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The LUNCHES Study: Elementary School Children's Packed Lunch Contents and Intake in the Traditional vs. Balanced School Day Schedule

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

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by

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Abstract

The Balanced School Day (BSD), an alternative to the Traditional Schedule (TS), provides two 20-minute eating periods during the school day, rather than a midday lunch break. Widespread implementation of the BSD schedule has occurred across Ontario with limited systematic evaluation of potential health outcomes. The purpose of this study was to compare the food and nutrient value of grade 3 and 4 students' packed lunch contents and consumption in the BSD versus TS, by direct observation. When compared to the TS, more BSD students had a sugar-sweetened beverage packed in their lunch. Greater portions of snack items were also packed and consumed in the BSD. Correspondingly, children in the BSD consumed more energy, carbohydrates, saturated fatty acids, total sugar, and percent energy from total sugar than in the TS. These findings suggest the BSD may negatively affect the quality of packed lunches, increasing the risk of adverse health outcomes.

Keywords

School schedule, elementary schools, packed lunches, child, food intake, and nutrient intake.

Co-Authorship Statement

Dr. Paula D.N. Dworatzek, and Dr. Marina I. Salvadori conceived the idea of the LUNCHES ("Let's Understand Nutrition and Children's Health in Elementary school Schedules") research study. Dr. Paula D.N. Dworatzek, Lesley A. Macaskill, and Dr. Steve M. Killip were involved in the design and development of the study, and Dr. Paula D.N. Dworatzek obtained funding through a grant from the Canadian Institutes of Health Research (POH-123776). Dr. Steve M. Killip approved the study with the Thames Valley District School Board and initially contacted schools requesting their participation. Annual observer training sessions were conducted by Lesley A. Macaskill, Navreeti Sharma, Lisa J. Neilson and Jonathan M.H. Luk. It is important to acknowledge and thank the many observers, upper year undergraduate food and nutrition students, who participated in data collection and data inputting. Navreeti Sharma, Lisa J. Neilson, and Jonathan M.H. Luk oversaw coordinated data collection and data inputting. The data were then cleaned by Lisa J. Neilson and Jonathan M.H. Luk. In fulfilment of her master's work, Lisa J. Neilson conducted all statistical analyses and wrote the two manuscripts contained within this thesis. Dr. Jamie A. Seabrook and Dr. Paula D.N. Dworatzek provided guidance regarding statistical analyses and data interpretation. Dr. Paula D.N. Dworatzek was also instrumental during the editing process, providing detailed advice on all methodologies, data interpretation and presentation of results.

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Chapter 1

1 Introduction and Research Objectives

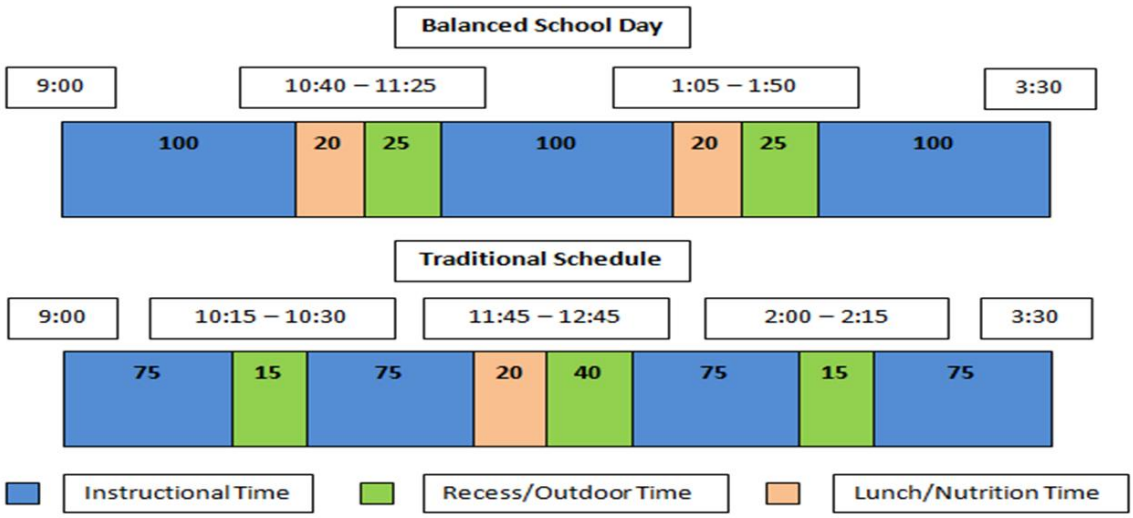
Schools have been recognized as important environments for promoting healthy eating behaviours through school policies, developing food knowledge and skills and providing access to healthy foods (1,2). The structure of the school day, including the length and timing of breaks, has also been identified as a potential influencer of food intake at school (1). The traditional morning and afternoon recesses, with a mid-day lunch break, have been the longstanding scheduled breaks from instructional time in many North American elementary schools (3). However, a new school timetable, labelled the Balanced School Day (BSD) schedule, has recently been implemented in numerous Ontario and Canadian schools (4,5) and provides a greater amount of time for eating during two scheduled breaks (3,6). Building healthy eating habits early in childhood can protect against the risk of obesity and development of chronic diseases later in life (7–9). Given the rates of childhood overweight and obesity remain elevated in Canada (10), assessment of the potential influence of the BSD schedule on consumption at school is essential. The purpose of the present study was to utilize a valid and reliable direct observation methodology to identify if there are differences in the food and nutrient value of grade 3 and 4 children`s home-packed lunch contents and intake in the BSD compared to the traditional elementary school schedule (TS).

1.1 The Balanced School Day

The BSD schedule was created as an alternative to the TS and consists of two 45-minute breaks (1,3,6,11). These two breaks are often referred to as ‘nutrition breaks’ that split up three 100 minute blocks of instructional time (1,3,11). Each ‘nutrition break’ provides 20 minutes for eating, 20 minutes for outdoor time/extracurricular activities, and 5 minutes for transition (e.g., use of the washroom, preparation for outdoors) (1,3,11). The total time allotted for breaks remains constant between schools, but there may be variations in timing or order of activities (11). Figure 1.1 illustrates an example of a BSD timetable and compares the new schedule to the TS timetable. The first 20 minutes of

each break is generally reserved for eating, while outdoor activity occurs during the second half of each break; however, the order of eating and outdoor activity has been reversed in some schools. This is in comparison to the well-established TS, which includes three breaks splitting up four 75 minute blocks of instructional time. The TS breaks consist of one 60-minute lunch period in the middle of the school day, during which 20 minutes is dedicated to eating, along with 15 minute mid-morning and mid-afternoon recesses for physical activity (Figure 1.1) (3). At some TS schools, the 10 minutes of class time prior to recess breaks is dedicated to food intake; however, this depends on each individual teacher, as there are no standardized policies for mid-morning or mid-afternoon snacks.

Figure 1.1. Balanced School Day Schedule Compared to the Traditional Schedule



In 2000-2001, the BSD schedule was created at Caledon East Public School (CEPS) in the Peel District School Board (PDSB) (3). The change made to the structure of the school day at CEPS was staff-driven and tailored for the needs of the school (3). Previous modifications to the school schedule had been made during provincial standardized tests, resulting in noted improved success rates (3). This success drove the implementation of the BSD schedule to provide large blocks of uninterrupted instructional time and additional opportunities for extracurricular activities during school hours to cater to a student population that was largely bussed to school (3). This change was not externally mandated and, although it was based on sound rationale, it was

implemented without the support of systematic research and scientific evidence (3). This becomes concerning when other schools and school boards implement this structural change based on the experience of one school setting, for which the change was specifically designed (3). Since 2001, the new schedule has been accepted and implemented by many schools (i.e. in Niagara, Thames Valley, Hamilton-Wentworth, Ottawa-Carleton, and Trillium Lakelands regions) and school boards (i.e. Avon Maitland (12), Grand Erie (13), Waterloo (14,15), Rainbow (16), Halton (17) and Hastings and Prince Edward (18–20)) in Ontario. System-wide implementation of the BSD schedule typically occurs following a pilot of the new schedule in a few self-selected schools, as in Halton and Waterloo (15,17). According to the research paper released by the Ottawa-Carleton District School Board (4), as of 2008, at least 13 Ontario school boards had implemented the BSD schedule in some or all of their schools. The BSD schedule is not as established in other provinces, but implementation is likely to increase. In 2006, the Interlake School Division in Manitoba piloted the BSD schedule in 5 elementary schools, and then implemented the schedule in all schools the following year (21). As of 2010, at least ten other Manitoba school districts reported having schools following the BSD schedule (5). More recently, the BSD schedule was piloted in two Manitoba elementary schools in the Seven Oaks School Division during the 2012-2013 school year (22,23). In Alberta, the BSD schedule is also being piloted during the 2013-2014 school year in one school within the Holy Spirit Catholic School Division (24). The spread of the BSD schedule across Ontario and Canada is difficult to capture, as the BSD schedule is not a mandated government policy or legislation and formal surveillance or evaluation is not in place.

A policy surrounding the implementation of the BSD schedule exists in the Thames Valley District School Board (TVDSB) (25). Prior to implementation, schools who wish to transition to the BSD schedule must provide information sessions to the teachers, school council members and parents (25). Surveys are then distributed to the parents of the whole student population. Implementation may only proceed if 75% of the distributed surveys are returned, with 80% of the responses indicating agreement with the suggested timetable change (25). Only then can the BSD schedule be piloted at the beginning of the next school year in September (25). After the BSD schedule has been in

place for four months, a second parental survey is distributed to ensure parental support for the new schedule still exists (25). A potential result of this policy may be a greater number of low-income schools implementing the BSD schedule. Low-income parents may have less time to attend information sessions, and may be more likely to agree to the new school schedule on the parental survey if the survey contains purported benefits of the new BSD schedule. However, to our knowledge, research has not yet assessed this potential concern.

The positive impact on the learning environment at school, due to 100-minute uninterrupted blocks of teaching time, is frequently referred to as the main benefit of the BSD schedule (11,13,15,16,21–24,26–28). Literacy for Learning Guidelines, created by an expert panel and financially supported by the Ontario Ministry of Education, encourages longer continuous blocks of classroom instructional time to allow for varied and interactive teaching methods, and has been used as a source to support the school structure change (27,29). However, systematic evaluation of this potential benefit has yet to occur. Additional purported advantages of the BSD schedule include less time lost in transition (11,15,27,30,31), reduced playground behavioural problems (3,11,15,23,24,26,27,31), greater length of time for eating (3,15,31), improved focus in the classroom (3,11,16,24,26,30–32), improved quality of physical activity (15,16,21–23,30–32), and improved healthy eating (3,13,15,16,21,23,24,30–33). Many Ontario schools and school boards have indicated that the two breaks offered by the BSD schedule are consistent with research recommending children should consume small frequent meals throughout the day (13,21,24,27,32). Health Canada does recommend children need small nutritious meals and snacks throughout the day (34); however, the benefit and the impact of having two time periods for eating at school is currently unknown (31).

CEPS staff indicated the creation and implementation of the BSD schedule was based on Brain Compatible Learning Research, although individual literature sources were not provided (3). Schools have continued to use this brain compatible research as evidence that the BSD schedule provides a structure that promotes optimal learning through fulfilling nutritional and exercise needs, and providing the opportunity for

multiple teaching techniques (13,26,27). However, rather than specifically addressing nutritional needs, brain compatible research is based on educational psychology and cognitive neuroscience research focused on key learning environment features, such as classrooms that feel safe yet challenging, early specification of teacher expectations, connecting novel concepts to previous experiences, and the use of learning strategies directly involving students in order to promote understanding and retention (35–38). The use of brain compatible research to persuade parents to support the implementation of the BSD schedule could be perceived as misleading, as this research does not specifically define the ideal school day schedule to foster optimal food intake and learning.

Despite numerous purported positive learning and health impacts commonly cited as support for the BSD schedule, resources and budgetary concerns influenced the accelerated implementation of the BSD schedule in all schools within one district (15). The BSD schedule was proposed by the school board as the best solution to provide a 40-minute lunch break for teachers, to meet the terms of the Collective Agreement, without incurring a drastic increase in expenses to provide necessary student lunch supervision (15). Although this is not an unsuitable reason for implementing the BSD schedule, concerns do arise, as there has been a lack of evidence supporting the connection between the BSD schedule and improved learning and health behaviour outcomes.

1.2 Evaluation of the Balanced School Day

There is a limited amount of systematic evaluation of the impact of the BSD schedule post implementation. Evaluation of the BSD schedule has largely been conducted by individual school boards, using surveys and/or focus groups to collect perceptions of the impact of the BSD schedule from stakeholders, including principals, teachers, parents/caregivers and students (11,30,32,39). Observational data and tracking of discipline referrals were used by the Hamilton-Wentworth District School Board evaluation to support subjective evidence collected (11). The majority of these evaluations targeting stakeholder perceptions of the BSD schedule have not been published, with the exception of one, which was published in a peer-reviewed university journal (32). We identified one thesis research project that assessed potential obesity risk factors including physical activity, fruit and vegetable consumption, and family meal

patterns, while comparing two school boards: one with wide spread implementation of the BSD schedule and the other following the TS with one school piloting the new school BSD schedule (40). To our knowledge, there are only two research studies published to date, both conducted in the same two Sudbury elementary schools, looking at specific health impacts (i.e. physical activity and nutrition) of the BSD schedule (41,42).

1.2.1 Survey Evaluations

Survey evaluation of the BSD schedule has taken place at schools in the Ottawa-Carleton District School Board (OCDSB) (30), Halton District School Board (HDSB) (39), and Hamilton-Wentworth District School Board (HWDSB) (11), as well as one school in Southern Ontario (32).

The two separate evaluations conducted in eight HDSB elementary schools and two OCDSB elementary schools, following the implementation of the BSD schedule, produced similar findings (30,39). The results indicate teachers perceive an improvement in student learning, observe a decrease in time lost from transition, and tend to be more supportive of the new BSD schedule compared to parents and students (30,39). Parental perceptions of the effects of the BSD schedule on food intake, absenteeism, and focus during the school day were not included in the HDSB evaluation, as parents either withheld their answers or provided a neutral response to questions regarding the BSD schedule (39). OCDSB parents indicated some concerns surrounding the BSD schedule, including maintenance of student concentration in longer teaching blocks, and adequate time for lunch and outdoor physical activity (30). Only 55% of HDSB students indicated they perceived the BSD schedule as an improvement from the TS, compared to 80% of teachers and 59.2% of parents (39). Similar results were found in the OCDSB, with 57% of students being dissatisfied with the new BSD schedule (30). The HDSB evaluation was conducted 7 months following the implementation of the BSD schedule and is one of the few evaluations to provide the survey questions with the executive summary. Only two closed-response survey questions, posed to both students and parents, related to eating. The first question was related to the consumption of all lunch food items during school hours, while the second inquired about going home for lunch. Given the wording of the questions it was difficult to assess previous lunch packing and consumption

behaviours; however, fewer students reported going home for lunch following the implementation of the BSD schedule (9% vs. 16%) (39). The survey utilized in the OCDSB's evaluation was adapted from the HWDSB survey tool, and was administered to parents and teachers pre-implementation of the BSD schedule and to parents, teachers and students 1 year post implementation (30). The majority of teachers perceived the type and quantity of foods students' were consuming was better following the BSD schedule than TS; however, parental perspective of the impact of the BSD schedule on reducing children's hunger level was mixed between schools (30). Parents in one of the elementary schools surveyed, Le Phare Elementary School, viewed the BSD schedule as having no effect on their child's hunger level, while a similar number of parents in the second elementary school surveyed, Viscount Alexander P.S., perceived their child's hunger to be better controlled in the BSD schedule (40% vs. 46%) (30). It is also noteworthy that the two OCDSB schools differed in both scheduling and type of instruction provided (French Immersion vs. English program/core French), which may impact interpretation of the differences reported (30). Overall, both evaluations found students were the least satisfied with and supportive of the new schedule change, while teachers perceived many positive benefits from the new BSD schedule.

The HWDSB study took place over two years academic years (2002-2003 and 2003-2004). During the first year of data collection two BSD schools were compared to two TS schools; however, participation expanded in the second year with four BSD schools, four TS schools and one school that transitioned from the TS to the BSD schedule during the study time period (11). This evaluation is thought to be more rigorous than previous evaluations of stakeholder perspectives as it included tracking of discipline referrals to the office, monthly observations of playground aggression, transition time, and classroom on and off task behaviour during the last period of the school day, in conjunction with survey data (11,40,43). Observers received eight hours of training and used an observational coding system (11). The BSD schedule showed improvement in school cleanliness (4.1 vs. 3.0 in the BSD vs. TS, on a 5-point perception scale), and organization of instructional time (3.7 vs. 3.1 in the BSD vs. TS, on a 5-point perception scale), while there was a reduction in overall transition time as fewer transitions needed to occur during the school day (9.7 vs. 13.2 min/d in the BSD vs. TS)

(11). However, stakeholder perspectives were mixed regarding eating time, outdoor time, and teacher planning and supervision time (11). Significantly more junior TS students indicated they had more time to play outside (54 vs. 41% in the TS vs. BSD, $p<0.05$, respectively), while intermediate students in the BSD schedule had a more positive response when asked about the amount of time they had to spend outdoors (3.5 vs. 3.1 in the BSD vs. TS, on a 5-point perception scale, $p<0.05$, respectively) (11). Only 54% of parents with children in the BSD schedule indicated their child had enough time for physical activity during breaks, whereas 81% of teachers reported the two outdoor breaks were sufficient (11). Significantly more junior students in the TS indicated they felt they had enough time to each lunch (3.8 vs. 3.4 in the TS vs. BSD, on a 5-point perception scale, $p<0.05$, respectively) (11). Yet, half of all of the parents surveyed, in both the TS and BSD schedule, believed their child had enough time to eat (11). Similarly, teachers in both schedules had mixed views regarding the adequacy of the time provided to their students to eat (11). TS teachers reported they had significantly more supervision duties per day (5 vs. 4 times in the TS vs. BSD, $p<0.05$, respectively), while BSD schedule teachers reported they had significantly more supervisory duty minutes per week (115 vs. 90 min/week in the BSD vs. TS, $p<0.05$, respectively). In reality, the total minutes of supervision were reduced in the BSD schedule, as indicated by BSD principals and timetables (80 vs. 90-120 min/week in the BSD vs. TS).

There was no significant difference between school schedules in the HWDSB with regard to perceptions on student learning, and student concentration. Parents with children in the BSD schedule indicated the schedule had a positive impact on student learning, while 63% of BSD schedule teachers and 70% of TS teachers reported no change in student achievements (11). BSD schedule teachers perceived their students' concentration during the longer teaching blocks as significantly better (3.5 vs. 2.4 in the BSD vs. TS, on a 5-point perception scale, $p<0.05$, respectively); however, observation of on and off class behaviour during the last period of the day was not significantly different between schools, although there was a trend towards less off task behaviours in the BSD schedule (11).

No significant difference was found between schedules in the HWDSB concerning the number of aggressive playground and hallways behavioural incidents and disciplinary referrals to the office (11). Overall satisfaction of the BSD schedule was rated the highest by principals (4.8 on a 5-point satisfaction scale), followed by caretakers (4.1), parents (3.6), teachers (3.5), secretaries (3.3), and lastly students (3.0 junior students and 2.9 intermediate students)(11). The same pattern was observed when participants were asked if the BSD schedule should continue the following year, with 100, 76, and 75% of principals, parents, and teachers, respectively, supporting the continuation of the BSD schedule (11). The researchers recommended that principals interested in implementing the BSD schedule should do so slowly and monitor outcomes due to the lack of strong evidence supporting or refuting the BSD schedule (11). The HWDSB has recently released a summary of current BSD schedule literature, and acknowledged that the continued small number of evaluations and studies of the BSD schedule prompted them to support their previous recommendation of taking time to implement the BSD schedule and tracking multiple outcomes during and after the transition (44).

A qualitative study, utilizing questionnaires and focus groups, sought the perceptions of teachers, in a southern Ontario elementary school, regarding the impact of the BSD schedule (32). Questionnaires were distributed prior to the implementation of the BSD schedule and at the end of the first academic year of implementation. Focus groups were conducted two months and five months post implementation of the new schedule, with the same questions posed at each time point. Following the implementation of the BSD schedule, questionnaire and focus group results demonstrated teachers perceived a significant increase in student focus in the afternoon, more time to complete work in class, and better use of outdoor time for meaningful physical activity (32). In addition, focus groups revealed teachers valued the longer teaching blocks allowing for interactive teaching methods delving deeper into curriculum topics. During the first focus group session, teachers viewed the nutritional intake of students as improved; however, the following focus group session revealed a perceived decrease in consumption of healthy foods, which they attributed to a decrease in healthy lunch

promotion by the school administration (32). At the end of the last focus group, all participating teachers indicated they would not want to go back to the TS (32).

Overall, the current array of survey response data from teachers, students and parents involved with the BSD schedule provides insight into the perceived impacts the new schedule has on student learning, behaviours, nutrition, and physical activity. Compared to students and parents, teachers tended to be more supportive of the new schedule and perceived more positive effects of the BSD on their students' academic achievement, nutrition, and physical activity. However, further research is needed to provide systematic and concrete evidence of the benefits or drawbacks of the BSD schedule, with regard to academic and/or health outcomes, to support informed decision making by school administrators concerning the implementation of the BSD schedule.

1.2.2 Assessment of Potential Health Impacts

Horbul (40) was the first to assess the potential impact of the balanced school day on food and activity behaviours in a thesis format. The purpose of the study was to determine if the BSD schedule promotes a healthy school environment by looking at food intake, physical activity, and food and meal behaviours by using the Youth Food and Physical Activity Behaviour Survey developed at the University of Waterloo (45,46). Grade 6 students (n=339) from 20 schools within three school boards following the TS, in the northern Ontario Porcupine Health Unit region, were compared to one school following the BSD schedule in the Porcupine Health Unit region, and 389 grade 6 students in a southern Ontario school board following the BSD schedule (40). Data from the southern Ontario school board were provided by the University of Waterloo and were collected during the same academic year (2005-2006). The data collection tool was a web-based survey consisting of a 24-hour recall of the previous day's intake, food frequency questionnaire (FFQ), and questions related to food and mealtime behaviours. The data collection tool has been tested for validity and reliability by comparing survey results to direct observation during a lunch break, 24-hr recalls administered by a Registered Dietitian, and test-retest reliability of the FFQ (45). Very few of the 200 variables analyzed were significantly different between the TS school boards and BSD board. Yet, significantly more boys in the TS than the BSD schedule did not meet the

lower end of the daily recommended fruit and vegetable serving range in the 1992 Canada's Food Guide (88% vs. 71%, $p<0.05$, respectively). Relative to the TS students, fewer girls in the BSD were below the Estimated Average Requirement for folate (54% vs. 69% in the BSD vs. TS, $p<0.05$, respectively), more BSD students reported always receiving vegetables with dinner at home (52% vs. 38% in the BSD vs. TS, $p<0.05$, respectively), more boys and girls in the BSD reported consuming breakfast daily (90% and 79% vs. 70% and 63% in the BSD vs. TS, $p<0.05$, respectively), and fewer BSD students reported eating lunch at home (13% vs. 36% in the BSD vs. TS, $p<0.05$, respectively) (40). There was no significance between the two school schedules with regard to the percentage of overweight and obese students, energy intake, snack food and pop consumption, watching TV during meals, and consuming meals with a family member daily (40). The author concluded that the BSD students portrayed more health-promoting behaviours that could reduce the risk of overweight and obesity by highlighting two variables that showed significance: increased reported vegetable and fruit intake, and daily breakfast consumption (40). The author acknowledged that the differences may have occurred due to the location of the schools rather than the school schedule; however, the author speculated that the BSD schedule has the potential to be health promoting, as more time dedicated to eating appeared to promote a focus on eating rather than rushing to get outside for outdoor time (40). Notably, participant fatigue could have occurred as the survey took 30-45min to complete, and required students to be cognisant of the portion and type of food items consumed in the past 24-hours, and for the FFQ, the past year. Data from 47 students (12%), attending schools within the Porcupine Health Unit Region, were excluded from analysis due to extreme food consumption values (40). Literature looking at the accuracy of self-reported dietary intake of fifth graders has shown pre-coded retrospective questionnaires, as in FFQ, result in the addition of items not actually consumed (47). Social desirability could have also resulted in the underreporting of perceived unhealthy foods, as 20% of girls and 15% of boys in the TS schools, and 27% of girls and 18% of boys in the BSD schedule reported consuming less to lose weight (40). It is noteworthy that the 1992 version of Canada's Food Guide (CFG) was used as the standard for comparing food group intakes. Thus, the proportion meeting CFG recommendations for vegetables and fruit is overestimated as

the minimum recommended servings was one serving below the current recommendations (40). It would be difficult to draw concrete conclusions regarding the impact of the BSD schedule on dietary intake due to the potential risk of error and underreporting. To our knowledge, this study has not yet been published in a peer-reviewed journal.

