.

All projects must submit a report to REB at least once per year. If involvement with human participants continues for longer than one year (e.g. you have not completed the objectives of the study and have not yet terminated contact with the participants, except for feedback of final results to participants), you must request an extension using the appropriate REB form.

In all cases, please ensure that your research complies with Tri-Council Policy Statement (TCPS). Also please quote your REB file number on all future correspondence with the REB office.

Congratulations and best of luck in conducting your research.

Susan James

Susan James, Acting chair
Laurentian University Research Ethics Board

Appendix C: Qualitative Nutrition Log

QUALITATIVE NUTRITION LOG

ELK RL

TIME	STUDENT COUNT	NOTES
9 - 11 am *Learning block #1*		
11-11:40 am *Nutrition break and indoor playtime*		
11:40-1:10 am *Learning block #2*		
1:10-1:50 am *Nutrition break and indoor playtime*		
1:50-3:10 *Learning block #3*		