In a study conducted by Gauthier et al. (41), physical activity measurements were collected from pedometers worn by 117 grades 3 to 6 students from two Sudbury, Ontario elementary schools following different schedule structures (i.e., BSD and TS). The authors expected a large percentage of daily physical activity would occur at school, as students spend a large proportion of their waking hours in a school setting; however, the average step count for both schools was less than half the amount of steps recommended for 6 to 12 year olds to result in positive health benefits (i.e., 12,000 steps per day) (48). Students on the BSD schedule took significantly fewer average steps compared to students on the TS (6017 vs. 6788 steps, $p=0.03$, respectively) (48). Total outdoor time in the typical BSD schedule is less than that in the TS (50 vs. 70 minutes) (31), which is likely contributing to fewer steps being accumulated in the BSD schedule. The common claim that the BSD improves physical activity is not reflected in the results of this study (48).

This same research group also studied the nutritional impact of the BSD by getting 117 participating grade 3 to 6 students to record the contents of their lunch on four separate days (42). Students were required to remove all of their food and beverage items from their lunch, and digital images were taken of the items for the purpose of capturing brand names and nutrition facts tables (42). This methodology has the potential to influence intake, as a child may have never considered consuming certain food items in their lunch bag until visually reinforced on the day of data collection (e.g., vegetables or fruit). Students recorded their intake by identifying if they had eaten all, half, or none of each food item in their lunch (42). The authors did not indicate if additional digital images were taken following consumption. Participant data were then entered into a nutrient database, relying on manufactures information from nutrition facts labels (42). The only statistically significant difference between the two schedules, based on what

was packed in the students' lunches, was an increase in the number of beverages brought by students attending the BSD school (1.42 vs. 1.18 items, p=0.04, respectively) (42). Yet, a higher number of beverages brought by BSD students did not translate into more calories consumed from beverages in the BSD (42). This may be related to BSD students declining to consume the total volume of the beverages packed in their lunches, as there was no significant difference in the total volume of beverages consumed by students in each of the two school schedules (42). Similarly, the total number of calories consumed did not significantly differ between school schedules or grade categories (i.e., grades 3/4 vs. grades 5/6) (42). The response rate of 81% was high, yet 117 students from two schools may not have been a large enough sample size to detect a difference in calories between the school schedules. Calories consumed from protein, carbohydrate, fat, as well as grams of carbohydrate, fibre, and sugars were also not significantly different between schedules, grade categories, or sexes (42). Accuracy of consumption, however, may have been reduced by the three broad self-reported categories from which students had to choose ("ate it all", "ate half", or "did not eat it"). Likewise, vitamin and mineral intake were not significantly different between schedules, grade categories, or sexes (42).

While the authors of this study did publish a paper on the inter-rater reliability of their method (49), there remain questions about the accuracy or validity of asking students to self-report their food consumption based on three categories of intake, as mentioned above. Furthermore, it is not clear from the Dorman study if they relied solely on manufacturer data, as provided in nutrition facts panels, but certainly it would not have provided a detailed nutrient profile of food items, because only four vitamins and minerals are required, including vitamin A, vitamin C, calcium, and iron.

Current comparisons of nutrition intake in the BSD schedule to the TS do not appear to show any differences, although the number of evaluations is limited and there are some methodological concerns. We maintain that the structural change to two 20 minute sit down eating periods, rather than one, has the potential to impact children's food intake. Parents planning for two eating periods may be prone to pack two meals or fill the additional perceived need by packing extra snacks and beverages, which could contribute excess intake of calories, fat and sugar. The long-term nutritional impact of the

BSD schedule remains unknown, which warrants the need for research with rigorous methodology to identify if there is a difference in the nutrient content, and type and quantity of foods being packed and consumed in the BSD versus the TS. Lafleur (3), in his 2004 paper at the Canadian Society for the Study of Education, summarizes the situation well: “Given the limited research to support early adoption of this change, it is imperative that early implementation efforts be carefully documented and that the existing research literature be carefully interrogated to identify positive connections and possible pitfalls with the balanced school day”.

1.3 Packed Lunches in Elementary Schools

In 2011, the American Dietetic Association recommended children enrolled in four to seven hour day-care programs consume at least one third of their daily nutrition requirements during the program (50). This time frame is comparable to the average length of an elementary school day in the Province of Ontario, which is between six to seven hours with a minimum of five hours of instructional time (51). At the same time, overweight and obesity continues to be a serious health problem among Canadian children, with approximately 31.5% of children ages 5 to 17 years classified as overweight or obese in 2009 to 2011 (10). Therefore, the elementary school environment has been recognized as an important setting for health promotion, and nutrition policies to improve children’s dietary intake and reduce their risk of obesity (52).

Many provinces have specific school nutrition policies aimed at supporting a healthy eating environment (53), including the Policy/Program Memorandum No. 150: School Food and Beverage Policy (PPM 150) in Ontario. PPM 150 was developed by the Ontario government and the policy was enacted in Ontario schools at the beginning of the 2011 school year (54). PPM 150 is a set of nutrition criteria for food and beverage products sold in publicly-funded elementary and secondary schools in Ontario (54). This policy has the potential to influence students’ attitudes and behaviours, while also prompting food service providers to reformulate their products to meet policy standards. Conversely, there has been limited published data on the implementation of PPM150 in school. This raises concern, as evaluation is an important component of program planning and the data collected can guide revisions to result in improvements and better outcomes

(55,56). Evaluation of the school meal guidelines in the UK revealed few schools were adhering to the 2001 guidelines, which led to changes to promote adherence and improve the quality of food and beverages being provided by schools (57–59). A small number of evaluations have been conducted to obtain the perspectives of stakeholders affected by the implementation of PPM 150, including food service companies (60) and school faculty (i.e., principals, vice principals and teachers) (61). One extensive evaluation of the impact of PPM 150 on children's eating patterns in the Region of Peel took place during the 2012 to 2013 school year. The results of the evaluation were presented at a recent Canadian dietetic conference, and demonstrated how accessibility of competitive foods, from food outlets located off of school property, may impact the effectiveness of the new policy on older adolescents (62). It stands to reason that PPM 150 likely has the potential to have a greater impact on secondary schools as the majority of elementary schools in Ontario do not have functioning cafeterias, and Canada does not have a national school food program. Consequently, home-packed lunches are more prevalent in Ontario elementary schools, with the option of adding food and beverage items from volunteer-run school milk, snack and/or breakfast programs, as well as occasional hot lunch days through outside caterers.

Studies from the U.K., U.S.A., Denmark, New Zealand and Canada have demonstrated that children's home-packed lunches need improvement in terms of nutrients and food items.

In 2001, government mandated food-based guidelines for meals provided by schools were implemented in U.K. primary and secondary schools (57,63,64). Nutrient standards for school meals, produced by the Caroline Walker Trust working group, existed up until this time, but were not statutory (63). A national survey in 2005 demonstrated schools were failing to meet the mandated food-based guidelines, with only 23% of primary schools meeting all of the guidelines for 5 consecutive days (57,58,63). The results of this survey, along with growing public awareness, led the government to agree to set new nutritional standards for school meals, and provide additional funding to schools (63). Food-based standards for lunches provided by schools were updated in 2005 and became mandatory in 2006 (63–65). Compulsory nutrient-based standards for

14 nutrients were subsequently implemented in 2008, to be used in conjunction with the food-based standards (57,58,65,66). Despite the availability of school provided meals in the UK, approximately 60% of students bring a home-packed lunch to school. Notably, the new food-based and nutrient-based standards do not apply to home-packed lunches brought to school for consumption. As a result, many studies have compared school meals to home-packed lunches, but only one study to date, conducted by Pearce et al. (66), has collected data in primary schools following the implementation of the new food-based and nutrient-based standards. Weighed food records, conducted by trained fieldworkers, were used to assess dietary intake of 10,002 students, from 136 primary schools, ages 4-12 years; 6,580 of whom received a school lunch and 3,422 who brought a home-packed lunch (66). Students with a home-packed lunch consumed a greater number of drinks, confectionery, meat products, and snacks restricted in food-based standards due to high fat, sugar or salt content (66). Correspondingly, mean intake of sugar and sodium, and percentage energy from saturated fat were significantly higher in packed lunches when compared to school meals (18.1g vs. 12.0g; 626.9mg vs. 443.3mg; 12.7% vs. 10.9%; all differences $p \leq 0.001$, respectively), and exceeded school nutrient recommended values (66). Although intake from both school meals and packed lunches met nutrient-standards for percentage energy from fat, the mean percentage energy from fat was significantly higher in packed lunches than school meals (33.9% vs. 28.7%, $p \leq 0.001$, respectively) (66). Higher intakes of calcium and vitamin C were observed from home-packed lunches versus school lunches (211.6mg vs. 167.5mg, and 25.9mg vs. 17.3mg; all differences $p \leq 0.001$, respectively), as fruit, fruit juice and dairy products were consumed more often from packed lunches (41% vs. 36% of lunches contained all three items) (66). In addition, students with school lunches consumed vegetables more often and consumed larger portions of fruit and vegetables per day than those with home-packed lunches (1.6 portions vs. 1.0 portion) (66). It is not surprising that studies conducted prior to the introduction of the 2006 food-based standards and 2008 nutrient-based standards found both school meals and packed lunches were in need of improvement (57,67,68). Yet, home-packed lunches still provided more savoury snacks, confectionery items, and energy from saturated fat and sugar, while providing fewer vegetables when compared to school meals (57,67,68). Gatenby (63), Evans et al. (65),

Harrison et al. (64), and Rees et al. (58) all collected data following the implementation of food-based standards, but before the implementation of compulsory nutrient standards; the results of these studies were similar to those found by Pearce et al. (66). Rees et al. (58) utilized direct observation to compare consumption of school meals to home-packed lunches in 120 students ages 6-11 years during 2006. Nutrients were compared to upcoming nutrient-base standards to provide baseline data for future studies. Intake of energy, protein, and energy from carbohydrates were similar between students consuming school meals and packed lunches (440kcal vs. 480kcal; 18g vs. 18g; 33% and 34%, respectively) (58). Yet, packed lunches had significantly more saturated fat (7.2g vs. 5.3g, $p=0.021$, respectively), sodium (834mg vs. 542mg, $p<0.001$), calcium (295mg vs. 124 mg, $p<0.001$), iron (2.2mg vs. 1.8mg, $p=0.016$), and twice as much energy from sugar (22% vs. 11%, $p<0.001$) than school meals (58). Confectionary, cakes, and biscuits were the main contributors of saturated fat and sugars in packed lunches, with 10% of students consuming more than one of these items from their packed lunch (58). In addition, only 8% of students with a packed lunch consumed a portion of vegetables compared to 81% of students who consumed a school meal. Intake of sodium from both home-packed lunches and school meals significantly exceeded school nutrient-base standards, while iron intake in both schedules failed to meet recommendations (58). Corresponding to the findings of Pearce et al. (66), intake of dairy products (i.e. cheese and yogurt) from home-packed lunches was identified as the source of calcium contributing to intakes exceeding school nutrient-base standards, while students intake of calcium from school meals fell below recommendations as they rarely selected the dairy food options available (58).

The National School Lunch Program (NSLP), founded in 1946, offers free or subsidized lunches to American students ages 5-18 years (69). The program has undergone many revisions over the years, as the focus of the program has slowly shifted from undernutrition to overweight and obesity (69). Similar to school meal standards in the U.K., the NSLP does not apply to foods brought from home, vending machines or snacks sold at school (70). The Healthy, Hunger-Free Kids Act of 2010 prompted the United States Department of Agriculture (USDA) to release nutrition standards for snack foods and beverages sold to children during school hours (71); however, these standards

do not apply to snacks that children bring from home or purchase outside of school. When compared to the U.K., little American research has been conducted to document what children are consuming during lunch at school. A study conducted by Hamilton (70) was the first to conduct research in this area, by comparing packed contents and intake of students consuming school meals to home-packed lunches. The weight of food items brought and remaining waste was obtained to determine intake (70). Students consumption from school meals were found to be significantly higher in vitamin D, vitamin B12, pantothenic acid, phosphorus, magnesium, zinc, riboflavin, vitamin B6, folate, and calcium (70). Similar intake of total energy and percentage of energy from fat, carbohydrate, and SFA was found between both meal types, while percentage of energy from sugar consumed was higher from packed lunches. However, caution should be taken when interpreting these results as very few participants brought a packed lunch (19.3%) (70). Furthermore, we cannot find a peer reviewed publication for this work. Conway et al. (72) looked at the food and beverage items provided in American children's home-packed lunches, but did not assess intake. The contents of home-packed lunches (n=1,381) brought by grade 6 to 8 students were assessed using direct observation (72). Participating students were asked to remove the food and drink items from their lunch bags to allow an observer to record the portion size and number of each item present (72). The average home-packed lunch was comprised of 596.2kcal (29.7% from fat), 20.8g of fat, 6.2g of saturated fat, 32.6mg of cholesterol, and 21.3g of sugar (72). Only 5.5% of home-packed lunches contained a portion of vegetables, while chips, snacks, and cookies were found in 28-40% of lunches. Furthermore, less than half of students had a portion of fruit present in their lunch (46.6%). Similarly, Johnston et al. (73) utilized direct observation to compare food and beverage items available to second grade students receiving a school meal or home-packed lunch (n=2,107). Actual portion size and consumption was not assessed, as only the presence or absence of the following foods and beverages were noted: vegetable, vegetable within another food item, fruit (fresh or canned or 100% fruit juice), dairy (yogurt, cheese, milk), high-fat/high-sugar snack (73). When compared to school meals, fruit and dairy items were observed significantly less often in home-packed lunches (45.3% vs. 75.9%; 41.8% vs. 70.0%, respectively), while high-sugar and/or fat snacks and sugar-sweetened beverages were seen significantly more

often in home-packed lunches (60.0% vs. 17.5%; 47.2% vs. 0.3%) (73). Notably, the proportion of fruit intake coming from fruit juice is unknown, as the fruit category in this study encompassed whole fruit, canned fruit, and fruit juice (73). The number of children receiving a portion of vegetables in their home-packed lunch was only slightly higher when compared to the results found by Conway et al. (72) ten years prior. Johnston et al. (73) found vegetables were only present in 13.2% of home-packed lunches, while 29.1% of students with a school meal received a vegetable (73). The differences in both food and nutrient content of home-packed lunches to school meals was explored by Hur et al. (74) utilizing direct observation. Data were obtained from 129 fourth and fifth grade students, and the results obtained corroborate with previously conducted studies (74). Regardless of lunch type, student's lunches did not meet NSLP standards for energy, vitamin A, iron and calcium (74). Consumption of saturated fat in both lunch types exceeded NSLP standards, while students consuming home-packed lunches also exceeded total fat standards (74). Students with home-packed lunches consumed significantly more total and added sugars (36.0g vs. 24.3g; 26.4g vs. 11.5g; both $p<0.001$, respectively), total fat (20.7g vs. 15.6g, $p=0.003$), carbohydrates (70g vs. 54g, $p=0.002$) and vitamin E (3.3mg vs. 1.4mg, $p=0.035$), and their lunches had a higher energy density (1.5 vs. 1.2, $p=0.006$) when compared to students' consumption from school meals. The mean portion of vegetables consumed from home-packed lunches was significantly lower than school meals (0.1 cups vs. 0.5 cups, $p<0.001$, respectively), while fruit and whole grain consumption was significantly higher (0.5cups vs. 0.4cups; 0.23 ounce equivalent vs. 0.002 ounce equivalent; both $p<0.001$)

A study assessing home-packed lunch contents of 626 grade three and four American students was recently published (75). The participating children were asked to empty their home-packed lunch items onto grid paper and divide them into two piles based on when they planned to eat them (75). The left side of the grid paper was items the child planned to eat as a snack during the day, and the right side was for items the child planned to consume at lunch (75). Food inventory checklists were used concomitantly with digital images to capture additional descriptive information regarding the food and beverage items while on site (75). Foods were categorized into beverages, sandwiches, snack foods, fruits (excluding juice), desserts, leftovers, diary foods, and

vegetables (75). Snack items brought from home by students intending to buy lunch at school were the only items included in analysis for those participants (75). Sandwiches (59%), snack foods (42%), fruit (34%), and desserts (28%) were brought and identified as lunch items by a larger proportion of students (75). However, 24% of students did not have a main entrée item (i.e., sandwich or leftover) in their lunch, which resulted in very few of these students having a source of protein at lunch (75). Only 8% of lunches had at least one green/orange/red vegetable, and 3% had a starchy/other vegetable (i.e. potato, cucumber or celery) (75). A large number of lunches (73%) included a beverage, usually water (28%), or a sugar-sweetened beverage (24%) (75). Only 3% of lunches included milk, while 11% of students indicated they intended to buy milk from school during the lunch break (75). The median number of snacks brought by students was two, which consisted of a food item and a beverage item (75). The most commonly observed snack foods were those categorized as snack foods (62%), desserts (35%) or sugar-sweetened beverage (SSB) (35%), while fewer children labelled fruits (30%), dairy foods (10%) and vegetables (3%) as snack items (75). Lunch items were compared to the NSLP food standards, while snack items were compared to USDA Child and Adult Care Food Program (CACFP) requirements (75). Children received a point each time one of their food or beverage items met a requirement in the appropriate food standard recommendations. Only 27% of lunches met three out of five NSLP food standards, and 4.2% of snacks met two out of four CACFP standards (75). However, the results of this study must be interpreted with caution as children may have classified foods differently than their parent intended, and self-report was relied upon for the details of fluid in refillable water bottles and intentions to purchase milk at school (75).

A single study has been conducted in Denmark exploring packed lunch contents and consumption (47), the main focus being to assess recall accuracy of 11-year-old children when using varying retrospective dietary assessment methods (47). Digital images were used as the reference to verify the accuracy of three self-reported methods of assessing dietary intake (47). The results indicated that girls consumed significantly more food items than boys (5.4 items vs. 4.6 items, $p=0.05$, respectively) when dietary intake was assessed using digital images (47). However, the portion size and type of those food items was not disclosed (47). The type and quantity of foods consumed could change the

interpretation of this finding, as girls may be consuming significantly greater fruit and vegetable items instead of sweet and savoury snack items, or smaller portions of a variety of items. A group in New Zealand has also evaluated the quality of home-packed lunches brought by 927 students, ages 5-11 years, utilizing digital images and assessment of food waste bins (76). The types of food items packed and left uneaten in home-packed lunches were presented; however, mean portions packed and consumed were not disclosed (76). A sandwich was the most common food item as it was present in 71% of home-packed lunches (76). Only 16% of home-packed lunches contained a grain/multigrain bread, while 52% have white bread (76). A high percentage of students had a fruit or vegetable packed in their lunch (70%), yet, 32.4% of home-packed lunches did not meet the 2004 UK Food Standards Agency recommendation of two servings of fruit or vegetables in home-packed lunches (76). A cake, biscuit or muffin was present in 45% of children's home-packed lunches; 45% had a granola type bar, 57% had potato chips, and 15% had a confectionery item (76). Three servings of biscuits, cakes, buns, chocolate or candy appeared in most home-packed lunches (76). Food waste data illustrated sandwiches, fruit and vegetables, and dairy items were more likely to be left uneaten than snack and confectionery items high in fat, sodium and sugar (80% vs. 20%) (76).

Only two research teams, Dorman et al. (42) and Taylor et al. (77), have assessed what Canadian children are consuming while at school. The study conducted by Dorman et al. (42) was previously discussed during the overview of current evaluations of the BSD schedule. The study was conducted in Sudbury and composed only of home-packed lunches; mean intakes were not compared to national standards (42). Students consumed on average 654kcal, 58g of sugar, and 1.1 vegetable and fruit servings, based on CFGs definition of a serving (42). Notably, these findings are higher than the results of the American study conducted by Hur et al. (74) (513kcal, 36.0g sugar), as well as two UK studies conducted Pearce et al. (66) (450.2kcal, 18.1g sugar, 1.0 portions of fruit and vegetables) and Rees et al. (58) (480kcal, 28g sugar). The other Canadian children's lunch study was conducted in PEI where all schools have adopted a school food and nutrition policy (SFNP), which impacts the type of foods available for students to purchase while at school (77). Taylor et al. (77) utilized food records to compare foods purchased at school to home-packed lunches consumed by 1,980 grade 5 and 6 students

(9-12 years of age) in 44 PEI elementary schools. Home-packed lunches were higher in energy (383.5kcal vs. 166.3kcal, $p<0.001$, respectively), protein (12.2g vs. 6.84g, $p<0.001$), fat (12.6g vs. 6.2g, $p<0.001$), carbohydrates (56.2g vs. 21.1g, $p<0.001$), sugar (24.1g vs. 11.8g, $p<0.001$), fibre (3.1g vs. 1.04g, $p<0.001$), iron (2.5mg vs. 0.85, $p<0.001$), potassium (412.3mg vs. 281.8mg, $p<0.001$), sodium (758.4mg vs. 266.8mg, $p<0.001$), and a number of other micronutrients (77). However, there were more home-packed lunches than meals purchased at school, which was accounted for by calculating nutrient densities (77). The nutrient densities for carbohydrates (152.8g vs. 126.8g, $p<0.001$, respectively), fibre (9.1g vs. 5.6g, $p<0.001$), iron (6.8mg vs. 4.3mg, $p<0.001$), vitamin C (92.6mg vs. 44.5mg, $p<0.001$), thiamine (0.76mg vs. 0.37mg, $p<0.001$), folate (199.5µg vs. 134.5µg, $p<0.001$) and sodium (2020.8mg vs. 1473.1mg, $p<0.001$) were higher in home-packed lunches than foods purchased at school (77). However, the nutrient densities for sugar (84.5g vs. 68.5g), fat (35.5g vs. 31.1g), and a number of other micronutrients were higher for foods purchased at school (77). Foods purchased at school had a higher nutritional quality, but the overall quality of both foods purchased at school and home-packed lunches were lacking, compared to one-third of the Dietary Reference Intakes (DRI) recommendations (77). Regardless of lunch type, students' intakes of calcium, magnesium, zinc, folate, and vitamins A, D, C and B6 were below recommendations (one-third of the Recommended Dietary Allowance) (77). Intake of potassium and fibre by both lunch types also fell below recommended values (one-third of the Adequate Intake [AI]) (77). In contrast, sodium intake from both meal sources exceeded one-third of the AI (AI; 500mg) and Tolerable Upper Intake Level (UL; 733.3mg) recommendations (77).

Overall, home-packed lunches appear to be largely composed of snack type items, while the presence of vegetables, and sometimes fruit, is lacking. This is concerning as a large number of Canadian elementary school students bring a home-packed lunch to school. Furthermore, it is possible that the increased total amount of time dedicated to eating in the BSD schedule could result in increased intakes of fat, saturated fat, sugar and sodium, without a concomitant increase in vegetable, or fruit items. This could have long-term negative effects on children's eating habits, weight status and risk for chronic

disease (8,52,78,79). Further research is needed to provide insight into what Canadian children are bringing and consuming from home-packed lunches while at school, and to determine if school schedule is an influencing factor.

1.4 Nutrients of Concern for Children

The 2004 Canadian Community Health Survey (CCHS), cycle 2.2, indicated that diets of Canadian children, aged 4 to 8 years, are inadequate in vitamin D, calcium, potassium, and fibre, while intake of sodium exceeds the DRI UL (1900mg /d). The diets of Canadian adolescents, aged 9 to 13 years, showed a similar dietary pattern, except they were also inadequate in vitamin A, phosphorus, and magnesium, while excess energy came from saturated fat each day (~10% of total energy) (80). In addition, 20% of 2 to 8 year olds, and 30% of 9 to 13 year olds had energy intakes that exceeded their needs, as identified by achieving a classification of overweight or obese using measured data (80,81).

Achieving adequate calcium intake is particularly important for children and adolescents, as calcium is necessary for optimizing the development of peak bone mass, which plays a role in reducing the risk of future health risks including fractures and osteoporosis (82). Vitamin D is also required in sufficient levels to support active absorption of calcium in the small intestine (82). Food and supplement sources are not the only method of obtaining adequate vitamin D; however, ultraviolet (UV) radiation emitted during the Canadian winter months is not sufficient to support synthesis of vitamin D through skin exposure (80,83). In addition, dietary sodium promotes renal excretion of calcium, as both micronutrients share the same renal transport system (82). Thus, high consumption of sodium, as seen in Canadian children and adolescents, could negatively impact calcium absorption; nevertheless, American and Canadian calcium guidelines do not differ for varying levels of sodium intake (82,84).

Excess sodium intake has been associated with elevated blood pressure and, thus, is a risk factor for cardiovascular disease (CVD) (85–88). He et al. (88) reviewed the

National Diet and Nutrition Survey for young people, which collected data from 4-18 year olds in Great Britain during 1997. A significant association was found between salt intake and systolic blood pressure, even when age, sex, body mass index (BMI), and dietary potassium intake were taken into account (88). An increase of one gram per day of salt intake was associated with a 0.4mm HG increase in systolic blood pressure (88). However, controversies over the lack of evidence supporting a low sodium diet in reducing the development of CVD and mortality exist (85,87). In particular, the Institute of Medicine released a report in 2013 stating the quantity and quality of existing studies does not support a population wide recommendation of reducing sodium intake below 2300mg per day, due to inconsistent dietary assessment tools and methodological techniques (89). In fact, long-term reduced sodium intake has been linked to adverse health outcomes in individuals receiving treatment for congestive heart failure (CHF), though, this was found by only one randomized control trial (RCT) looking at an older adult population (85,89). A recent Cochrane review by Taylor et al. (85) in 2011 found a reduction in sodium intake had a slight impact on sodium excretion and blood pressure, with adults who are hypertensive seeing a greater improvement compared to normotensive individuals (2-4 mm HG vs. 1 mm HG). Taylor et al. (85) concluded that there is not enough evidence at this time to dispute the effects of low sodium diets on CVD morbidity and mortality, despite the impact of reduced sodium intake (i.e., ≤1800mg/d) being quite minute (85). The American Heart association continues to recommend the general public consume less than 1500mg of sodium per day, while the Heart and Stroke foundation recommends a reduced sodium intake of equal to or less than 2300mg per day (90,91). Despite the controversy, Canadian children and adolescents' intake of sodium above the DRI UL has the potential to contribute to future CVD health risks. Furthermore, consumption of potassium and bicarbonate obtained from fruits and vegetables has been shown to enhance calcium retention, as potassium and bicarbonate can outweigh the stimulation of urinary calcium excretion prompted by high sodium intake (82). However, Canadian children and adolescents are likely not benefiting from this mechanism, as CCHS, cycle 2.2 data shows intake of both age groups fell below adequate intake (AI) recommendations for potassium (AI; 3800mg/d and 4500mg/d) (80,81).

Dennison et al. (92), using 7-day written food records, reported that inadequate intakes of vitamin A, vitamin C, and dietary fibre, and high consumption of total fat and saturated fat was related to low daily intake of vegetables and fruit in 2 and 5 year old children. A recent review by Ledoux et al. (93) found a weak inverse relationship between vegetable and fruit intake and adiposity in adults, while the relationship was not consistent in studies assessing children. The connection between vegetable and fruit intake and adiposity is often difficult to distinguish as studies frequently use multiple dietary behavioural strategies to decrease weight and adiposity, in addition to increasing vegetable and fruit intake (93). However, strong evidence exists linking adequate vegetable and fruit consumption to a decreased risk of hypertension, coronary heart disease, and stroke (94). There is also a potential connection between an increased risk of developing cancer and poor vegetable and fruit consumption (94,95). It is important to note that vegetable and fruit intake is often cited as being positively related to measures of socioeconomic status (SES) including income, education, nutritional knowledge and neighbourhood quality (92,96). In addition, parental income (97,98) and education (98–101) have been shown to have an inverse relationship with the risk of childhood overweight and obesity. Simen-Kapeu et al. (97) found that parents with higher incomes and education were more likely to promote and encourage physical activity and healthy eating habits (e.g., selecting healthy foods and avoidance of eating in front of the TV) in their children. The inverse relationship between SES measures and childhood obesity has also been attributed to socioeconomically advantaged parents having the means to purchase healthy food items, provide financial support for physical activities, and live in neighbourhoods that are conducive to a healthy lifestyle (e.g., access to parks and healthy eating options) (98,101). Furthermore, SES has been found to influence what is packed in students' lunches. Participating schools in Dresler-Hawke et al. (76) were randomly selected based on their SES level, which was determined through the rating system created by New Zealand's Ministry of Educations (low, medium and high). There was no significant difference between home-packed lunch contents from schools in the three different SES levels regarding the presence of fruit and vegetables, and sodium (76). However, when compared to home-packed lunches in high SES level schools, home-packed lunch contents in low SES level schools were significantly higher in fat and sugar

(76). Thus, when assessing children's packed lunch contents and intake, it is important to determine if varying measures of socioeconomic status are influencing the nutrients being provided to those children.

In general, the diets of Canadian children and adolescents are deficient in a number of important nutrients, but are also high in sodium. This is concerning as nutrient deficiencies, as well as excessive sodium intake, have the potential to negatively impact health and development during childhood. A diet that provides an adequate amount of a variety of nutrients is fundamental in decreasing future health risks. In addition, parental measures of SES should be acknowledged as potential contributing factors to the nutrients children are consuming, particularly the foods children are bringing with them to school.

1.5 Dietary Assessment of Children

Dietary assessment is difficult to conduct in children under the age of 9 due to their limited cognitive and literacy skills (102,103). Different assessment methods, including 24-hour recalls, food records, and food frequency questionnaires using both child self-report and varying levels of parental proxy, have been used in previous studies (102–106). These self-report methods require children to be able to estimate portion size and to have a developed sense of time to express frequency and timing of meals, good recall skills, and knowledge of food preparation (103,107–109). The literature in this area has revealed both over- and underestimation of energy intake when using these subjective techniques, thereby, demonstrating the likelihood these methods may not be reliable for children (102–104,106,110). Direct observation is used as a validation standard in the assessment of food intake by self-reported dietary assessment methods (103,111,112). When carried out by trained observers in controlled settings, such as structured school lunches, direct observation is particularly reliable (47,111,113–115). Observers typically watch subjects for a set period of time (i.e., school lunch) and record their intake including food items, portion sizes and items traded or spilled (114). As a result, standardized procedures, observational training with continuous feedback, and assessment of interobserver reliability (IOR) during training, data collection, and retraining are a necessity to help ensure the collection of reliable and accurate data

(108,112–114). Although direct observation can be tedious, expensive, labour intensive, and may impact usual eating behaviour, the objective nature of the technique minimizes the impact of recall error, inaccurate reporting and errors related to poorly worded questions in other dietary intake assessment methods (47,108,113,116). The risk of direct observation resulting in altered usual behaviour is also reduced in the school setting as children feel comfortable in that environment and are accustomed to lunchtime supervision (113). This method is also less disruptive to the classroom schedule and has minimal impact on the teachers' workload; therefore, utilizing the technique of direction observation to assess dietary intake is ideal in a school lunch environment.

1.6 Influence of Picky Eating and Food Neophobia on Food Intake

Food neophobia is a personality trait, presented in varying degrees, in which an individual avoids unfamiliar or new foods (117–120). Prevalence of food neophobia typically peaks at age 2, and has been attributed to an evolutionary protective mechanism as the child gains more independence and mobility (120–122). However, researchers have found avoidance of specific foods or food groups has continued to present itself in older children (119,123,124). Conversely, picky eating is typically defined as an unwillingness to eat a variety of familiar (or unfamiliar) foods, usually due to flavour or texture (122,125,126). Picky eating and food neophobia have been found to be related (118,125), while at the same time evidence supports they are behaviourally distinct and have different predicting factors (125,127). Picky eating is thought to extend beyond food neophobia where a child rejects whole food groups based on texture rather than refusing to try a single food (122,128).

Dietary outcomes of food neophobia and picky eating overlap in that children classified as picky eaters or food neophobics have been found to consume fewer fruit and vegetables (119,121–123,125,126,128,129), and have less dietary variety (117,129). Increased intake of saturated fat (117), and decreased intake of protein foods and total kilocalories (119) have also been connected to food neophobia, while studies regarding picky eating have found children to have lower weight (121,126,130). Consumption of sweets and snacks has been shown to both increase and decrease with rising levels of

pickiness (121,126). Therefore, the food intake of children with high neophobia scores and/or picky eating status needs to be considered when assessing dietary intake.

1.7 Objectives and Hypotheses

The primary objective of this research was to compare the type and quantity of foods grade 3 and 4 students are bringing and consuming for lunch in the BSD versus the TS through direct observation. A secondary objective was to capture factors that may impact intake (i.e., picky eating and/or neophobia, body mass index (BMI)) or parental preparation of a packed lunch (i.e. income and education). The following hypotheses, based on the results of published packed lunch literature and consideration of the increased amount of time dedicated to eating in the BSD schedule, will be tested to achieve the objectives of this study:

> Hypothesis 1: When compared to the TS, packed lunch contents in the BSD schedule will consist of (i) higher caloric value; (ii) greater macronutrient content (protein, fat, CHO); (iii) similar micronutrient content (i.e., B vitamins, vitamin C, Ca2+, Fe, Na and K); (iv) similar proportion of food group servings and vegetables; and (v) more sugar-sweetened beverages and snack food items.

> Hypothesis 2: When compared to the TS, students' intake in the BSD schedule will be (i) higher in calories; (ii) higher in macronutrients (protein, fat, CHO); (iii) similar in micronutrients (i.e., B vitamins, vitamin C, Ca2+, Fe, Na and K); (iv) similar in the proportion of food group servings and vegetables; and (v) higher caloric intake from sugar-sweetened beverages and snack food items from their packed lunches.

1.8 Thesis Structure

This thesis was structured in an integrated-article format. Chapter two contains a detailed description of the methods used to obtain participants and collect data. The two chapters following the methods were prepared for independent publication. Chapter three ("Elementary school home-packed lunches: comparison of foods packed and eaten in the traditional vs. balanced school day schedule") examines the difference between food

groups packed and consumed in BSD versus TS schedules. The nutrient content of packed lunches consumed in each schedule is then analyzed in Chapter four ("The LUNCHES study: nutrient composition of elementary school students' home-packed lunches comparing two school schedules in Ontario, Canada"). Finally, this dissertation is completed with a concluding chapter, Chapter 5, in which a summary of key findings, limitations, recommendations, and suggestions for future research are presented. Chapter 5 is followed by appendices, which contain information pertaining to ethics, consent, and instruments used to collect data. Additional statistical tests that were not included in the articles structured for independent publication can also be found in the appendices. There may be some overlap between chapters, as chapters submitted for publication were created to be read apart from the thesis as a whole, and follow journal guideline specifications.

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Chapter 2

2 Methodology Overview

This cross-sectional study assessed population level caloric and nutrient value of children's packed lunch contents and intake in the BSD versus the TS. Elementary schools situated within the Thames Valley District School Board (TVDSB) in Southwestern Ontario were recruited to participate by email and telephone. Children from third and fourth-grade classes located in the participating elementary schools were then provided with information regarding the study, consent forms and a survey. Direct observation was conducted during all eating periods to assess food and beverage items brought in and consumed from home packed lunches. Data were only collected from students who had returned parental consent, child assent and a completed survey. The study was approved by the Non-Medical Research Ethics Board at The University of Western Ontario prior to initiation of data collection (Appendix A), with subsequent approval from TVDSB.

2.1 School Recruitment

Elementary schools in TVDSB were initially recruited through an email sent by a school board representative at the beginning of the 2011 school year. School principals self-selected their school to participate in the study comparing children's at-school food intake in the TS vs. BSD schedule. Targeted recruitment was later used in an effort to obtain a representative sample based on school location (rural vs. urban) and a measure of socio-economic risk for disadvantage (Social Risk Index). Urban and rural schools were identified based on the school boards categorization method. The majority of rural schools were located in small communities with students commuting from surrounding locations. Socio-economic status (SES) was based on the school board's Social Risk Index (SRI), which uses 2006 census data and data from students in the 2009-2010 academic year (S. Killip, personal communication, March 26, 2014). The index was constructed from seven indicators, each of which had equal weight: lone parents (%), non-official languages spoken most often at home (%), newcomers to Canada - in the last

5 years (%), movers in a one year period (%), education less than high school diploma (%), unemployed with children present at home (%), and average household income in 2005 ($) (S. Killip, personal communication, March 26, 2014). SRI scores were grouped into tertiles of high risk (SRI scores between 1.178 and 0.564), moderate risk (SRI scores between 0.563 and -0.050) and low risk (SRI scores between -0.051 and -0.665). A high-risk school would indicate the majority of families within that community had characteristics associated with disadvantage, signalling a potential need for supportive resources and programs. The SRI is not as effective in rural settings as the census data covers a large geographical region (S. Killip, personal communication, March 26, 2014). However, SRI provided a single value to capture school level covariates that could impact parental ability to pack a child's lunch.

The political environment in the 2012 to 2013 Ontario school year, wherein teachers unions recommended reduced participation in voluntary or extra-curricular activities in elementary schools, may have had an impact on the number of schools who agreed to participate in the research study (1–5). During this time, extra effort was taken to ensure principals and teachers were aware of the very limited role staff members played in the research study.

A letter of information and either a BSD or TS school survey was sent out to school principals upon agreement to participate in the study (Appendix B). School principals would then identify grade 3 and 4 classrooms willing to participate in the study. Following completion of data collection at a school, a $150 honorarium was provided to the school.

2.2 Participant Recruitment

The teachers of the identified grade 3 and 4 classrooms were provided with parent packages, which contained a parental letter of information, a child assent form, and either a BSD or TS parental survey for each student in the class (Appendix C). Teachers were informed of the exclusion criteria and parental packages were not sent home with children who met the criteria (i.e., those who go home for lunch daily; are on a therapeutic diet; or have a chronic or debilitating condition which may impact their food

intake, metabolism, growth, or ability to stand unassisted (e.g., Prader-Willi syndrome, diabetes, phenylketonuria). The recruitment age of 7-10 years (grade 3 and 4 students) was used for this study as older children may be in pubertal Tanner stage 2 or greater, and experiencing an elevated rate of growth, which could have an impact on their BMI and food intake (6). Children 6 years of age or less were excluded because they may have smaller caloric intakes and less prevalence of overweight and obesity (7–9); thus, it may be harder to detect any differences in intake or BMI between the two school schedules. Upon receiving the parent package, interested parents or guardians were asked to review the information with their child, sign the letter of information, complete the survey, and have their child complete the assent form. The completed parent package contents were returned back to the child's teacher. All three items of the parent package had to be received for the child to be eligible to participate on the day of data collection. A $25 gift certificate to a grocery store chain was given to the parents following the observation of their child.

2.3 Survey Instruments

Two novel self-administered surveys, one for principals and one for parents, were created for this study (Appendix B & C). Survey items were pretested for content validity by caregivers, parents, public health nutritionists, a school board administrator, and a principal. Suggestions regarding content, clarity, comprehension, and length were incorporated into the final versions of the surveys.

2.3.1 School Survey

Two variations of the school survey were created for the TS and BSD schedules (Appendix B). The school survey was designed to obtain logistic information such as class size, timing of breaks, and days of the week hot/catered lunch was offered in order to aid in planning data collection days. Questions also captured factors that may influence the school food environment, including breakfast or snack programs, nutrition resources, school food policies, and the school food retail environment.

2.3.1.1 School Food Environment Score

School survey questions pertaining to factors influencing the school food environment were categorized into the following themes: healthy eating education, school food retail environment, school food programs, and healthy behaviour programs. Creating a school environment score was not the primary reason or outcome of this research, but one was created from items within the measurement tool to be used as a covariate to determine if school food environments influenced potential differences between schedules. School food environment scores were calculated as a sum of all available responses, if at least five of the nine questions were completed. Table 2.1 provides a summary of the scoring system used to create the total mean score for each school, where a higher score indicates a healthier school food environment.

Although elementary schools tend to have fewer vending machines and a la carte services/tuck shops than middle schools and secondary schools, items for sale in these venues have been shown to be high-fat, low-nutrient, energy-dense food and beverage items (10). Competitive foods from these sources have also been shown to displace fruit and vegetable consumption (10,11). Canadian elementary schools are restricted in the food and beverages they are able to sell through vending or a la carte services/tuck shops, due to the implementation of the Ontario School Food and Beverage Policy (PPM 150) in 2011 (12). However, an 80/20 rule is also in place through PPM 150, in which at least 80% of the products sold must be part of the "sell most" category, while no more than 20% of items are in the "sell less" category (12). Given vending machine and a la carte service/tuck shop availability and contents were based on self-report from school principals, and were not physically assessed to determine compliancy with PPM 150, the absence of these food sources in a school was rated higher. Fundraisers in elementary schools have been found to provide unhealthy competitive foods that are typically high in sugar (13). PPM 150 does not apply to fundraising occurring off school property, and schools are also allowed 10 policy free days a school year (12). Thus, schools that had foods available for sale for the purpose of fundraising less often (i.e., <10 times a year) received a higher score. Conversely, the availability of school food programs was considered an improvement to the school food environment based on their contribution to

food security and positive health outcomes (14,15). School milk programs are typically offered to students at a subsidized price (16), while school breakfast and snack programs can be offered free of charge through various funding sources such as Breakfast for Learning or the Ontario Student Nutrition Program (17,18). School breakfast programs, in particular, have been associated with improved diet quality, cognitive function, school attendance, and reduced obesity-related health risks (19–21). Thus, schools providing daily school food programs were provided with a higher score.

Table 2.1. Summary of School Food Environmental Score Items and Corresponding Scoring Structure

Topic	Survey question	Available response categories (points)
Packed lunch resources	Indicate whether your school provided print or online nutrition resources related to bag lunch preparation or the Balanced School Day.	No (0), Yes (1)
School food retail environment	Does your school have a canteen or tuck shop?	No (1), Yes (0)
	Does your school have a hot or catered lunch program? If so, indicate the number of times offered per year.	No (1), ≤20 times per year (0.5), >20 times per year (0)
	Are there other foods available for sale at any other time during the year (i.e., fundraising)? If so, indicate the number of times offered per year.	No (1), ≤10 times per year (0.5), >10 times per year (0)
	Does your school have a vending machine available to students?	No (1), Yes with healthy options (0.5), Yes (0)
School food programs	Does your school have any of the following programs? If yes, indicate frequency.	
	− Milk program	No (0), <5 days/week (0.5), 5 days/week (1)
	− Snack program	No (0), <5 days/week (0.5), 5 days/week (1)
	− Breakfast program	No (0), <5 days/week (0.5), 5 days/week (1)
Healthy eating programs	Does your school run a Public Health Nutrition Program?	No (0), Yes (1)

2.3.2 Parental Survey

Two variations of the parental survey were created for the TS and BSD schedules (Appendix C). Questions were arranged in a logical order with consideration to the school schedule surveyed. A variety of question formats were used: Likert-type scales, dichotomous, multiple-choice, and a few open-ended to allow for more depth in the response. The parental survey was designed to measure potential covariates that could impact the provision of packed lunches and intake; it gathered information regarding the child's age, sex, eating behaviours, parental income and education level, as well as physical activity through parental proxy. The BSD version of the survey contained questions specific to the transition to the new schedule.

2.3.2.1 Socioeconomic Status

Measures of socioeconomic status (SES), including parental income (22,23) and education (24–26), have been shown to be inversely related to the risk of child overweight and obesity. Children of parents with higher incomes or education are more likely to receive parental encouragement and support to apply healthy eating and physical activity behaviours daily (27). A higher income and education level are thought to provide adequate funds to support children's healthy eating habits and involvement in organized sports and activities (24). Families with parents who have higher incomes and education are also more likely to reside in a safe neighbourhood that promotes a healthy lifestyle through active transportation and access to healthy foods (24). In addition, SES has had an effect on the amount of fat and sugar provided by the foods in children's home-packed lunches (28). For these reasons, measures of parental education and income were included in the parental survey.

2.3.2.2 Parental Perceptions of Child's Weight, Physical Activity Patterns, and Eating Behaviours

Questions regarding parental perceptions of their child's weight status, barriers and facilitators to packing a lunch for their child, and resources obtained and utilized for packing a healthy lunch were included in the survey. Specific information regarding food provision and intake was collected by inquiring about the number of days per week the

child consumes breakfast, the food types that are typically included in and returned in the child's lunch, and the child's afterschool snacking behaviour. Children's physical activity levels were assessed by parental proxy, through which parents indicated, in 10-minute blocks, the amount of physical activity their child participates in before, during and after school, and on weekends. Segmented time blocks were used as prompts for recall of both physical activity and diet as they may have more meaning to parents and aid in making a more accurate estimate (29,30). Notably, analysis of parental perceptions of children weight, physical activity and eating behaviours has been recorded in a separate report and are not reported on in this thesis.

2.3.2.3 Picky Eating and Food Neophobia

Food neophobia is the avoidance of unfamiliar or novel foods (31–34), whereas picky eating is an aversion to an array of food items with similar flavours or textures (35–37). Both of these food behavioural traits have been connected to a lower intake of vegetables and fruit (33,35–41) and a poor variety of foods typically consumed (32,40). Thus, eating behaviour questions assessing a child's food neophobia status and parental perceptions of picky eating were included in the survey, as these were thought to be possible cofounders of intake.

A Food Neophobia Scale (FNS) for adults was developed by Pliner and Hobden in 1992 (34), and consisted of 10 questions measuring willingness to sample new foods. Each question was measured on a seven-point agree-to-disagree scale for a score range of 10-70 (34). The scale was subsequently labelled the Child Food Neophobia Scale (CFNS) after it demonstrated high correlation to actual behavioural outcomes of children presented with 10 familiar and 20 novel foods (42). Later, the CFNS was adapted by Cooke et al. (33) to be relevant for younger children by removing three questions related to ethnic foods, restaurants, and dinner parties (33,43). The six questions, included in the CFNS used by Cooke et al. (33), each consisted of a four-point agree-disagree scale, in which higher scores indicate a greater presence of the food neophobia trait (33,43). In our study, four of the six questions from the CFNS adapted by Cooke et al. (33) were utilized in the parental survey (Table 2.2). Two questions were excluded: "My child is constantly sampling new and different foods (reverse scoring)", and "My child does not trust new

foods". The four remaining questions were included in the parental survey: "If my child doesn't know what is in a food, he/she won't try it", "My child is afraid to eat things he/she has never had before", "My child is very particular about foods he or she will eat", and "My child will eat almost anything (reverse scoring)". The scale was condensed to increase parental response rate and remain applicable to the packed lunch school environment. The wording and structure of questions regarding food neophobia were uniform in both versions of the parental survey. The range of possible scores was from 4 to 20, as each question had a 5-point scale ranging from 'strongly disagree' to 'strongly agree'. A 5-point scale was used to provide consistency with other measurement scales used in the survey and higher scores were also indicative of higher food neophobia.

In contrast to the well established measurement of food neophobia, methods of assessing and defining picky eating vary in the literature, making it difficult to compare results (39,40). Tharner et al. (39) recently developed a picky/fussy eating behaviour profile as a first step towards the creation of a working definition of picky eating. The picky eating profile includes items such as food intake, BMI, and child and family characteristics (i.e., parental education, SES, parental pressure) (39). Picky eating has been measured using the Child-Feeding Questionnaire (36,37,44), Child Eating Behaviour Questionnaire (CEBQ) (39), and asking the child's caregiver, in a single question, if they consider their child to be a picky eater (40,41,45). Jacobi et al. (40) demonstrated a single question approach, using a 5-point scale, was predictive of actual picky eating behaviour. As picky eating was not a main outcome of interest for this study, it was measured by asking parents to indicate if they agree with the statement "My child is a picky eater", using a 5-point scale ranging from 'strongly disagree' to 'strongly agree'.

Table 2.2. Food Neophobia Survey Questions

If my child doesn't know what is in a food, he or she won't try it.
My child is afraid to eat things he or she has never had before.
My child is very particular about foods he or she will eat.
My child will eat almost anything. (Reverse scoring)

2.3.2.4 Parental Perceptions of the Impact of the BSD

Overall impression of the BSD schedule was inquired of parents with a child in the BSD schedule through a number of questions in the parental survey. Parents were asked to indicate if they packed more pre-packaged snacks, sent more food, and found it more difficult to know what to pack in their child's lunch following the switch to the BSD. Food safety concerns, time for eating, and child's ability to go home at lunch/break were also addressed. Parents were asked to indicate if they received nutrition-related resources following the change in school schedule, and how useful they found the resources. Lastly, open-ended questions were presented to obtain a comprehensive understanding of parent's perception of the impact the BSD schedule had on their child's food intake and physical activity. However, data from survey questions regarding parental perceptions of the effect of the BSD on children's eating behaviours and home-packed lunches will be not be presented in this thesis.

2.4 Direct Observation

Direct observation was used to assess all visible food and beverage items packed and consumed by students during all eating periods during a school day, including portion sizes, and items traded, spilled, or discarded. This method is best suited to a defined setting such as school classroom or lunchroom, and is particularly reliable when conducted by trained individuals (46–50). In this study, trained upper-year undergraduate food and nutrition students conducted all observations, and interobserver reliability was assessed prior to data collection to ensure high consistency between the different observers (50). Procedures used to collect direct observation data in participating elementary schools are further described in the "overview of data collection" section.

2.4.1 Training

Data collection took place over two years from September 2011 to October 2013. During the first year of data collection, fifteen upper-year undergraduate nutrition students were recruited; eleven new upper-year undergraduate nutrition students were recruited during the second year to account for turnover of graduating students. Students applied for the position by submitting their resume, transcript, and a statement of interest.

Prior to training, these students had academic knowledge of standard measurements and portion sizes, food intake recording and nutrient analysis procedures, theory of direct observation, and overall awareness of common food products from mandatory undergraduate course work. Observer training occurred annually in the fall as a way to update and reinforce observation skills for returning observers and to introduce new observers to the methodology. It also enabled new observers to learn from more senior students in addition to the instruction they received from the instructor. Observers underwent 10 hours of training in a food lab setting over a period of 1 month. The training consisted of hands-on practical activities and discussion to enable observers to perform unobtrusive observation and visual identification of pre-packaged and non-packaged food items, portion size estimation, and detailed data recording on the Food Intake Observation Form (OF) (Appendix D). All observers were trained by a master's level registered dietitian with previous experience in direct observation at the elementary school level. A training manual was also created for observers to use as a resource (Appendix E; abridged version) (50). The training manual contained capacities of frequently used reusable containers, Eating Well with Canada's Food Guide (EWCFG) serving sizes, and details of foods typically found in children's lunches, including brand names and serving sizes of both commercially and home-packaged foods (50). Containers and food items were photographed with a ruler to determine relative size and accompanied capacities in the training manual to help observers identify food items and estimate portion size while observing in an elementary school setting. Standardized anthropometric procedures were also included in the training manual to help ensure accuracy of the measurements. Two methods of evaluation were used to test the knowledge of the observers during each training session. The first evaluation method was through observation of sample lunches and the second included observation of volunteer-consumed lunches. These methods were previously shown to produce valid and reliable observation data (50).

2.4.1.1 Sample Lunches

Five sample lunches, each containing five to seven food and beverage items, were constructed and the actual types and amounts of the food items were recorded. The food

and beverage items chosen were items that are typically found in children's bag lunches, and different types of containers, thermoses, and bottles were used (50). Observers recorded amount packed and a detailed description of all food and beverage items detected while remaining approximately six feet away from the display table (50). Observers were trained to be discreet while observing in order to reduce the pressure on the child being observed. The observers' records were then compared to the master copy of the actual types and amounts of food items present. Each observer was then provided with individualized feedback at the following training session. This method has been shown to produce a 96% agreement for item identification and an 86% accuracy for portion size estimation (50).

2.4.1.2 Volunteer-consumed Lunches

During the second evaluation method, observers watched and recorded the intake of two to four volunteers who consumed lunches, each with varying amounts and types of foods and beverage items (50). The actual portion sizes of the food and beverage items in the lunches were recorded before observation, and volunteers were informed of the percentage of each item to consume. To simulate an elementary school environment, volunteers ate at the same time, interacted in conversation with each other, traded items, did not consume everything in their lunches, ate at different paces, and had a 20 minute time period for consumption (50). Each observer estimated and recorded the type and amount of items packed and the percentage consumed for each food and beverage item in individual volunteer lunches (50). The dietitian-trainer provided either an individual or group feedback session to discuss strengths and areas for improvement.

2.4.2 Interobserver Reliability

From 2010-2011 the direct observation methodology was piloted and validity and interobserver reliability (IOR) were assessed. IOR reveals the level of agreement between two different observers when measuring observations of foods and/or portion sizes of foods eaten by the same subject (47,48,50). Due to the potential variability of different individuals conducting observations, assessment of IOR is essential to ensure data collected is an accurate measure of actual dietary intake (48,50). Adequate IOR has been

defined as at least 85% agreement (48). A detailed explanation of the methodology used to assess IOR and the corresponding results have been previously described in Richter et al. (2012) (50). The two evaluation methods described in the training section of this manuscript were initially used by Richter et al. (50) to assess IOR. Sample lunches were used to determine assess accuracy (i.e., item identification and portion size estimation), and volunteer-consumed lunches assessed both accuracy (i.e., item identification and portion size estimation) and reliability (i.e., consistency between observers) (50). The third phase to assess IOR consisted of observation of student lunches in an elementary school setting, in which observers were paired to assess IOR of item identification, portion size and amount consumed of students' packed lunches (50). A field setting was used as it presents more difficulties than predetermined packed lunches, including a greater variety of items that may not have been seen during training, atypical portions, culturally diverse foods, and nontransparent containers (50). Each pair of observers were responsible for concurrently observing one or two students during all eating opportunities during school hours (50). Data collected included item identification, portion sizes, and amounts consumed, as well as additional notes of items split or traded (50). The sample size consisted of 32 students in grade three or four from three elementary schools (50). Results indicated an average item agreement of 95% when observer reports were compared to known food items in sample lunches and this remained consistent for volunteer consumed lunches (50). The percentage of accurately reported portion sizes improved between sample and volunteer lunches (86% to 94%), which indicates there may have been an improvement in the skills of the observers (50). IOR was found to be $\geq$0.79 for item identification, portion size, and amount consumed in student lunches in an elementary school setting (50). The resulting IOR values for amount consumed in portion size and macronutrient composition were marginally lower than the recommended 85% agreement (48). However, other studies have reported IOR for fat and energy to be 0.74 and 0.81, which may suggest that, for some nutrients, it is more challenging to obtain the suggested 85% agreement (47). Overall, the training procedures and use of direct observation provide an accurate and reliable method to measure home-packed lunch contents and intake by elementary school students (50).

2.5 Anthropometric Measurements

The height and weight of students was taken by a member of the research team prior to lunch consumption so as to minimize classroom disruption and allow observers to identify the students they were to observe. BMI was then calculated from the two anthropometric measurements. Measurements were conducted in a private room to reduce participant discomfort and enhance cooperation. The results were kept confidential and were not shared with anyone, including the participating student, parents, school staff, or other students. The observers taking the measurements were trained on ways to appropriately respond to possible questions or comments posed by the children regarding the measurements. Standardized methodology and training was utilized to reduce personnel, equipment, and protocol measurement errors and ensure accuracy (51,52). Anthropometric protocols were similar to those described in the National Health and Nutrition Examination Survey (NHANES) anthropometry procedures manual (52).

Standing height was measured with a portable stadiometer (Seca Model 213, Seca N. America East, Hanover, MD USA), which is accurate to 0.1cm. Measurements of height are more susceptible to error than weight, thus three sequential measurements of height were taken in the following order: height, weight, height, height (51). The means of the replicate height measurements were utilized, as this approach diminishes random errors of measurements producing a better estimate of the actual value (51). The portable stadiometer was levelled prior to measuring the first standing height at each elementary school location. Each individual participant was asked to stand on the baseboard with their arms relaxed at their side, head alighted in the Frankfort horizontal plane, and heels together with their toes pointed slightly outward. Prior to the measurement being taken the researcher confirmed the student's head, shoulder blades, buttocks and heels were in contact with the height rod of the stadiometer. The student was then asked to take a breath, to straighten the spine, before lowering the headboard to the crown of the student's head and recording the measurement at eye level (Appendix F) (52).

To measure weight, a Tanita WB-100A, professional digital scale (Tanita Arlington Heights, Illinois, USA) accurate to 0.1 kilogram (kg) was used. The electronic

scale is portable with a remote digital display that assisted in keeping the measurements confidential. The scale was situated on a flat and hard surface. Prior to taking weight measurements, students removed their footwear, heavy outer clothing, and any heavy objects from their pockets. Students were then asked to stand in the centre of the scale, facing outward, with their feet slightly apart, and remain still until the weight appeared on the display. Body weight was measured in kilograms and recorded to the nearest 100 gram unit (0.1 kg).

2.6 The Food Intake Observation Form

The research team created a Food Intake Observation Form (OF) as a standardized way to record the type and amount of all foods students brought in their packed lunch and consumed during eating breaks (Appendix D). To aid the trained observers during observations, the form was split into 8 categories: sandwich/entrée, beverage/milk and alternatives, fruit, vegetables, baked goods, chips, candy, and other. Each category had sections where the trained observers could record the number of each food item, the portion size of each food item packed and consumed, a detailed description of the product (brand, dimensions, and preparation details), the source of the food item (from a school program or friend), and how the food item was prepared (home-packaged vs. commercially packaged). Prompts for each category, such as usual food products, preparations, and descriptions, were included in the far right column of the form. A new OF was filled out during every eating opportunity for each participating student (i.e., Recess 1, Lunch, and Recess 2 in the TS, or Nutrition break 1 and Nutrition break 2 in the BSD schedule).

2.6.1 Food and Beverage Categories

The reserve side of the OF contained a form created by the LUNCHES research team to acquire servings of food and beverage categories, including EWCFG categories, of items packed and consumed during each eating break (Appendix D). Following completion of the OF, trained observers transferred the type and portion of each food and beverage item packed and consumed into the appropriate food and beverage category. Food group categories included grain products, milk and alternatives, meat and

alternatives, fruit, vegetables, 100% fruit/vegetable juice, sugar-sweetened beverages, and snacks. Vegetables and fruit were separated into two categories, as were sugar-sweetened beverages and 100% fruit/vegetable juice, to compare the study's results with previous findings that children's packed lunches are low in vegetables (53–58) and high in sugar (28,55–59). Vegetables recorded and classified as an EWCFG serving included both vegetables served independently and as part of a main entrée. Sugar-sweetened beverages included fruit drinks, sweetened fruit juice, fruit-flavoured drinks, sweetened iced tea, sports drinks, energy drinks, and sweetened soft drinks. Diet beverages were not categorized into either beverage category because they do not contain sugars; furthermore, they do not tend to be a popular choice by children 7 to 10 years of age (60,61). Fruit and 100% fruit juice were recorded as separate categories in order to determine the proportion of whole fruits being packed and consumed by study participants and allow flexibility for variations in analysis. Controversies exist over the benefits and negative consequences of 100% fruit juice consumption. While 100% fruit juice provides essential nutrients and has been shown to improve diet quality (62,63), it does provide less fibre and can be consumed more quickly than its whole fruit counterpart, potentially failing to activate the same satiety cues as whole foods (64–66). Although evidence associating 100% fruit juice consumption and increased adiposity in children is inconsistent, a few studies have found an association between 100% fruit juice consumption and increased adiposity in children who are already overweight or obese. (67,68). This is particularly concerning as the prevalence of childhood overweight and obesity in Canada continues to remain elevated (69). The 2010 Dietary Guidelines for Americans recommends limiting juice consumption in children based on the association with weight gain for children who are already overweight or obese (70). Moore and Lloyd (71) also recommend reporting fruit and vegetable consumption, as well as 100% fruit juice separately from fruit consumption for the purpose of comparison between different countries as portion size and recommendations differ. Additionally, national recommendations from Canada, the United Kingdom, and the United States are united in recommending a limit of 100% fruit juice consumed daily (71). Therefore, we recorded fruit and fruit juice as two separate categories.

An additional category was added to capture the number of snacks packed and consumed. Snacks were defined as non-entrée, non-beverage, non-fresh fruit or vegetable, sweet or savoury items, packaged for consumption in one sitting. Snacks were further categorized into Health Canada's Bureau of Nutritional Sciences (BNS) food group classifications, which include sweet snacks, crackers and cereal, baked goods, dairy, popcorn and chips, nuts and seeds, and other snacks (Appendix G) (72). The professional judgement of research team members was used to include additional items in the appropriate BNS classifications, as the snack food market has grown and evolved since the classifications were created in 2008. Certain food items, such as cheese strings and yogurt tubes, fit into both a BNS classification and a CFG food group; however, these items are often marketed for the consumption outside of a meal in one sitting. If overlap occurred, a food item was classified in the appropriate CFG food group and BNS classification. Double classification did not take place when assessing caloric and nutrient intakes, only in the case of food group data. A consensus in the literature regarding the definition of a snack is lacking. Snacks have been defined based on varying nutrient content cut-offs (53,73,74), BNS categories (75), sweet and savoury taste (76,77), level of processing (78), the time of day a food item is consumed (75), and categories created to fit the measurement tool utilized (79). BNS categories were utilized in this study as Canadian food data were collected, and the method allowed increased efficiency of on-site data entry by not requiring nutrient data for each individual item at the time of classification. Snack items were also identified as being commercially packaged or home packaged. Home packaged items referred to snack items that were prepared at home, or taken out of commercial packaging, and placed into plastic wrapping or plastic containers.

Portion sizes from the OF were then used to calculate the total number of food or beverage servings for each category and were recorded to the nearest 0.1 of a serving. A single serving of sugar-sweetened beverages was 125mL to be comparable to the 125mL EWCFG portion of 100% fruit or vegetable juice. A snack was classified as one serving if its portion size was within 20-35grams, based on the reference amounts established by Health Canada for the Food and Drug Regulations (80), and the usual portion size of most snack items available to purchase at grocery retailers. An exception was made for

single serving fluid type snacks such as yogurt, pudding, gelatin desserts, and fruit cups, in which a single serving was defined as 100-120mL. Observers were instructed on how to properly fill out the OF and corresponding food group category serving sizes during the mandatory annual training sessions.

2.7 Overview of Data Collection

Observation days were coordinated with the schools and the observers following retrieval of parental packages and consents from classroom teachers. Parents and students were not informed which day observations were to take place, to avoid influencing what was packed in the students' lunches. Observers arrived at the school prior to the morning break (BSD) or recess (TS) to collect anthropometric data from participating students, and to ensure they were observing any food intake occurring during the morning. The trained observers collected food intake observation data at all breaks. Each observer monitored two to three children at a time, estimating the type and amounts of all visible foods packed and consumed, together with any food items traded, given away, discarded and remaining at the end of the snack/meal. Observers were trained to record fluids in opaque water bottles as water if they could not be sure of it being otherwise, and did not assume fillings or toppings if they were not able to detect their presence (e.g., mayonnaise). Food or beverages provided to students from school, through milk, snack, and/or breakfast programs, were only recorded in consumption data. A maximum of four observers were located in each classroom and stood six feet from the lunch table to remain unobtrusive and minimize any interaction with the students. A separate OF was utilized for each student at every recess or break. Food items were then entered into ESHA: The Food Processor SQL (ESHA, Version 10.12.0; Esha Research Inc., Salem, OR, 2012) onsite to reduce error from interpreting OF's at a later date. Health Canada from the Canadian Nutrient File (CNF) or U.S. Department of Agriculture (USDA) food items rather than manufacturer items were selected in the ESHA database, when possible, to provide a more detailed nutrient analysis, as there is the possibility that manufacturers' data contains missing nutrient values. Two independent research team members then crosschecked the data with original OF's to increase accuracy. ESHA was used to compute group level macro- and micronutrient data for all packed and consumed food

and beverage items for each school schedule. Observations were conducted over three academic years to capture the desired sample size (Appendix H).

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Chapter 3

3 Elementary school home-packed lunches: comparison of foods packed and eaten in the traditional vs. balanced school day schedule

3.1 Introduction

A sizable amount of children's food consumption occurs at school, as a large portion of their waking hours are spent in that setting (1,2). In 2011, the American Dietetic Association recommended children consume at least one-third of their nutritional requirements during a four to seven hour day-care program (3). The average length of a Canadian elementary school day falls within that range, as it typically spans six to seven hours with a minimum of 5 hours of instructional time (4).

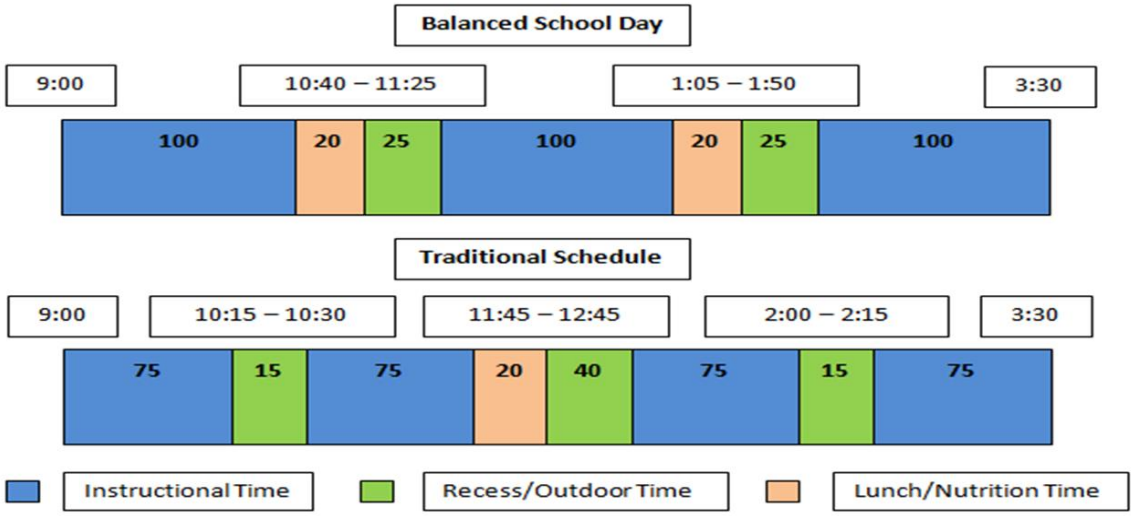
Home-packed lunches in the UK and USA have been shown to be of lower nutritional quality than school provided meals. Home-packed lunches generally provide more savoury snacks, confectionery items, sodium, fat and sugar, while providing fewer micronutrients, fibre and vegetables (5–10). Rees et al. (6) found high fat and sugar values in UK home-packed lunches were linked to the high number of confectionary, cake and biscuit items present. Only 8% of UK students with a home-packed lunch consumed a portion of vegetables, compared to 81% of students with a school provided meal (6). Similarly, Pearce et al. (8) reported UK students with home-packed lunches consumed vegetables less often while at school, and consumed smaller portions of fruit and vegetables than those students with school meals (1.0 portions vs. 1.6 portions). The portion of vegetables consumed by American students was also significantly lower for those with a home-packed lunch compared to those with a school meal (0.1 cups vs. 0.5 cups) (9). In Canada, the majority of foods consumed in elementary schools are brought from home, as cafeteria facilities are often not available. Elementary school students generally have the option to supplement their lunch through volunteer-run school milk, snack and/or breakfast programs, as well as periodic hot lunch days provided by external caterers.

Few studies have been conducted to determine the quality or type of foods packed and consumed by Canadian elementary school children; however, one study found the overall quality of both home-packed lunches and those purchased from school were lacking when compared to one-third of the Dietary Reference Intakes for Mg, K, Zn, folate, fibre, and vitamins A, D, C, and B6 (11). This is likely due to the absence of a national school meal program in Canada (12,13) and the consequent reliance on fast food outlets for foods purchased at school. Thus, this study is not consistent with the results of those demonstrating that home-packed lunches are typically less healthy than school meal program lunches.

In addition to concerns about home-packed lunches, there have also been changes to the elementary school schedule in Canada that have the potential to impact children's consumption while at school (12). The Balanced School Day (BSD) schedule, which reportedly began in an elementary school in 2000 to 2001, is an alternative way to structure the school day, in contrast with the well-established Traditional Schedule (TS) used in many North American elementary schools (Figure 3.1) (14–16). The BSD schedule consists of two 45-minute breaks dividing three 100-minute teaching blocks, with 20 minutes dedicated to eating, 20 minutes for outdoor activities, and 5 minutes for transition during each break (14–16). In comparison, the TS provides one scheduled 20-minute eating period in the middle of the school day, together with 40 minutes of outdoor time after lunch, and two 15-minute recesses for physical activity (14). Widespread implementation of the BSD schedule has occurred, but the extent is difficult to quantify, as the BSD schedule is not government mandated and formal surveillance is not in place. Limited systematic evaluation of the potential health impacts, including the influence on children's eating habits, has taken place. One published study to date, compared the nutrient composition of packed lunches consumed by students attending one BSD schedule school to those at a school following the TS (17). Significantly more beverages were provided in BSD schedule home-packed lunches (1.42 vs. 1.18 beverages per day, $p=0.04$), but the volume and calories from beverages was not significantly different between school schedules (17). Consumption of macronutrients and micronutrients also did not significantly differ between schedules (17). However, further research is required, using a larger number of schools and students, to determine if there are differences in

home-packed lunch contents and intake in this new school structure, which has additional time provided for eating. The purpose of the present study was to compare the type and quantity of foods elementary school children are bringing and consuming while on the BSD schedule compared to the TS.

Figure 3.1. Structure of Instructional and Break Times in the Balanced School Day vs. Traditional Schedule



3.2 Methods

3.2.1 Participants

Elementary schools within a Southwestern Ontario school board were contacted through email and telephone to participate in the study. Initially school principals self-selected their school to be part of the study, while targeted recruitment was later used to capture a representative sample based on school location (rural vs. urban) and the school board's measure of socio-economic status (Social Risk Index). Following signed consent from a school principal, parent packages were sent home with students in participating classrooms, containing a parental letter of information, child assent form and a parental survey tailored for the specific school schedule. Grade 3 and 4 students (aged 7-10 years) were recruited to participate, as they have likely not reached a stage of puberty where

rapid growth spurts could be impacting food intake (18). Exclusion criteria included students who went home for lunch daily, received a therapeutic diet, and/or had a chronic or debilitating condition that could impact food intake, metabolism, growth, or ability to stand on their own (e.g., diabetes, phenylketonuria, Prader-Willi syndrome). This research protocol was approved by the University of Western Ontario's Non-Medical Research Ethics Board with concurrent school board approval, and all participants (principals, parents, and children) provided informed consent.

3.2.2 Dietary Assessment

A cross-sectional study design was utilized in which direct food observation data were collected from each child participant. All visible food and beverage items packed and consumed by students during all eating periods of a school day were assessed. This dietary assessment method has been shown to be effective in a defined setting, such as a school classroom or lunchroom, and is accurate and reliable when conducted by trained individuals (19–23). Upper year undergraduate food and nutrition students (observers) received ten hours of annual training focused on direct observation techniques: visual identification of home-packed and pre-packaged items, and portion size estimation in both a controlled setting and a simulated school lunchroom environment. A training manual, containing the study's protocol, portion sizes of typical pre-packaged items and reusable containers, and Eating Well with Canada's Food Guide (CFG) serving sizes, was provided to observers to refer to during data collection. Training also provided time for observers to become familiar with the standard observation form and practice providing detailed information for each food and beverage item observed, including brand name, packaging description, portion size packed and consumed, CFG serving size when applicable, and if the item was traded, spilled or discarded during the observation time period. Interobserver reliability (IOR) was assessed prior to data collection, and showed a high level of agreement between observers for item identification, portion size, and amount consumed (23). Full details of the methodology used to test IOR and the corresponding results have been outlined elsewhere (23).

Observation dates were not disclosed to parents and students, in an effort to minimize influence on what was packed in students' lunches, and consideration was

taken for holidays and other school events that might interfere with usual consumption at school. Each observer viewed up to three participating students at one time, while maintaining some distance from lunch tables to remain unobtrusive. Food items were classified into eight categories: grain products, milk and alternatives, meat and alternatives, fruit, vegetables, 100% fruit juice, sugar-sweetened beverages, and snacks. Vegetables, fruit, sugar-sweetened beverages and 100% fruit juice were recorded as separate categories to determine the individual contribution of each category to packed lunch intake, as packed lunches have been reported to be high in sugar (10,24), while providing few vegetables (10,25–27). Vegetables included both vegetables served independently and as part of a main entrée. One serving of sugar-sweetened beverage was identified as 125mL for comparison to a CFG serving of 100% fruit juice. A single snack serving was based on the reference amounts established by Health Canada for the Food and Drug Regulations (28), as well as the typical packaging size of pre-packaged snack items found at grocery retailers (20-35grams or 100-120mL). Separate categories also allow for comparison between studies conducted in different countries with varying national recommendations (29). In addition, the fluid content of opaque water bottles was recorded as water if observers were uncertain of the exact fluid content, and food or beverages consumed from a school milk, snack, or breakfast program were only recorded as consumption data, as parents did not pack these items.

There is no standard definition for snacks in the literature, and snacks have been classified according to varying methods, e.g., nutrient cut-off values (10,30,31), sweet and savoury taste (7,32), level of processing (33), time of day a food item is consumed (34), Health Canada's Bureau of Nutritional Sciences (BNS) food group classifications (34), and perceived energy density (35). For the purpose of this study, a snack was defined as a non-entrée, non-beverage, non-fresh fruit or vegetable, sweet or savoury item, packaged for consumption in one sitting. In addition, snack items were grouped into BNS food group classifications (i.e., sweet snacks, crackers and cereal, baked goods, dairy, popcorn and chips, nuts and seeds, and other snacks) (36), with a small number of snacks requiring professional judgement to determine the appropriate category. A few food items fit into both a snack category and a CFG group, and were recorded in both

places when appropriate. These items were often packaged and advertised for consumption outside of meals in one sitting (e.g., yogurt tubes).

3.2.3 Data Analyses

Statistical analyses were performed using Statistical Package for Social Sciences (SPSS) (IBM Corp. Released 2012,Version 21.0, Armonk, NY). Descriptive statistics were generated for demographic data and all outcome variables according to school schedule. The proportion of children receiving each food category and each snack category (by BNS food group classification) packed in their lunch by school schedule was assessed using the χ^2 test. Mean servings of food categories packed and eaten in the BSD and TS were compared using the Independent t-test; however, the distributions of some food categories (e.g., vegetables) were negatively skewed due to the large proportion of children who did not have these categories packed. Thus, for these food categories, median servings packed and eaten by students in the TS and BSD schedule were compared using the Mann Whitney U test, with mean values presented for ease of interpretation. The mean serving sizes of packed food categories were presented for all students and for only those students who received the food category packed in their lunch, in order to provide perspective of the actual serving size packed. This is especially important for food items that few children received (e.g., vegetables). Likewise, the mean serving size of food categories eaten was shown for all students and for only those who consumed the food category that was packed in their lunch or purchased from school. The χ^2 test was also used to evaluate the proportion of children achieving one-third of CFG recommendations by school schedule. Lastly, a one-sample t-test was utilized to compare the mean servings of food groups consumed within each schedule to one-third of CFG recommendations, with the exception of food groups with skewed data. Adequacy of intake from food groups with skewed data were determined by comparing median servings consumed to one-third of CFG recommendations, using a One-Sample Wilcoxon signed rank test; however, mean values were presented for consistency. Notably, the age range of participating students, aged 7-10 years, spanned two age group recommendations in CFG (4-8 years and 9-13 years). The mean serving size of CFG food groups packed and consumed by participating students in each schedule, were compared

to the appropriate CFG recommendation based on participant age at the time of data collection. A $p<0.05$ was considered statistically significant.

3.3 Results

Third and fourth-grade children from nineteen elementary schools (10 TS and 9 BSD) in a Southwestern Ontario school district were invited to participate in the study. Of the 731 children (aged 7-10 years) invited, 339 (46%) provided consent; however, there were 5 screen failures, whereby the consent was not signed or the parental survey was not returned. The final response rate was further reduced to 321 (44%), because 13 children who provided consent were absent from school or went home for lunch during observation.

Table 3.1. Characteristics of Students by School Schedule

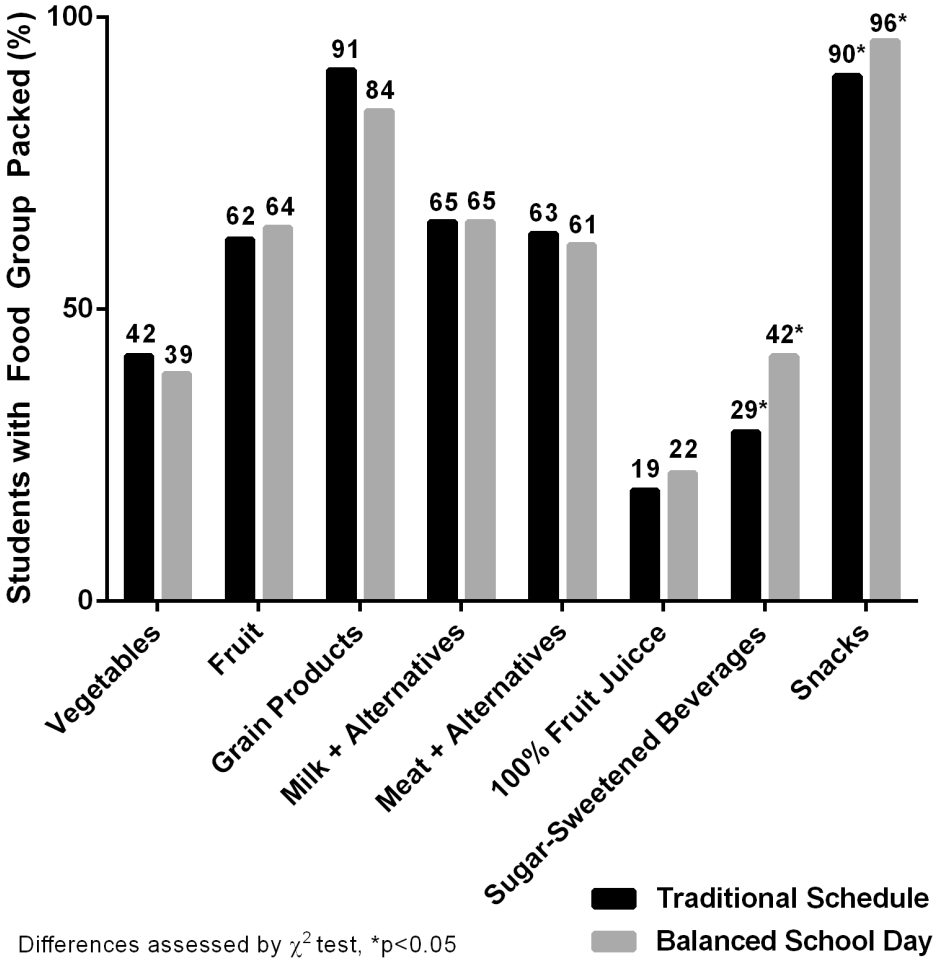
	Total		TS		BSD		p value
	Mean or n	SD or %	Mean or n	SD or %	Mean or n	SD or %	
Number of participants	321	100	168	52	153	48	
Sex (n, %)							0.953†
Male	160	49.8	84	50	76	49.7	
Female	161	50.2	84	50	77	50.3	
Grade (n, %)							0.18†
Three	172	53.6	57.1	57.1	76	49.7	
Four	149	46.4	42.9	42.9	77	50.3	
School Location (n, %)							0.413†
Rural	133	41.4	66	39.3	67	43.8	
Urban	188	58.6	102	60.7	86	56.2	
Age (years)	9.12	0.63	9.00	0.63	9.25	0.59	<0.001¶

†Differences assessed using χ^2 test

¶Differences assessed using Independent T-Test

Characteristics of the participating schools and students are shown in Table 3.1. There was no significant difference between school schedules for sex, grade, or school location. Students in the BSD schedule were older than those in the TS ($p<0.001$); however, this difference was not deemed relevant because it was only three months and the overall age range was narrow. Milk was available to students for a subsidized cost through school milk programs in 67% of BSD schedule and 100% of TS schools observed (data not displayed).

Figure 3.2. Food Group Categories in Packed Lunches by School Schedule



Significantly more children in the BSD schedule had sugar-sweetened beverages (SSBs) or snacks packed in their lunch than the TS (42% vs. 29% and 96% vs. 90%, $p<0.05$, respectively) (Figure 3.2). There were no significant differences in the proportion of children in the two schedules who had the other food group categories packed. Regardless of school schedule, only 41% of students had vegetables in their lunch, while 93% had a snack packed (data not displayed). With respect to snacks, there were no significant differences in the proportion of students in the BSD, compared to the TS, with snacks in each of the BNS classifications (i.e., sweet snacks, crackers and cereal, baked goods, dairy, popcorn and chips, nuts and seeds, and other snacks) (all $p>0.05$) (data not displayed). The baked goods BNS classification was the most prevalent, with 72% of

BSD and 64% of TS packed lunches containing such a food item (not significant [ns]; data not displayed). Table 3.2 depicts the mean serving size of food categories packed in BSD compared with TS packed lunches, for both the entire sample and for only those students who were observed with the food category packed in their lunch. Students in the BSD had significantly greater mean servings of milk and alternative, SSB, and snack items packed in their lunches than TS students (0.69 vs. 0.47 servings, $p=0.016$; 0.91 vs. 0.57 servings, $p=0.014$; and 2.74 vs. 2.24 servings, $p=0.003$, respectively). The mean serving sizes of milk and alternatives and snack items packed in lunches remained significantly higher in BSD lunches when students, who did not have the food category packed, were excluded from the analysis. The portion size of SSBs received in packed lunches was similar between schedules when analysis was confined to only those children who received a sugar-sweetened beverage in their lunch (1.96 TS vs. 2.19 BSD, ns). Nevertheless, significantly more students in the BSD schedule than TS received a SSB in their lunch (42% vs. 29%, $p<0.05$).

Table 3.2. Students with Food Group Categories Packed by School Schedule

	TS (n=168)			BSD (n=153)			
Food Group Category	%	Mean	SD	%	Mean	SD	p value†
Vegetables (CFG serving)							
All Students	100.0	0.37	0.60	100.0	0.45	0.83	0.957 ‡
Students with packed food group category	42.3	0.86	0.65	39.2	1.14	0.98	0.063
Fruit (CFG serving)							
All Students	100.0	0.83	0.89	100.0	0.81	0.79	0.879 ‡
Students with packed food group category	61.9	1.35	0.76	64.1	1.26	0.63	0.377
Grains Products (CFG serving)							
All Students	100.0	1.67	0.97	100.0	1.60	1.06	0.547
Students with packed food group category	91.1	1.84	0.85	76.8	1.90	0.88	0.526
Milk & Alternatives (CFG serving)							
All Students	100.0	0.47	0.49	100.0	0.69	0.70	0.016 ‡
Students with packed food group category	65.5	0.72	0.44	64.7	1.07	0.60	<0.001
Meat & Alternatives (CFG serving)							
All Students	100.0	0.38	0.41	100.0	0.42	0.49	0.725 ‡
Students with packed food group category	62.5	0.60	0.37	61.4	0.68	0.46	0.179
100% Fruit Juice (CFG serving)							
All Students	100.0	0.33	0.69	100.0	0.41	0.83	0.479 ‡
Students with packed food group category	19.0	1.72	0.35	22.2	1.83	0.71	0.435
Sugar-Sweetened Beverages (125mL serving)							
All Students	100.0	0.57	0.99	100.0	0.91	1.24	0.014 ‡
Students with packed food group category	29.2	1.96	0.79	41.8	2.19	0.95	0.173
Snack (20-35g serving/ 100-120mL serving)							
All Students	100.0	2.24	1.48	100.0	2.74	1.55	0.003
Students with packed food group category	89.9	2.49	1.35	96.1	2.86	1.48	0.026

†Differences assessed using Independent T-Test, except where noted; ‡Differences assessed using Mann Whitney U-test to compare medians due to negative skew in the data (however, for consistency, data is presented as means).

Table 3.3. Food Group Categories Consumed by School Schedule

	TS (n=168)			BSD (n=153)			
Food Group Category	% n	Mean	SD	%n	Mean	SD	p value†
Vegetables (CFG serving)							
All Students	100.0	0.27	0.48	100.0	0.33	0.58	0.831 ‡
Students with packed food group category	42.3	0.65	0.56	37.9	0.77	0.65	0.246
Fruit (CFG serving)							
All Students	100.0	0.73	0.81	100.0	0.65	0.75	0.543 ‡
Students with packed food group category	61.3	1.15	0.74	63.4	0.98	0.75	0.096
Grains Products (CFG serving)							
All Students	100.0	1.34	0.87	100.0	1.27	0.98	0.486
Students with packed food group category	90.5	1.46	0.85	83.7	1.50	0.89	0.670
Milk & Alternatives (CFG serving)							
All Students	100.0	0.52	0.52	100.0	0.59	0.60	0.585 ‡
Students with packed or purchased food group category	72.0	0.72	0.48	67.3	0.87	0.54	0.031
Meat & Alternatives (CFG serving)							
All Students	100.0	0.34	0.39	100.0	0.31	0.38	0.461 ‡
Students with packed food group category	61.3	0.54	0.37	61.4	0.50	0.38	0.449
100% Fruit Juice (CFG serving)							
All Students	100.0	0.27	0.61	100.0	0.38	0.81	0.254 ‡
Students with packed food group category	19.0	1.37	0.65	22.2	1.64	0.90	0.155
Sugar-Sweetened Beverages (125mL serving)							
All Students	100.0	0.48	0.83	100.0	0.75	1.02	0.028 ‡
Students with packed food group category	29.2	1.64	0.70	41.8	1.78	0.80	0.309
Snack (20-35g serving/ 100-120mL serving)							
All Students	100.0	1.93	1.36	100.0	2.37	1.44	0.005
Students with packed or provided by school food group category	92.9	2.08	1.30	97.4	2.43	1.40	0.023

†Differences assessed using Independent T-Test, except where noted; ‡Differences assessed using Mann Whitney U-test to compare medians due to negative skew in the data (however, for consistency, data is presented as means).

When comparing mean serving sizes of food categories consumed from home-packed lunches (Table 3.3), SSBs and snacks were significantly higher in the BSD versus the TS (0.75 vs. 0.48 servings, p=0.028; and 2.37 vs. 1.93 servings, p=0.005, respectively). Students in the BSD consumed greater mean servings of milk and alternatives, and snack items when analysis included only those who had the category available to them (i.e., they had the item packed in their lunch, purchased it from school, or had it provided to them through a snack program at the school).

Table 3.4 shows the mean proportion of children achieving one third of CFG recommendations for both packed and eaten food groups by school schedule. A significantly greater proportion of packed lunches in the BSD schedule provided an adequate amount of milk and alternative items for one third of daily intake (36% vs. 21%, p=0.003, respectively); however, in both schedules less than half of children had adequate intakes of milk and alternatives. The mean proportion of children whose consumption met one-third of CFG recommendations for vegetables and fruit was also poor in both schedules (28% BSD and 31% TS, ns). The proportion meeting recommendations is further reduced when fruit juice is excluded from the analysis (16% BSD and 24% TS, ns). Similarly, the number of servings of vegetables and fruit consumed by students less than 9 years of age, in both school schedules, fell significantly below CFG recommendations (one-third CFG, 1.67 servings) (Table 3.5). Intake of vegetables and fruit remained inadequate when fruit juice was not included as a fruit serving. TS students, less than 9 years of age, consumed significantly fewer servings of milk and alternatives than one-third of CFG recommendations (0.49 vs. 0.67 servings, p=0.001, respectively); however, consumption of milk and alternatives by BSD students less than 9 years of age adequately met recommendations (0.71 vs. 0.67 servings, p=0.674, respectively).

The intake of students, 9 years and older, in both schedules, failed to meet one-third of CFG recommended servings for grain products, milk and alternatives, and vegetables and fruit (i.e. with and without the inclusion of fruit juice). BSD students, aged 9 years and older, consumed significantly fewer servings of meat and alternatives than one-third of CFG recommendations (0.26 vs. 0.33-0.67 servings, p=0.003), whereas intake of TS students 9 years and older did not significantly differ from recommendations (0.32 vs. 0.33-0.67 servings, p=0.679) (Table 3.5). Notably, the contents of packed lunches were not always consumed in their entirety, with the proportion of vegetables left uneaten higher in both schedules (30% BSD and 20% TS), compared to only 10% and 11% of snacks and 13% of SSBs left uneaten in the BSD and TS, respectively (Table 3.6).

Table 3.4. Mean Proportion of Children Achieving One-Third CFG Recommendations

Food Group	TS (n=168) % (no.) meeting recommendations	BSD (n=153) % (no.) meeting recommendations	p value†
Vegetables and Fruit, including fruit juice			
Packed	40.5 (68)	39.2 (60)	0.818
Eaten	31.0 (52)	27.5 (42)	0.491
Vegetables and Fruit, excluding fruit juice			
Packed	29.8 (50)	30.7 (47)	0.852
Eaten	23.8 (40)	16.3 (25)	0.096
Grain Products			
Packed	55.4 (93)	52.3 (80)	0.582
Eaten	42.9 (72)	32.7 (50)	0.061
Milk & Alternatives			
Packed	20.8 (35)	35.9 (55)	0.003*
Eaten	28.6 (48)	30.7 (47)	0.674
Meat & Alternatives			
Packed	53.0 (89)	52.3 (80)	0.902
Eaten	44.0 (74)	41.2 (63)	0.603

CFG, Eating Well with Canada's Food Guide; TS, Traditional Schedule; BSD, Balanced School Day Schedule; no., number of students; †Differences assessed using χ^2 test, *$p<0.05$

Table 3.5. Comparison of Intake to One-Third of CFG Recommended Servings

		TS				BSD			
Food Group	One-third of CFG recommendations	no.	Mean	SD	p Value*	no.	Mean	SD	p Value*
Students aged 4-8 years									
Vegetable and Fruit, including fruit juice	1.67	83	1.39	1.07	0.018	54	1.22	1.10	0.004
Vegetable and Fruit, excluding fruit juice	1.67	83	1.14	1.02	<0.001	54	0.85	0.78	<0.001
Grain Products	1.33	83	1.33	0.77	0.967	54	1.42	1.08	0.558
Milk and Alternatives	0.67	83	0.49	0.48	0.001	54	0.71	0.61	0.674
Meat and Alternatives	0.33	83	0.35	0.43	0.494 †	54	0.40	0.45	0.451 †
Students aged 9-13 years									
Vegetable and Fruit, including fruit juice	2.00	85	1.19	1.17	<0.001	99	1.42	1.35	<0.001
Vegetable and Fruit, excluding fruit juice	2.00	85	0.91	0.94	<0.001 †	99	1.05	1.11	<0.001 †
Grain Products	2.00	85	1.35	0.95	<0.001	99	1.19	0.92	<0.001
Milk and Alternatives	1.00-1.33	85	0.56	0.56	<0.001 †	99	0.26	0.33	<0.001 †
Meat and Alternatives	0.33-0.67	85	0.32	0.36	0.679 †	99	0.26	0.33	0.003 †

CFG, Eating Well with Canada's Food Guide; TS, Traditional Schedule; BSD, Balanced School Day Schedule; no., number of students
*Differences assessed using a One-Sample T-Test, except where noted; † Differences assessed using a One-Sample Wilcoxon signed rank test for food groups with skewed data (however, for consistency, data is presented as means).

Table 3.6. Proportion of Food Group Categories Left Uneaten

	TS			BSD		
Food Group Category	n	%	SD	n	%	SD
Grains	153	20	32.3	129	21	33.8
Milk	110	-9	80.7	99	14	31.7
Meat	104	12	24.4	94	19	44.5
Fruit	104	13	45.7	98	23	40.3
Vegetables	71	20	30.9	60	30	39.5
100% Fruit Juice	32	19	37.9	34	16	34.1
Sweetened Beverages	49	13	27.4	64	13	29.0
Snacks	151	11	38.9	147	10	41.6

3.4 Discussion

The present study is one of the first in Canada to investigate the association between school schedule (BSD vs. TS), and packed lunch contents and consumption of 7-10 year old elementary school children. A greater proportion of BSD schedule students were found to receive sugar-sweetened beverage and snack items packed in their lunches,

and the portion sizes of snacks were larger in the BSD than in the TS. Although more BSD schedule students had a SSB packed in their lunch, the overall portion size of SSBs that children had packed in their lunch and consumed during school hours did not differ between school schedules. The results of Dorman et al. (17) similarly indicated that the number of beverages packed, although not confined to sugar-sweetened beverages, was significantly higher in the BSD schedule, yet there was no difference between the BSD and TS for total volume of beverages consumed (17). Conversely, one might assume that, in their study, the increased beverages packed in the BSD were not sugar-containing beverages, as total energy and total sugar consumption from beverages was not different between school schedules (17). However, the result of the current study indicates that although BSD and TS student are receiving the same portion size of SSBs, more BSD schedule students are receiving a SSB in their lunch. Parents of children in the BSD schedule may be providing a SSB in addition to the beverage they would typically pack (e.g., water, milk or 100% fruit juice), to ensure their child has something to drink during the second 20 minute eating period in the BSD schedule. Alternatively, socio-economic factors may be influencing the number of SSBs provided in the BSD schedule, as low-income children have been found to be more likely than high-income children to consume SSBs (37). Future research is needed to explore the mechanisms behind the number of students receiving SSBs in the BSD schedule, in order to establish appropriate intervention strategies.

The percentage of students receiving a milk and alternative item was similar between schedules, but the serving size packed was significantly greater in BSD home-packed lunches. This is likely related to the greater number of TS schools offering a milk program to their students, prompting fewer TS parents to pack a fluid milk in their child's lunch. This is also a probable explanation for fewer TS packed lunches meeting one third of CFG recommendations for milk and alternatives; however, the proportion of children in the TS who consumed adequate milk and alternatives increased due to consumption from milk purchased at school. Nevertheless, after accounting for those who purchased milk from school or received a dairy product in their lunch, the average serving of milk and alternatives consumed was greater for BSD students than for TS students. It is important to note, however, that the intake of less than 50% of all participating students

adequately met CFG recommendations for milk and alternatives, and the mean serving size of milk and alternatives consumed by older students in both schedules fell below recommendations. Similarly, fewer home-packed lunches in the UK and USA were found to provide a dairy item when compared to school provided meals (10,38). In the American GREEN Project Lunch Box Study, only 31% of home-packed lunches and 12% of home-packed snacks contained a portion of milk, yogurt or cheese, and very few lunches (15%) and snacks (1%) met the federal school nutrition standard (1 cup of milk) (26). Given the inadequate intake of milk and alternatives in the BSD and TS of the current study, it would not be surprising if the corresponding intakes of calcium and vitamin D were also inadequate. This is concerning as adequate levels of calcium and vitamin D are needed during childhood to support optimal bone development to mitigate the risk of future bone related health risks (39); however, the analyses of nutrient intake between school schedules will be described in a separate report. Thus, promotion of milk and alternative items in home-packed lunches in both schedules appears necessary. Low fat milk, particularly in the BSD schedule, would be a beneficial alternative to SSBs, as it provides less energy from sugar and more beneficial nutrients including protein, vitamin A, vitamin D, calcium, phosphorus and magnesium (40).

When compared to TS students, a greater number of BSD schedule students received a snack in their home-packed lunch, and the portion size was larger for both snacks packed and consumed in the BSD. Baked goods (e.g., cookies, muffins, cakes) were the most common type of snack packed in both school schedules. Snack items are also a prominent feature in elementary school home-packed lunches in the USA, UK and New Zealand (6,24,25). In the UK, Evans et al. (7) reported 60% of home-packed lunches contained savoury snacks, 63% contained confectionery items, and 40% contained both a savoury and confectionery snack that did not align with school meal standards. Similarly, chips, cookies, and other snack type foods were found in 28-40% of American home-packed lunches (25) and 45-57% of New Zealand home-packed lunches (24). Likewise, in the study by Pearce et al. (8), UK students with home-packed lunches consumed more non-permitted snacks according to school meal standards, and more confectionery items than students with school meals. Consequently, those students with home-packed lunches also had higher intakes of sugar, sodium, and percentage of energy

from saturated fat than those with school meals (8). Evans et al. (7) also found very few UK home-packed lunches met school nutrient standards for energy, sugar, and sodium, as the average amount of each of these nutrients exceeded recommended values. In contrast to previous home-packed lunch literature, more students in the present study had a snack item packed in their lunch (90% TS and 96% BSD), which is likely related to the utilization of a more broad snack definition. Snack items included those that may be perceived as healthy as they fit into a CFG category (e.g., individually packaged cheese, yogurt tubes); however, these items also contributed to the appropriate CFG food group servings packed and consumed. In addition, these food items are packaged and frequently marketed in a way that would suggest they should be eaten apart from the main entrée of a meal. Nutrient analysis of snacks, which will be described in a separate report, will also provide further perspective on the nutritional quality of snacks being consumed in each schedule. However, given the findings of previous packed lunch studies, it is likely that greater portions of snacks consumed in the BSD schedule are contributing additional sugar, sodium and saturated fat to BSD students' intake during school hours.

The proportion of students receiving vegetables in their lunch was less than other food categories. In addition, the serving size of vegetables, including those incorporated into mixed dishes, packed in the lunches of both schedules was quite small. These findings are consistent with other home-packed lunch studies. The presence of vegetables has been found in very few USA home-packed lunches: 5% of home-packed lunches in Conway et al. (25), 11% in Hubbard et al. (26), and 13% in Johnston et al. (10). Similarly, only 18% of home-packed lunches in a UK study, by Evans et al. (7), had a portion of vegetables. In the current study, a greater proportion of students were receiving a portion of vegetables in their lunch than in previous home-packed lunch research (42%TS and 39% BSD); however, the average serving of vegetables and fruit consumed by students in both schedules did not meet one-third of CFG recommendations. Less than 50% of BSD and TS children met CFG recommendations for vegetable and fruit consumption, even when fruit juice was included as a fruit serving. Notably, 20-30% of packed vegetable servings were being left uneaten in both schedules, while only 10-11% of snacks and 13% of SSBs were left uneaten. This is concerning as high sugar intake, from food items such as snack foods or sugar-sweetened beverages, has been associated

with decreased vegetable and fruit consumption, and weight gain (41–45). Therefore, if parents pack more high sugar food and beverage items in their child's lunch, these items may take the place of vegetables and fruit, or children may become satiated after consuming the preferential high sugar foods and chose to return their packed vegetables and fruit items home.

Multi-stakeholder approaches to increasing children's vegetable and fruit consumption while discouraging the intake of sugar-sweetened beverages and high fat/high sugar snacks is warranted, particularly in the BSD schedule, as consumption behaviours learned in childhood often extend into adulthood (46). An intervention could be in the form of a government funded standardized hot meal program that follows a set of food and nutrient standards to provide daily nutritionally balanced meals to elementary school students at a subsidized cost. In addition, parental and student support could also be addressed through education on healthy eating and approaches to overcoming common barriers to packing a healthy lunch. Multicomponent interventions have been found to be the most effective way to increase vegetable and fruit intake in a school setting (47,48). There is also the possibility that a corresponding positive decrease in snack foods will follow an increase in fruit and/or vegetable intake (49). However, further research is needed to examine the long-term impact of interventions focused on improving the quality of home-packed lunches in elementary schools, as changes observed in consumption may not be sustained (47,50). Overall, it is apparent that changes in children's intake at school will require the involvement of government policies, school principals and teachers, parents and students, and community members (51).

A limitation of the present study relates to the unobtrusive nature of direct observation, whereby observers were only able to record visible food and beverages. Some food items, such as vegetables and fruit, may be underreported if children did not remove them from their lunch bag. However, this approach also minimizes unintended changes in food intake that could occur with a more intrusive food intake assessment. The generalizability of the results is also limited to grade 3 and 4 students and may not be nationally representative. However, a valid and reliable method was used to assess

dietary intake that did not rely on children's self-reporting and has demonstrated efficacy for the population and type of setting utilized in this study. Furthermore, only one observation of food intake was collected per child, which is representative of group level intake, but cannot be inferred to individual usual intake (52).

3.5 Conclusion

The results of the present study suggest the BSD may have unintended negative consequences on the school food environment, which could impact weight status and contribute to future health risks. Support provided to families when switching to the BSD should focus on encouraging more vegetables and fruits and fewer sugar-sweetened beverages and snacks in packed lunches. Future research should further investigate the effect of the BSD on home-packed lunch contents and intake by assessing individual children's packed lunch contents and intake before and after the transition from the TS to the BSD. In addition, research should assess the feasibility and effectiveness of interventions to promote sustainable improvement in the quality of home-packed lunches provided to children who attend elementary schools.

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Chapter 4

4 The LUNCHES study: nutrient composition of elementary school students' home-packed lunches comparing two school schedules

4.1 Introduction

Overweight and obesity continues to be a serious health problem among Canadian children, with approximately one in three children aged 5 to 17 years classified as overweight or obese (1). Given that a large segment of children's days are spent at school, the school environment can be used to positively influence a sizable portion of children's dietary intake, and potentially reduce obesity through health promotion and nutrition policies (2,3). Recently, the Healthy Kids Panel, in Ontario, Canada, released a report with their strategies and recommendations to help achieve the provincial goal of a 20 percent reduction in childhood obesity by 2018 (4). The panel took a multi-sectoral approach with multiple action points to improve the school food environment (4).

At present, many Canadian provinces currently have established polices regulating the type of food and beverages sold to students in elementary and secondary schools, in an attempt to improve the school food environment (5). In the province of Ontario, the Policy/Program Memorandum No. 150: School Food and Beverage Policy (PPM 150), implemented in 2011, classified foods for sale into 'sell most', 'sell less', and 'not permitted for sale' categories (6). The three classifications are based on standard nutrient cut-offs (for fat, saturated fat, sodium, fibre, protein and/or sugar) depending on the food group category (6). However, these standards do not apply to home-packed lunches provided by parents, which is the most common source of food for Canadian elementary school students. Studies in the UK and USA found home-packed lunches to be of low nutritional quality. Compared to children who receive school provided meals, children with home-packed lunches tend to consume more energy (7,8), sugar (7–11), saturated fat (8–11), and sodium (8,10). The food packed and consumed from home-packed lunches in Canadian elementary schools is no exception. The nutrient densities of foods consumed from home-packed lunches by 10-12 year old Prince Edward Island

(PEI) students were found to be of poor nutritional value and were deemed inadequate when compared to DRI recommendations (12).

Another factor that may affect the school environment and packed lunch contents is an adjustment to the school timetable. Such a schedule change has occurred in many Ontario elementary schools and has been labeled the Balanced School Day (BSD) schedule. In contrast to the traditionally offered breaks in the school day (i.e., lunch and two recesses), the BSD schedule provides two 40-50 minute breaks (13,14). During each of the two breaks, 20 minutes is provided for eating (13,14), resulting in more time dedicated to eating than the 20 minutes offered during the 60-minute lunch in the traditional elementary school schedule (TS) (15). Many individual schools and whole school boards in Ontario have adopted this new schedule, although the exact number is difficult to quantify as the implementation is not formally monitored (14,16). Improved learning, dietary intake, and physical activity are often cited as the benefits of the BSD schedule (14,17); however, limited systematic evaluation supporting these benefits exist. Considering home-packed lunches have been shown to be high in energy, saturated fat, sodium and sugar, it is quite plausible that the additional 20-minute eating period provided in the BSD could further diminish the quality of home-packed lunches. It was hypothesized that parents in the BSD schedule may respond to the perceived need for increased food, due to the two eating time periods, by adding an additional pre-packaged snack type item to their child's lunch. To our knowledge, only one study has looked at the nutritional differences between the two school schedules, comparing students' lunches from a BSD schedule school to those in a TS school (18). Additional research is warranted to address the purported nutritional benefits of the BSD schedule. The LUNCHES study (Let's Understand Nutrition and Children's Health in Elementary school Schedules) was instigated to explore the differences in energy and nutrient value of home-packed lunch contents and consumption in the BSD schedule versus the TS.

4.2 Methods

4.2.1 Recruitment and Participants

Email invitations were sent to all elementary schools within a Southwestern Ontario school board requesting their participation in the LUNCHES study. An effort was made to obtain a representative sample of schools from rural and urban locations with varying levels of socio-economic risk. Face-to-face meetings were conducted with school principals to obtain consent, provide a school survey, and ascertain the grade 3 and 4 teachers who were willing to have their classrooms participate. Students 7-10 years of age (grades 3 and 4) were recruited, as they are less likely to have reached the stage of puberty where rapid growth rate could impact food intake and body mass index (BMI) (19).

Parent packages, containing consent forms and a parental survey, were sent home with students in participating classroom. Exclusion criteria included students requiring a therapeutic diet and/or having a chronic condition that could impact food intake, growth, or metabolism (e.g., diabetes). To reduce the influence on what was packed in students' lunches, parents and students were not informed of scheduled data collection dates. Holidays and special school functions were avoided, as typical consumption at school would be disrupted. The study protocol was approved by the University of Western Ontario's Non-Medical Research Ethics Board. All participating schools, parents and children provided consent or assent.

4.2.2 Direct Observation

Trained research assistants utilized direct observation techniques to record every detectable food and beverage item packed and consumed by participating students at each eating opportunity during a school day, as previously described (20). Direct observation is used to validate self-reported dietary assessment methods; when conducted by trained individuals, it has demonstrated reliability in a controlled setting like a school lunchroom or cafeteria (20–22).

4.2.3 Anthropometric Measurements

Height and weight measurements of each participating student were taken by a trained research assistant. A portable stadiometer (Seca Model 213, Seca N. America East, Hanover, MD USA) and a professional digital scale (Tanita WB-100A, Tanita Arlington Heights, Illinois, USA) with a portable digital display were utilized. Three measurements of height were taken for each student, as height is more susceptible to error, and the mean value was recorded to the nearest 0.1cm (23). In an effort to reduce participant discomfort, measurements were taken in a private room, and the results were not disclosed to the participating student, parents, school staff or other students. BMI was calculated from the two anthropometric measurements, and World Health Organization growth charts were used to determine the corresponding gender specific BMI-for-age Z-score and weight category.

4.2.4 School and Parental Surveys

School and parental surveys were used to measure additional factors that could contribute to food and beverage items packed and consumed at school. The Social Risk Index (SRI) was provided by the school board and used as a measure of socio-economic status for each participating school. It was derived using data from students in the 2009 to 2010 school year and incorporated seven risk indicators, including average household income, lone parents and newcomers to Canada in the last five years.

A school food environment score was derived from school survey questions pertaining to the school food retail environment, school food programs, packed lunch resources and healthy eating programs. Scores spanned from zero to nine, with higher scores being indicative of a healthier school food environment.

Parental surveys obtained information regarding food neophobia or picky eating, and two measures of socio-economic status (SES): parental educational attainment and income. Food neophobia occurs when an individual eschews unfamiliar or new foods, while picky eating is an unwillingness to eat a variety of foods related to flavour or texture (24–27). The modified Child Food Neophobia Scale (CFNS) used by Cooke et al. (24) was condensed to promote a high response rate and remain relevant to the packed

lunch school setting. In this study, four questions were used from the 6-item CFNS (24), with each question using a 5-point scale ranging ‘strongly disagree’ to ‘strongly agree’, and higher scores being associated with higher food neophobia (Table 4.1). This 4-question version showed good internal consistency (Cronbach’s alpha= 0.91). In contrast, a single 5-point scale question of ‘My child is a picky eater’ was used to assess picky eating status, as picky eating has been shown to correlate with poor dietary intake (28). Food neophobia and picky eating have both been associated with poor dietary behaviours such as limited fruit and vegetable intake (24,27,28). Parental income and education have also been connected to diet quality. Less healthy dietary patterns have been observed in families with less educated parents (29–31), while healthy eating and active lifestyles appear to be promoted in families with higher incomes and parents who have attained more education (31,32). Parental income ranges provided in the parental survey were identified by the midpoint of each range. Parents who declined to provide their income range (24%) had a value imputed based on the median income level of the school their child attended, allowing for the total sample size to be retained. In addition, low parental education and income rates have been inversely related to the risk of childhood overweight and obesity (33–35). Frequent consumption of nutrient-poor energy-dense foods has in turn been linked to the rising rates of obesity (36). Thus, BMI Z-scores were calculated as higher energy intake could be influenced by an above normal BMI.

Table 4.1. Survey Questions Regarding Food Neophobia

If my child doesn’t know what is in a food, he or she won’t try it.
My child is afraid to eat things he or she has never had before.
My child is very particular about foods he or she will eat.
My child will eat almost anything. (Reverse scoring)

4.2.5 Data Analyses

All recorded food and beverage items were entered into ESHA food processor software (version 10.12.0; ESHA Research, Salem, OR), and two research team members crosschecked all entries with the corresponding hardcopies to ensure accuracy. Food and beverage items were coded with Canadian Nutrient File (CNF) or U.S. Department of Agriculture (USDA) items, when possible, as specific manufacturer-provided nutrient

data tended to have more missing nutrient data values. The data were reviewed for extreme values, and appropriate corrections were made if related to a data entry error.

Data were analyzed using the Statistical Package for Social Sciences (SPSS) (IBM Corp. Released 2012, Version 22.0, Armonk, NY). The significance level used was $p<0.05$. Descriptive statistics were produced, by school schedule, for all demographic and socioeconomic characteristics, as well as packed lunch content values and dietary intake values. The χ^2 test was used to compare categorical demographic and socioeconomic data according to school schedule. Notably, the SRI scale ranges from 1.78 to -0.655, with higher (positive) values representing higher risk schools. An independent t-test was used for continuous variables, while a Mann Whitney U test was performed for skewed nutrient variables. Mean values are presented for all nutrient variables for consistency. The percentage of CNF and USDA food items with vitamin K and vitamin E values was less than 60% (37,38); therefore, these vitamins were excluded from analysis, as the limited information may prevent a complete understanding of students' intake of these vitamins. For the nutrients included in the analysis, the CNF and USDA databases contained information for greater than 70% of food items (37,38), allowing for a more accurate understanding of students' intake of these nutrients.

To determine adequacy of dietary intake, the proportion of children achieving one-third of available reference standards, by school schedule, was evaluated using the χ^2 test. In addition, a one-sample t-test was utilized to compare the mean intake of normally distributed nutrients, within each schedule, to one-third of an available reference standard. A One-Sample Wilcoxon signed rank test was used to assess adequacy of skewed nutrients compared to reference standards, and means were presented for consistency. Dietary Reference Intakes (DRI) had to be relied upon as reference standards, since total nutrient cut-offs for complete school meals do not exist in Canada as they do in the USA (6,39). Available Estimated Average Requirement (EAR), Adequate Intake (AI), or general population values were used as reference standards. The use of EAR values in determining adequacy of group level intakes has been recognized as being suitable (40,41). Thus, EAR values were used for comparison in most cases with only a few exceptions. The Recommended Daily Allowance (RDA) was used for protein,

as it provided a total daily gram value based on a reference body weight. Estimated energy requirement (EER) values were obtained from the 2002/2005 DRI report for low active 9 year old male and female children (42), as 9 years was the mean age of the present study's sample. It is estimated that Canadian children spend sixty percent of their waking hours participating in sedentary behaviours (43), which prompted the use of a low activity level when estimating energy needs of children who participated in the LUNCHES study. Health Canada recently released proposed updates to improve the nutrition information on food labels in Canada, which included a postulated total daily sugar intake associated with a healthy population (44). A value of 100 grams of total sugar was recommended to be the reference value to produce a % Daily Value (%DV) based on a 2000 kilocalorie diet (44,45). While it is recognized that this value is intended to be a reference for an adult population, to our knowledge there is no other standard available that could be used to assess total sugar intake from home-packed lunches. Therefore, the reference value of 100 grams of total sugar per day was utilized as a reference standard in the LUNCHES study.

The energy and nutrient contribution of snack food items was also analyzed separately. A food item was classified as a snack if it was a non-entrée, non-beverage, non-fresh fruit or vegetable, sweet or savoury item, packaged for consumption in a single sitting. Nutrient values of snack food items were analyzed in the same manner as overall nutrient intake.

Linear regression was used to ascertain associations between energy packed or consumed, and potential covariates. Total energy packed was selected to be the dependent variable in the linear regression, as it was the primary outcome variable of interest in the LUNCHES study. A linear regression was also conducted on the secondary outcome variable, energy consumed. Potential predictor variables that significantly correlated with the dependent variable ($p<0.05$) were included in the linear regression models. Bivariate correlations were also conducted for all potential predictor variables to ensure cases of multicollinearity were not simultaneously included in the models.

4.3 Results

A total of 321 grade 3 and 4 students, aged 7-10 years, were observed in 19 recruited elementary schools in Southwestern Ontario. Of the 19 participating schools, 9 were following the Balanced School Day (n=153), whereas 10 were adhering to the Traditional Schedule (n=168). The final sample size represented a 44% response rate (after accounting for 18 students for whom we were unable to obtain all data), as 731 children were invited to participate.

Table 4.2. Participant Characteristics by School Schedule

	Total		TS		BSD		P value†
	Mean or n	SD or %	Mean or n	SD or %	Mean or n	SD or %	
Number of participants (n, %)	321	100	168	52	153	48	
Sex (n, %)							0.953
Male	160	49.8	84	50.0	76	49.7	
Female	161	50.2	84	50.0	77	50.3	
Grade (n, %)							0.180
Three	172	53.6	96	57.1	76	49.7	
Four	149	46.4	72	42.9	77	50.3	
School Location (n, %)							0.413
Rural	133	41.4	66	39.3	67	43.8	
Urban	188	58.6	102	60.7	86	56.2	
Highest education attained by parent*							0.005
Less than post-secondary (n, %)	90	29.5	36	22.5	54	37.4	
Post-secondary (n, %)	215	70.5	124	77.5	91	62.8	
Age (years)	9.12	0.63	9.00	0.63	9.25	0.59	<0.001
Parental income ($)	72,394	35,939	83,296	36,766	60,424	30,959	<0.001
School food environment score	5.7	1.2	5.0	0.8	6.6	0.9	<0.001
Food neophobia score	11.4	4.3	11.5	4.3	11.3	4.4	0.779
BMI Z score	0.6	1.4	0.5	1.3	0.8	1.5	0.085
Social risk Index	0.2	0.4	0.1	0.4	0.3	0.3	<0.001

* Total sample size is 305 due to decline to answer responses (TS= 160, BSD= 145); † Differences assessed using χ^2 test for categorical variables and an Independent t-test for continuous variables

Participating children in the BSD schedule were slightly older (9.25 vs. 9.00 years, P<0.001, respectively) compared to children in the TS; however, the difference of 3 months is unlikely to be clinically significant (Table 4.2). More TS children had parents with post-secondary education (77.5% vs. 62.8%, P=0.005, respectively) and a higher income level ($83296 vs. $60424, P<0.001, respectively) than children in the BSD schedule. Similarly, the mean SRI was significantly higher in the BSD schedule than TS (0.26 vs. 0.12, P<0001, respectively), indicating a higher number of families within the

communities of the BSD schedule schools were at higher risk of disadvantage. Conversely, a significantly higher school food environment score occurred in BSD schedule schools compared to the TS (6.59 vs. 4.95, $P<0.001$, respectively), suggesting the school food environments in BSD schools were more likely to foster healthy eating behaviours.

Students in the BSD schedule had significantly greater energy, carbohydrate, total sugar, percent energy from total sugar, total protein, fat, saturated fatty acids, sodium, calcium and iron from foods packed in their lunches than TS students (Table 4.3). Children in both schedules did not consume all foods packed in their lunches, but consumption of energy, carbohydrates, total sugar, saturated fatty acids and percent energy from total sugar remained significantly higher for BSD schedule students than TS (Table 4.4). However, the mean percentage of energy intake from protein was significantly higher for TS students compared to BSD schedule students (11.61% vs. 10.37%, $P=0.020$, respectively).

Table 4.3. Nutrients Packed by School Schedule

	Total (n=321)		TS (n=168)		BSD (n=153)		
Nutrient	Mean	SD	Mean	SD	Mean	SD	P value*
Energy (kJ)	2885.9	1046.88	2658.98	951.34	3128.14	1100.36	<0.001
Energy (kcal)	688.96	250.96	635.51	227.38	747.64	262.99	<0.001
Carbohydrates (g)	107.29	39.95	98.79	38.08	116.62	39.99	<0.001
% Energy from Carbohydrates	63.25 §	12.42	62.74	12.92	63.81 ‡	11.87	0.439
Total sugar (g)	47.56	26.10	40.64	23.23	55.16	27.03	<0.001
% Energy from Total sugar	27.97 §	13.60	25.67	13.05	30.50 ‡	13.77	0.001
Fibre (g)	5.76	2.92	5.52	2.90	6.03	2.93	0.123
Protein (g)	18.48	9.09	17.51	8.45	19.55	9.65	0.046
% Energy from Protein	10.89 §	4.54	11.30	4.80	10.44 ‡	4.20	0.085
Fat (g)	22.03	12.61	20.14	11.49	24.10	13.48	0.005
% Energy from Fat	27.71 §	10.54	27.68	11.03	27.73 ‡	10.00	0.965
SFA (g)	7.68	5.03	6.87	4.36	8.57	5.55	0.003
% Energy from SFA	9.64 §	5.01	9.50	5.16	9.80 ‡	4.86	0.591
Na (mg)	1014.06	506.79	923.53	445.65	1113.48	550.89	0.001
Ca (mg)	263.87	181.61	240.34	153.91	289.71	205.25	0.016
Fe (mg)	4.54	2.31	4.17	2.27	4.94	2.30	0.003
P (mg)	336.48	179.59	323.54	160.50	350.69	198.02	0.181
Mg (mg)	72.93	38.27	70.17	37.62	75.97	38.87	0.176
K (mg)	653.08	332.37	623.99	327.38	685.01	335.93	0.101
Zn (mg)	2.35	1.53	2.27	1.67	2.45	1.36	0.305
Vit A RAE (µg)	135.95	197.35	115.45	164.66	158.45	226.34	0.094 †
Thiamin (mg)	0.52	0.32	0.49	0.28	0.56	0.36	0.063
Vitamin B12 (µg)	0.73	0.72	0.70	0.73	0.77	0.71	0.386 †
Folate DFE (µg)	97.87	75.11	91.39	77.80	104.99	71.61	0.104
Riboflavin (mg)	0.54	0.35	0.50	0.30	0.58	0.39	0.064
Niacin NE (mg)	8.65	5.12	8.17	4.58	9.17	5.60	0.082
Vitamin B6 (mg)	0.42	0.35	0.40	0.30	0.44	0.39	0.259
Vitamin C (mg)	45.78	50.34	45.73	53.95	45.85	46.23	0.467 †
Vitamin D (µg)	0.41	0.91	0.37	1.02	0.44	0.78	0.190 †

kcal, Kilocalorie; Na, Sodium; RAE, retinol activity equivalents; NE, Niacin Equivalents; DFE, dietary folate equivalents

*Differences assessed using Independent T-Test, except where noted; †Differences assessed using Mann Whitney U-test to compare medians (however, for consistency, data is presented as means).

‡n=152 for the following as one student had nothing packed in their lunch but received food from school. Therefore, total sample size is impacted and noted by §n=320.

Table 4.4. Nutrients Consumed by School Schedule

	Total (n=321)		TS (n=168)		BSD (n=153)		
Nutrient	Mean	SD	Mean	SD	Mean	SD	P value*
Energy (kJ)	2421.5	914.41	2318.14	827.29	2541.92	987.20	0.025
Energy (kcal)	579.54	218.09	554.05	197.73	607.53	235.95	0.029
Carbohydrates (g)	90.46	35.10	86.06	32.73	95.30	37.05	0.019
% Energy from Carbohydrates	63.62	13.01	62.92	12.87	64.39	13.16	0.312
Total sugar (g)	42.08	22.55	37.68	19.78	46.91	24.41	<0.001
% Energy from Total sugar	30.07	14.80	27.91	13.54	32.45	15.77	0.006
Fibre (g)	4.83	2.59	4.82	2.56	4.84	2.62	0.932
Protein (g)	15.89	8.22	15.91	8.31	15.87	8.16	0.959
% Energy from Protein	11.02	4.81	11.61	5.09	10.37	4.41	0.020
Fat (g)	18.29	10.51	17.27	9.49	19.40	11.45	0.073
% Energy from Fat	27.24	10.62	27.17	10.50	27.31	10.79	0.911
SFA (g)	6.55	4.35	6.00	3.69	7.14	4.92	0.020
% Energy from SFA	9.70	5.09	9.51	4.92	9.91	5.29	0.485
Na (mg)	824.29	461.47	786.89	420.43	865.36	500.87	0.131
Ca (mg)	239.81	164.90	234.96	155.54	245.14	174.97	0.583
Fe (mg)	3.77	2.19	3.55	2.11	4.01	2.26	0.058
P (mg)	301.10	164.70	304.06	159.29	297.84	170.91	0.737
Mg (mg)	62.93	32.19	61.82	31.50	64.16	32.98	0.517
K (mg)	579.45	313.85	577.53	298.45	581.54	330.90	0.910
Zn (mg)	2.06	1.45	2.06	1.61	2.07	1.26	0.941
Vit A RAE (µg)	122.87	158.04	111.20	139.34	135.68	175.89	0.632 †
Thiamin (mg)	0.43	0.28	0.42	0.27	0.44	0.29	0.556
Vitamin B12 (µg)	0.69	0.65	0.71	0.70	0.66	0.59	0.514
Folate DFE (µg)	81.15	69.57	78.33	74.42	84.24	63.92	0.445
Riboflavin (mg)	0.47	0.28	0.48	0.29	0.46	0.27	0.572
Niacin NE (mg)	7.18	4.28	7.20	4.39	7.17	4.18	0.952
Vitamin B6 (mg)	0.35	0.27	0.35	0.28	0.35	0.27	0.886
Vitamin C (mg)	38.59	43.43	37.57	43.31	39.71	43.68	0.618 †
Vitamin D (µg)	0.57	1.07	0.68	1.27	0.44	0.78	0.351 †

kcal, Kilocalorie; RAE, retinol activity equivalents; NE, Niacin Equivalents; DFE, dietary folate equivalents

*Differences assessed using Independent T-Test, except where noted; †Differences assessed using Mann Whitney U-test to compare medians (however, for consistency, data is presented as means).

Table 4.5 illustrates the mean proportion of children whose intake achieved one-third of the DRI standards or population recommendations by school schedule. Mean intakes were compared to the DRI recommendations for 9-13 year olds, as the mean age for the total sample size was 9.12 years. There were no significant differences between school schedules in the proportion of children meeting recommendations ($p>0.05$). Notably, less than 7% of students in both schedules met one-third of the DRI recommendation for fibre, potassium and vitamin D. The mean intake of each nutrient consumed within each schedule was also compared to one-third of the DRI standard or population recommendation (Table 4.6). In both schedules, intake of calcium, phosphorus, zinc, vitamin A (females), and vitamin D fell below recommendations (one-third of EAR). Fibre and potassium intakes in both schedules were below recommended

adequate intake (one-third of AI) levels, while sodium exceeded one-third of daily recommendations. In fact, sodium intake surpassed one-third of the tolerable upper level (UL) of 733.3mg. At the same time, intake of carbohydrates, iron, thiamin, riboflavin, niacin, vitamin B6, vitamin B12, and vitamin C exceeded recommendations in both schedules (one-third EAR). Protein intake was also above recommendations in both schedules (one-third RDA). Total sugar intake surpassed the recommendation purported by Health Canada. Only folate and female energy intake in both schedules were not significantly different from nutrient recommendations. Conversely, the amount of magnesium consumed in the TS, and the intake of energy and vitamin A by male TS students were significantly below recommendations, while intake of these nutrients by BSD students adequately met recommendations.

It is important to note that one child in the TS had a multivitamin supplement packed in their lunch, and the vitamin was consumed during data collection. In addition to current nutrient differences observed between school schedules, home-packed lunch contents in the BSD schedule contained significantly more folate, thiamin, and riboflavin than TS home-packed lunches when the nutrient data of this child were removed from analyses (data not displayed). Furthermore, it was found that BSD students also consumed significantly more iron than TS students when the intake of the child with the multivitamin was excluded from analyses (data not displayed). However, the data presented in the current study includes the nutrient profile of the child who consumed the multivitamin supplement, as it was ingested during school hours.

Table 4.5. Mean Proportion of Children Consuming One-Third of Recommendations

		TS (n=168)		BSD (n=153)		
Nutrient	One-third Recommended nutrient intake*	no.	% meeting recommendations	no.	% meeting recommendations	P value†
Energy (KJ)	7475.8♂, 6945.4♀	73	43.5	82	53.6	0.069
Energy (kcal)	595.7♂, 553.33♀	73	43.5	82	53.6	0.069
Carbohydrate (g)	33.3	163	97.0	148	96.7	0.881
Total Sugar (g)	33.3	100	59.5	105	68.6	0.090
Fibre (g)	10.3♂, 8.7♀	10	6.0	8	5.2	0.778
Protein (g)	11.3	114	67.9	103	67.3	0.918
Sodium (mg)	500.0	122	72.6	120	78.4	0.227
Calcium (mg)	366.7	31	18.5	31	20.3	0.682
Iron (mg)	2.0	134	79.8	125	81.7	0.661
Phosphorus (mg)	351.7	67	39.9	50	32.7	0.181
Magnesium (mg)	66.7	65	38.7	61	39.9	0.829
Potassium (mg)	1500.0	0	0.0	2	1.3	0.137
Zinc (mg)	2.3	54	32.1	57	37.3	0.336
Vitamin A RAE (µg)	148.3♂, 140.0♀	48	28.6	47	30.7	0.674
Thiamin (mg)	0.2	126	75.0	119	77.8	0.559
Vitamin B12 (mg)	0.5	97	57.7	79	51.6	0.272
Folate DFE (µg)	83.3	62	36.9	58	37.9	0.853
Riboflavin (µg)	0.3	127	75.6	120	78.4	0.547
Niacin NE (mg)	3.0	147	87.5	133	86.9	0.878
Vitamin B6 (mg)	0.3	96	57.1	82	53.6	0.523
Vitamin C (mg)	13.0	98	58.3	93	60.8	0.655
Vitamin D (µg)	3.3	4	2.4	0	0.0	0.055

no., number of students meeting recommenations; DRI, Dietary Reference Intakes; RAE, retinol activity equivalents; NE, Niacin Equivalents; DFE, dietary folate equivalents; ♂, male; ♀, female; *One-third of the available Estimated Average Requirement (EAR), Adequate Intae (AI), Acceptable Macronutrient Distribution Range (AMDR), Estimated Energy Requirement (EER), or general population recommendation value, for 9-13 year old children, were the reference values used for the appropriate nutrients; Protein intakes were compared to RDA values, and energy was compared to a gender specific EER calculated for the sample; Fibre, sodium, and potassium intakes were compared to the appropriate AI; Total sugar was compared to Health Canada's suggested daily intake; All remaining nutrients were compared to the appropriate EAR value; †Differences assessed using χ^2 test

Table 4.6. Comparison of Intake in each School Schedule to One-Third of Recommendations

		TS				BSD			
Nutrient	One-third Recommended nutrient intake*	no.	Mean	SD	P value†	no.	Mean	SD	P value†
Energy (kcal/d)	595.7 ♂	84	546.61	186.79	0.018	77	644.93	220.49	0.054
	553.3 ♀	84	561.48	208.95	0.722	76	569.65	246.32	0.565
Carbohydrate (g/day)	33.3	168	86.06	32.73	<0.001	153	95.30	37.05	<0.001
Total Sugar (g/day)	33.3	168	37.68	19.78	0.005	153	46.91	24.41	<0.001
Fibre (g/day)	10.3 ♂	84	4.44	2.58	<0.001	77	5.19	2.69	<0.001
	8.7 ♀	84	5.20	2.51	<0.001	76	4.50	2.51	<0.001
Protein (g/day)	11.3	168	15.91	8.31	<0.001	153	15.87	8.16	<0.001
Na (mg/d)	500.0	168	786.89	420.43	<0,001	153	865.36	500.87	<0.001
Ca (mg/d)	366.7	168	234.96	155.54	<0.001	153	245.14	174.97	<0.001
Fe (mg/d)	2.0	168	3.55	2.11	<0.001	153	4.01	2.26	<0.001
P (mg/d)	351.7	168	304.06	159.29	<0.001	153	297.84	170.91	<0.001
Mg (mg/d)	66.7	168	61.82	31.50	0.048	153	64.16	32.98	0.347
K (mg/d)	1500.0	168	577.53	298.45	<0.001	153	581.54	330.90	<0.001
Zn (mg/d)	2.3	168	2.06	1.61	0.030	153	2.07	1.26	0.012
Thiamin (mg/d)	0.2	168	0.42	0.28	<0.001	153	0.44	0.29	<0.001
Vitamin B12 (µg/day)	0.5	168	0.71	0.70	<0.001	153	0.66	0.59	0.001
Folate DFE (µg/day)	83.3	168	78.33	74.42	0.385	153	84.24	63.92	0.861
Riboflavin (mg/d)	0.3	168	0.48	0.29	<0.001	153	0.46	0.27	<0.001
Niacin NE (mg/d)	3.0	168	7.20	4.39	<0.001	153	7.17	4.18	<0.001
Vitamin B6 (mg/d)	0.3	168	0.35	0.28	<0.001	153	0.35	0.27	<0.001
Vit A RAE (µg/day)	148.3 ♂	84	95.43	92.72	<0.001 ‡	77	143.82	174.12	0.061 ‡
	140.0 ♀	84	126.97	170.34	0.001 ‡	76	127.45	178.43	0.007 ‡
Vitamin C (mg/d)	13.0	168	37.57	43.31	<0.001 ‡	153	39.71	43.68	<0.001 ‡
Vitamin D (µg/day)	3.3	168	0.68	1.27	<0.001 ‡	153	0.44	0.78	<0.001 ‡

no., number of students meeting recommenations; DRI, Dietary Reference Intakes; RAE, retinol activity equivalents; NE, Niacin Equivalents; DFE, dietary folate equivalents; ♂, male; ♀, female; *One-third of the available Estimated Average Requirement (EAR), Adequate Intae (AI), Acceptable Macronutrient Distribution Range (AMDR), Estimated Energy Requirement (EER), or general population recommendation value, for 9-13 year old children, were the reference values used for the appropriate nutrients; Protein intakes were compared to RDA values, and energy was compared to a gender specific EER calculated for the sample. Fibre, sodium, and potassium intakes were compared to the appropriate AI; Total sugar intake was compared to Health Canada's suggested daily intake; All remaining nutrients were compared to the appropriate EAR value; †Differences assessed using a One-Sample T-test, except where noted; ‡Differences assessed using a One-Sample Wilcoxon signed rank test (means shown for consistency).

Nutrient intakes from snack food items are shown in Table 4.7 by school schedule. Snacks consumed in the BSD schedule were significantly higher in energy, carbohydrates, total sugar, fat, saturated fat and sodium than those eaten in the TS. Conversely, snack items consumed in the BSD schedule were also significantly higher in protein, calcium, iron, potassium, zinc, vitamin A, vitamin B6 and vitamin D when compared to the TS.

Table 4.7. Nutrients Consumed from Snack Items by School Schedule

	Total (n=321)		TS (n=168)		BSD (n=153)		
Nutrient	Mean	SD	Mean	SD	Mean	SD	P value*
Energy (kJ)	1019.14	705.51	920.33	667.23	1127.65	732.2	0.009
Energy (kcal)	243.58	168.62	219.96	159.47	269.52	175.00	0.009
Carbohydrates (g)	37.87	27.03	34.75	25.61	41.30	28.19	0.030
% Energy from Carbohydrates	63.78	16.42 ‡	64.65	15.07 §	62.91	17.78 §	0.364
Total sugars (g)	14.48	13.83	11.91	11.99	17.31	15.14	<0.001 †
% Energy from Total sugars	25.16	19.25 ‡	23.07	19.61 §	27.25	18.71 §	0.061
Fibre (g)	1.53	1.47	1.47	1.41	1.60	1.55	0.428
Protein (g)	4.20	3.53	3.71	3.20	4.73	3.80	0.010
% Energy from Protein	6.92	4.16 ‡	6.71	3.33 §	7.12	4.87 §	0.404
Fat (g)	8.73	7.35	7.67	6.74	9.89	7.83	0.007
% Energy from Fat	30.69	14.48 ‡	29.87	13.64 §	31.52	15.43 §	0.333
SFA (g)	3.02	2.93	2.65	2.68	3.43	3.14	0.019 †
% Energy from SFA	10.76	7.81 ‡	10.63	7.64 §	10.89	8.05 §	0.777
Na (mg)	241.55	204.09	213.00	192.67	272.89	212.15	0.009
Ca (mg)	78.28	87.69	65.95	79.91	91.83	93.92	0.002 †
Fe (mg)	1.45	1.49	1.25	1.20	1.67	1.74	0.021 †
P (mg)	102.08	91.36	93.00	87.12	112.05	95.09	0.063
Mg (mg)	22.39	19.77	20.33	18.70	24.64	20.72	0.052
K (mg)	149.16	150.96	132.97	147.22	166.94	153.48	0.007 †
Zn (mg)	0.61	0.55	0.52	0.52	0.70	0.59	0.003 †
Vit A RAE (µg)	23.04	43.04	22.39	45.70	23.77	40.06	0.038 †
Thiamin (mg)	0.13	0.17	0.12	0.14	0.15	0.19	0.072 †
Vitamin B12 (µg)	0.16	0.22	0.14	0.21	0.18	0.22	0.091 †
Folate DFE (µg)	19.69	23.71	19.99	24.87	19.37	22.45	0.312 †
Riboflavin (mg)	0.15	0.14	0.14	0.14	0.17	0.14	0.053 †
Niacin NE (mg)	1.89	1.76	1.74	1.71	2.05	1.80	0.118
Vitamin B6 (mg)	0.10	0.12	0.08	0.11	0.11	0.14	0.012 †
Vitamin C (mg)	3.55	8.56	3.85	9.67	3.21	7.16	0.165 †
Vitamin D (µg)	0.03	0.10	0.17	0.06	0.41	0.13	0.047

kcal, Kilocalorie; RAE, retinol activity equivalents; NE, Niacin Equivalents; DFE, dietary folate equivalents

*Differences assessed using Independent T-Test, except where noted; †Differences assessed using Mann Whitney U-test to compare medians (however, for consistency, data is presented as means); ‡n=296 for the following as some students did not consume a snack

‡n=296 for the following as some students did not consume a snack; § n=148 for the following as some students did not consume a snack

Table 4.8 displays the outcomes of the regression of energy packed in children's lunches on school schedule, BMI Z-score and school environment score. Both school schedule (p=0.006) and BMI Z-score (p<0.001) were highly related to energy packed in home-packed lunches, while school environment score was not predictive of energy packed (p=0.995). Attending the BSD schedule and higher BMI Z-scores were predictive of more energy being packed in student's lunches.

The results of the regression of energy eaten from home-packed lunches on school schedule, BMI Z-score, school location and SRI are shown in Table 4.9. School schedule (p=0.035), BMI Z-score (p<0.001) and SRI (p=0.037) were highly related to energy consumed from home-packed lunches. The location of participating schools, either rural or urban, was not highly related to the amount of energy eaten from home-packed lunches (p=0.157). Attending the BSD schedule and higher BMI Z-scores were predictive of higher energy consumption, whereas a higher SRI, corresponding to school populations at a higher risk for disadvantage, was predictive of lower energy intake. A number of covariates were not significantly associated with the outcome variables of interest, and as such, were not included in either regression model: food neophobia score, picky eating, age of participating students, parental educational attainment, and parental income (data not displayed). In addition, grade and sex were not included as independent variables in either regression model, as participating students' grade and sex did not result in significant differences in the amount of energy packed and consumed from home-packed lunches (data not displayed).

Table 4.8. Linear Regression assessing the effects of School Schedule, BMI Z-Score, and School Food Environment Score on energy (kcal) packed in students' lunches (n=321)

	β	SE β	Standard β	p value
School Schedule	100.122	36.543	**0.200**	0.006
BMI Z-score	44.657	9.775	**0.244**	<0.001
School Food Environment Score	0.099	15.112	0.000	0.995
Constant	612.567			
Adjusted R^2	0.100			

Significant coefficients are indicated in bold font.

Table 4.9. Linear Regression assessing the effects of School Schedule, BMI Z-Score, Social Risk Index, and School Location on energy (kcal) consumed from home-packed lunches (n=321)

	β	SE β	Standard β	p value
School Schedule	50.001	23.637	**0.115**	0.035
BMI Z-score	45.518	8.429	**0.286**	<0.001
Social Risk Index	−74.018	35.247	**−0.119**	0.037
School Location	34.922	24.608	0.079	0.157
Constant	526.683			
Adjusted R^2	0.117			

Significant coefficients are indicated in bold font.

4.4 Discussion

Home-packed lunches brought to school by children in the BSD schedule contained more energy, carbohydrate, total sugar, protein, fat, saturated fatty acids, sodium, calcium, iron and percent energy from total sugar, resulting in higher intakes of energy, carbohydrates, saturated fatty acids, total sugar and percent energy from total sugar. The total amount of protein consumed was similar between schedules; however, due to higher consumption of other macronutrients in the BSD, the percentage of energy from protein was lower in the BSD schedule.

The findings of the LUNCHES study do not correspond to those of Dorman et al. (18), in which no difference was found in the macronutrient and micronutrient composition of the foods and beverages consumed in the BSD schedule when compared the TS. The present study's findings may contrast those previously found, for a number of reasons: a larger sample size of students and schools following each school schedule, location of data collection, and the methodology used to assess dietary intake.

The overall quality of home-packed lunches in both schedules was poor when compared to recommended intakes. Home-packed lunch intake failed to meet fibre, potassium, vitamin D, calcium, zinc and phosphorus recommendations. Consumption of vitamin A by females in both schedules was also below recommendations. At the same

time, consumption of carbohydrates, total sugars, and sodium exceeded recommendations in both school schedules. This is concerning as Health Canada recommends limiting intake of these nutrients, as they are not conducive to a healthy population when consumed in excess (46). Sodium, in particular, was above the upper limit of DRI recommendations, which is related to an increased risk of negative health outcomes (47). Consumption of thiamin, riboflavin, niacin, iron, protein, and vitamins B6, B12, and C also surpassed recommendations; however, population health recommendations typically promote the importance of consuming an adequate amount of these nutrients to maintain health (46). Fortification of white flour with B vitamins, iron and folic acid has been mandatory in Canada since 1998, to support adequate intake of these vitamins from the food supply (48,49). Taylor et al. (12) found home-packed lunches of grade 5 and 6 PEI students to be lacking in magnesium, potassium, zinc, vitamin A, D, C, B6, folate and fibre when compared to DRIs. The findings of the present study are similar to those of Taylor et al. (12), with the exception of magnesium, folate, vitamin B6 and vitamin C. Adequate magnesium intake in the BSD schedule may be due to larger servings of milk and alternatives consumed from BSD home-packed lunches (unpublished data reported elsewhere). In view of poor vitamin D and calcium intake in the BSD schedule, it would be reasonable to assume cheese string and yogurt tube items are contributing to magnesium intake. Hard cheese is often considered a healthy snack option for kids; however, greater servings of hard cheese may be providing a greater amount of sodium and saturated fat, and less vitamin D to overall intake than an equal CFG serving of milk. Furthermore, flavored yogurt tubes also contribute a considerable amount of energy from sugar relative to their small size. Adequate magnesium intake could also be related to the almonds consumed by a child in the BSD schedule (data not published). Similarly, consumption of vitamin C in the LUNCHES study was likely above recommendations due to the popularity of sugar sweetened fruit juice/cocktails as well as gummy type snacks that typically include vitamin C added by the manufacturer (unpublished data reported elsewhere). Snack items were prevalent in both schedules home-packed lunches when compared to other food categories (unpublished data reported elsewhere). Moreover, intake from sugar-sweetened beverages was greater than that from 100% fruit juice in both schedules, whereas vegetable and fruit intake was poor (unpublished data

reported elsewhere). In addition, the mandatory fortification of white flour, in Canada, is likely contributing to adequate folate intake in the LUNCHES study; however, coupled with low fibre and excess thiamin, riboflavin, and niacin intakes, refined carbohydrates are likely the type of grain products typically consumed.

The type of dietary pattern observed in the present study does not reflect public health messages focused on limiting sugar, fat, saturated fat, and sodium intakes (4,46). Rising intakes of sugar, fat, saturated fat, and sodium have been recognized as one factor contributing to an overweight status in childhood, which in turn increases a child's risk for morbidities and premature mortality later in life (50,51). Overall intake, as well as increased consumption of snack items, contributed to higher amounts of these nutrients in the BSD schedule when compared to the TS; however, snack items in the BSD also contributed protein and micronutrient benefits. Snack frequency has been positively associated with an increase in both healthy and less healthy foods that contribute to daily intake of macronutrients and some micronutrients in both adults and children (52,53). However, it is difficult to compare literature surrounding snack intake and snack frequency, as the definition of a snack is not consistent between research studies. Despite the possibility of the inclusion of a few snack foods with micronutrient content, the consumption of a greater number of snack items in the BSD schedule contributed additional carbohydrates, total sugar, fat, saturated fat, sodium and energy, and this could be a concern for children who are on the BSD schedule.

Children in the BSD schedule consumed more energy from their home-packed lunch than children in the TS. A prolonged energy intake above estimated daily energy requirements, even by a minimal amount, could lead to an increase in weight (54). The energy intake of both genders in the BSD schedule did not significantly differ from recommendations, but the values were above the recommended amount. A sustained additional daily consumption of 220KJ per day, as we observed in the BSD vs. TS, has been associated with weight gain (54-56). Thus, it is plausible that increased energy consumption in the BSD schedule has the potential to contribute to the already elevated childhood overweight and obesity rates in Canada, unless there is a corresponding increase in energy expenditure. Unfortunately, an increased participation in physical

activity has not been demonstrated in the BSD schedule (57). One published study to date, comparing the number of steps taken by students during breaks from instructional time in the BSD schedule compared to the TS, found students in the BSD schedule took fewer steps (57).

After controlling for potential covariates, school schedule continued to be a predictor of energy packed and consumed while at school. The BSD schedule in particular was predictive of having more energy packed in home-packed lunches, and more energy consumed while at school. Interestingly, parental income was not related to energy packed or eaten and was, therefore, not controlled for in the regression models. A low income has been related to a nutrient poor diet (58,59): low in fibre, potassium, and vitamins A and C, while contributing more fat and saturated fat (58). Parental income may have a larger impact on the nutrient-density of the food items packed and consumed in the BSD schedule, rather than overall energy content.

Added sugars have gained recent media attention with the release of the draft version of the updated sugar guidelines by the WHO, recommending intake from added sugars should be further reduced to less than 5% of total daily energy intake for added health benefits (60). For a normal weight adult this would equate to approximately 25 grams of added sugar per day (60). Added sugars encompass those added to a food item by the manufacturer, cook, or consumer, as well as free sugars present in honey, syrups and fruit juices (60,61). The new recommendations were proposed due to the potential association between a high intake of free sugars and dental caries, increased total caloric intake, reduced intake of more nutrient-dense foods, weight gain, and therefore increased risk of chronic diseases (62). Recently added sugars have been found to be positively associated with elevated diastolic blood pressure and triglycerides, cardiovascular risk factors, in children (63). At this time, the sugar value presented on the nutrition facts table in Canada combines both added and naturally occurring sugar (64). A weakness of the food composition database used in the present study was that added sugar values for food and beverage items were not available. Nevertheless, consumption of total sugar was high in the present study (38g TS and 47g BSD), as both schedules intake exceeded adult recommendations suggested by Health Canada (44,45). Observations only captured

one part of daily consumption; therefore, the combination of high total sugar intake along with a high intake of snack items in the BSD schedule compared to the TS (unpublished data reported elsewhere), suggests that added sugar intake could also be a concern for children in the BSD schedule.

A few limitations exist in the present cross-sectional study. Although we attempted to obtain a representative sample based on indicators of SES, and controlled for these indicators during regression analyses, it is possible that another variable, other than school schedule, is causing the differences observed between the school schedules in the LUNCHES study. A study with a natural trial design is needed to determine if there is a change in home-packed lunch intake of children who transition to the BSD from the TS. This would involve collecting data from the same individual children before and after their school changes from the TS to the BSD. In addition, fat consumption may have been underestimated, as research assistants did not record fillings and spreads, such as mayonnaise on a sandwich, if they were not visible. Finally, observation only captured part of daily consumption, which would not account for compensations that could be made at other times in the day. It is important to note, however, that after-school food choices by this age group have been found to provide additional energy with few nutrients (65).

4.5 Conclusion

Lunches brought by students in the BSD schedule provided more energy across all macronutrients, with only a few micronutrients showing increased amounts. Similar trends were observed for snack items brought by BSD schedule students. These findings suggest two 20-minute eating opportunities could contribute to excess energy intake during school, which could ultimately lead to weight gain and contribute to the already high childhood overweight and obesity rates in Canada. More research is needed to determine the long-term impact of the BSD schedule on dietary and anthropometric measures. The potential influence of parental income on the nutrient value of children in the BSD schedule and TS should also be investigated. Interventions are warranted in both schedules to attempt to decrease the intake of high-fat, high-sodium, high-sugar foods. More discussion is needed to determine whether school food guidelines should include

the goal of promoting the packing and consumption of nutrient dense whole foods in students' lunches.

4.6 References

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Chapter 5

5 Summary and Conclusions

The school environment has been identified as a setting that can be used to educate children on healthy eating habits, promote access to healthy food choices, and help prevent childhood obesity (1,2). Many North American school food guidelines and school meal programs are focused on reducing the risk of childhood obesity and chronic diseases (3–5). The School Food and Beverage Policy, currently implemented in Ontario's publically funded elementary and secondary schools, restricts the sale of competitive food and beverages that are high in energy but provide few nutrients (1,4). However, many Ontario elementary school students bring food and beverage items from home, which do not need to meet School Food and Beverage Policy guidelines. Structural changes to the elementary school day schedule, such as greater time dedicated to eating in the Balanced School Day (BSD) schedule, have the potential to impact what is packed in and eaten from elementary students' home-packed lunches. The present study compared the food and nutrient intake of grade 3 and 4 students in the BSD schedule with the long-standing Traditional Schedule (TS).

5.1 Summary of Key Findings

5.1.1 Packed Food and Nutrients in the BSD vs. TS

As hypothesized, home-packed lunches in the BSD schedule contained more energy and were higher in macronutrients (i.e., carbohydrates, total sugar, protein, fat and saturated fatty acids [SFA]) than in the TS; additionally, the proportion of students receiving a sugar-sweetened beverage (SSB) and snack item was higher in the BSD than in the TS. Few micronutrient differences were observed in packed lunch contents between school schedules; however, BSD home-packed lunches were higher in sodium, calcium, and iron content. Evans et al. (6) identified savoury snacks as the source of the high sodium content of UK home-packed lunch contents. Thus, greater sodium content of home-packed lunches in the BSD schedule is likely reflective of the inclusion of more snack items. This also corresponds to the present study's finding that intake from snacks

in the BSD contributed more sodium than in the TS. Although it was thought that packed servings of Eating Well with Canada's Food Guide (CFG) groups would be similar between schedules, larger servings of milk and alternatives were found in BSD schedule home-packed lunches when compared to the TS. The difference in the serving size of packed milk and alternatives is likely the result of fewer BSD schools offering a school milk program to their student population; thus, if a BSD schedule parent wanted their child to receive milk, they would have to include it in their lunch. For this reason, it is not surprising that the calcium content of packed lunch contents in the BSD was greater than the TS. The proportion of students receiving meat and alternative and grain products in their lunch was not significantly different between school schedules, and the serving size of those items also did not significantly differ between the BSD and TS. It is possible that the greater amount of iron found in BSD lunch contents is simply related to a greater amount of food in BSD home-packed lunches, as demonstrated by a greater amount of energy available from the contents of BSD lunches. Overall, it appears as though parents are packing additional SSB and snack items to meet a perceived need to pack more food to fill two eating breaks in the BSD schedule. Consequently, these items seem to be influencing the energy and macronutrient profiles of BSD schedule home-packed lunch contents.

5.1.2 Food and Nutrients Consumed in the BSD vs. TS

Results from the LUNCHES study demonstrated that, as hypothesized, intake in the BSD schedule was higher in energy and macronutrients (e.g., carbohydrates, SFA and total sugar), while there were no micronutrient differences when compared to consumption in the TS. Macronutrient differences may be the result of a greater number of BSD students consuming a SSB and snack item than TS students, together with consumption of larger portions of snacks in the BSD schedule. Although there was a lower percentage intake of energy from protein in the BSD schedule compared to the TS, it is likely the outcome of a greater intake of other macronutrients (i.e., carbohydrates and SFA), as the total amount of protein consumed in both schedules was similar. Examining only those children who consumed a milk and alternative item that was originally packed in their lunch or purchased from school, the servings of milk and alternatives consumed

in the BSD were higher than in the TS. However, less than half of all participating students' intakes met one-third of the daily milk and alternative servings recommended in CFG. In addition, there was no difference between school schedules in the portion size consumed from SSBs originally packed in students' lunches. This finding is not in accordance with our hypothesis, as it suggests the energy consumed from SSBs was similar between schedules. Nevertheless, a greater proportion of BSD schedule students consumed a SSB than TS students. Moreover, larger servings of snack items were consumed in the BSD schedule, providing more energy, carbohydrates, total sugar, protein, fat, SFA, and sodium. Despite a few micronutrients showing increased amounts from snack consumption in the BSD schedule over the TS, consuming more snacks contributed excess energy, fat, sugar, and sodium, all of which are recommended to be limited to maintain adequate health (1,7). Johnston et al. (8) found that a diet higher in energy and fat, along with poor fibre intake, was related to a greater gain of fat mass during childhood. Similarly, elevated consumption of soda, fat and sodium have been connected to overweight status in children (9). The dietary intake observed in the BSD schedule could place those children at a higher risk of becoming overweight and obese, which may lead to the development of chronic disease and negative health outcomes (10). This is concerning as Canadian childhood overweight and obesity rates remain elevated (11).

5.1.3 Overall Quality of Home-Packed Lunches in the BSD vs. TS

The overall quality of home-packed lunches in both the BSD and TS was quite poor. Less than half of participating students' packed lunch contents met one-third of CFG serving recommendations for milk and alternatives, and vegetables and fruit. In addition, the intake of less than 50% of students met one-third of CFG serving recommendations for each of the four food groups (i.e., grain products, meat and alternatives, milk and alternatives, and vegetables and fruit). Moreover, the serving size of vegetables and fruit consumed in both the BSD and TS did not meet one-third of the recommended servings in CFG. Vegetable intake is of particular concern, as a relatively large proportion of vegetables were left uneaten (20% TS and 30% BSD). Conversely, snacks were a popular item in home-packed lunches, as 90% of TS and 96% of BSD

home-packed lunches contained at least one snack item, and few snacks were left uneaten (10% BSD and 11% TS). Given the types of foods consumed from home-packed lunches in both the BSD and TS, it is not surprising that the intake of nutrients from home-packed lunches is not ideal when compared to DRI and general population reference standards. Consumption of fibre, potassium, vitamin D, calcium, zinc and phosphorus fell below recommendations in both the BSD and TS. Although excess intake of some beneficial micronutrients was observed in both schedules, consumption of carbohydrates, total sugars, and sodium surpassed recommendations. This dietary intake pattern could be problematic, as a diet high in sugar, fat, and sodium has been associated with an overweight status in childhood (9). In addition, an increased risk of gaining excess fat mass during childhood has been related to a low-fibre intake along with a high consumption of fat and energy (8). Despite the differences observed between the BSD and TS, it appears as though home-packed lunches in elementary schools are in need of improvement regardless of the school schedule.

5.2 Health Impact Assessment

Health Impact Assessment (HIA) is an approach that uses a variety of techniques to determine potential health implications of policies, programs and projects (12). HIA helps bring a health perspective into sectors where it may be inadvertently overlooked, such as transportation, housing and education (12). This model of thinking considers not only the risk of disease, but also social, behavioural and physical environmental factors that impact the health of a population (12). Canada was one of the first to integrate a HIA approach into the well-established environmental assessment procedures for policies, programs and projects (12). HIA is typically utilized by public health or government professionals for formal government propelled policies, programs and projects (13). Since the creation of the BSD schedule originated from a single school, and because it is not government regulated, but rather, implemented on an ad hoc basis by schools and school boards, a HIA has not been conducted. However, as many individual schools and whole school boards, in Ontario and across Canada (14–17), continue to accept and implement the BSD schedule, despite limited evaluation of the potential health effects, a HIA becomes imperative. Awareness of the BSD schedule and the need for a HIA to

analyze the potential health effects of the new approach to structuring the school day should be emphasized in public health and government professions. Dissemination of research findings can help to raise this awareness among health care and teaching professionals, and promote the importance of advocating for a HIA for the BSD schedule.

5.3 Future Research

It would be valuable for future research to assess physical activity along with dietary intake, to determine if physical activity in the BSD schedule is directly proportional to energy intake. One study, using pedometers to compare levels of physical activity between the BSD schedule and TS, ascertained students in the BSD schedule took fewer steps during school breaks than TS students (18); however, it is unknown if the intensity of physical activity differed. It would be beneficial to assess both physical activity and dietary intake of the same students in future studies and compare the results between the two school schedules. In addition, the influence of parental income on the transition to the BSD schedule as well as the food and nutrient value of children's home-packed lunches as children transition from the TS to the BSD schedule should be examined. Ultimately, children's full-day intake, in both the home and school environment, could be assessed by future studies to determine if differences in consumption at school impact overall daily food and nutrient intake. Children in the BSD schedule could be reducing energy intake at other points in the day, which may result in equivalent overall daily energy consumption of children in the BSD schedule and TS. Lastly, future research should develop and implement interventions focused on improving packed lunch contents and intake in both the BSD schedule and TS. The feasibility of widespread implementation and the effectiveness of these interventions should also be investigated. School programs, focused on increasing children's fruit and vegetable intake while at school, have shown short-term improvements in intake (19,20); however, long-term effectiveness of these programs has been neither demonstrated nor studied (20,21). Addressing barriers to packing a healthy lunch, in addition to providing parental and student education surrounding components of a healthy lunch, may promote more sustainable behaviour changes. Strategies should not only place an emphasis on long-term behaviour change, with respect to packing and consuming more fruit and

vegetables in home-packed lunches, but also encourage decreasing the number of high-energy, high-fat, high-sugar, and high-sodium snack and beverage items.

5.4 Strengths and Limitations

The present study has both strengths and limitations. Underestimation of some food groups and nutrients could have occurred, as research assistants could only record visible food and beverage items. Children may have left some of their home-packed food or beverage items in their lunch pails if they decided they were not going to consume the item. It is possible that food items, such as vegetables and fruits, were concealed by children who had them packed, as less than 50% of all participating students met one third of EWCFG recommendations for fruit and vegetables for both packed and consumed items. Research assistants were also trained to avoid assuming food and beverage items were present if they were not observed. Sandwich toppings, such as mayonnaise, or sugar-sweetened beverages in opaque water bottles would not have been recorded unless research assistants were certain of their presence. Furthermore, data were only taken during one part of the day, which does not account for possible reductions in consumption before or after school to compensate for increased intake during school.

In addition, a drawback of the food composition database used to produce nutrient profiles for each participating student was the absence of added sugar values for food and beverage items. The cross-sectional nature of the study also did not allow for assessment of usual intake, nor was there the possibility of determining a cause and effect relationship with the switch to the BSD schedule. Despite an attempt to acquire a representative sample, and control for potential influencing factors, there is still a possibility that something other than school schedule is causing the differences observed between the BSD and TS.

In terms of strengths, this study utilized a valid and reliable dietary assessment methodology. Direct observation is used to validate self-reported dietary assessment methods (22,23), and has been shown to be reliable when conducted by trained observers in a closed setting such as a lunchroom (24,25). Furthermore, direct observation does not rely on the students' cognitive ability to recall food and beverage items and estimate

portions sizes. Students are also likely familiar with the presence of lunchtime supervisors during eating breaks at school, which reduces the risk of behaviour change during observation (26). Although the characteristics of the participants' parents varied between school schedules, many participant characteristics were similar between school schedules, including sex, grade, mean BMI Z-score and mean food neophobia score. In addition, by achieving the desired total sample size, the present study was able to identify the estimated 100kcal difference in food and beverage items packed between the two school schedules. The findings of this study also contribute to the limited published literature concerning packed lunch contents and intakes of Canadian elementary school children.

5.5 Concluding Remarks

The LUNCHES study provides insight into the potential unintended negative impact of the BSD schedule on children's packed lunch contents and intake. The dietary pattern of BSD schedule children, in the present study, may increase the risk of childhood weight gain and future health complications if this pattern is sustained. Continued assessment of the potential health implications of the BSD schedule is needed. Support should be provided to parents and schools transitioning to the BSD schedule to encourage more nutrient dense whole foods and fewer SSB and snack items in home-packed lunches, while addressing potential barriers to packing a healthy lunch.

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Appendices

Appendix A: Ethics Approval

Research Western

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Paula Dworatzek
Review Number: 17319S
Review Level: Delegated
Approved Local Adult Participants: 0
Approved Local Minor Participants: 686
Protocol Title: Packed lunch contents and intake in Grade 3 and 4 students in the balanced school day versus the traditional schedule in the Thames Valley District School Board
Department & Institution: Nutrition and Food Sciences, Brescia University College
Sponsor:
Ethics Approval Date: August 24, 2011 **Expiry Date:** June 30, 2013

Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Revised Study End Date	The study end date has been revised to June 30, 2013 to allow for project completion.	

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

Members of the NMREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussions related to, nor vote on, such studies when they are presented to the NMREB.

The Chair of the NMREB is Dr. Riley Hinson. The UWO NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

[redacted]

Ethics Officer to Contact for Further Information

[redacted]

This is an official document. Please retain the original in your files.

[redacted]

Western Research

Research Ethics

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Paula Daorstzek
File Number:7254
Review Level: Delegated
Approved Local Adult Participants: 0
Approved Local Minor Participants: 686
Protocol Title: Packed lunch contents and intake in Grade 3 and 4 students in the balanced school day versus the traditional schedule in the Thames Valley District School Board - 173198
Department & Institution: Brescia/Nutrition and Food Sciences,Brescia University College
Sponsor:
Ethics Approval Date: September 09, 2013 **Expiry Date:** December 31, 2013

Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Revised Study End Date	The study end date has been revised to December 31, 2013 to allow for project completion.	

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB's periodic requests for surveillance and monitoring information.

Members of the NMREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussions related to, nor vote on, such studies when they are presented to the NMREB.

The Chair of the NMREB is Dr. Riley Hinson. The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000941.

[redacted]

Ethics Officer to Contact for Further Information

[redacted]

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[redacted]

Appendix B: Principal Consent and Abridged Versions of the Schedule Specific School Surveys (BSD and TS)

PRINCIPAL'S LETTER OF INFORMATION/CONSENT

Invitation
Your school is being invited to participate in a research study that will investigate the nutritional impact of the balanced school day schedule (BSD) in the Thames Valley District School Board (TVSDB). The purpose of this letter is to provide you with the information you require to make an informed decision on allowing your school to be involved in this research.

Title: LUNCHES - Let's Understand Nutrition and Children's Health in Elementary Schools

Principal Investigator: Dr. Paula Dworatzek, PhD RD, Associate Professor, Brescia University College, Division of Food & Nutritional Sciences, [redacted]
Co-investigators: Dr. Marina Salvadori, MD, Pediatrician, Associate Professor, University of Western Ontario, Faculty of Medicine & Dentistry, [redacted]
Ms. Lesley Macaskill, MHSc, RD, Lecturer, Brescia University College, Division of Food & Nutritional Sciences [redacted]
Student Researchers: Lisa Martin, HBSc, MScFN Candidate, Brescia University College, Jonathan Luk, HBSc, MScFN Candidate, Brescia University College, Navreeti Sharma, HBSc, MScFN Candidate, Brescia University College

Purpose of the study
The BSD schedule is an alternative to the Traditional Schedule (TS), whereby the division of instructional time by two recesses and one lunch break is divided by only two breaks. We propose to observe actual food intake in each of the two school schedules in the TVDSB. Our primary objective is to compare grade 3 and 4 students packed lunch contents and intake in the BSD vs. the TS by direct observation. Our secondary objectives are to assess factors which may impact student intake (e.g. picky eating, physical activity) or parental bag lunch preparation (e.g. health intentions, resource utilization, income, etc.); and to compare prevalence of overweight by Body Mass Index-for-age in the two schedules. We will also be collecting information about your school via a survey to enable the planning of observation days (e.g. days of the week to avoid because of catered/hot lunches). The survey will also capture any factors which may impact the school food environment or the activity level of the students (e.g. breakfast or snack programs, lunchroom supervision practices, schoolyard / playground equipment).

Description of Research and Experimental Procedures
We are aiming to recruit 25-30 grades 3 or 4 students from each of 12 schools (6 BSD and 6 TS) in the TVDSB during the 2012-2013 academic year. If your school takes part in this study, one

or more grade 3 and/or grade 4 classroom will be selected and the teachers will be provided with an envelope package for each student, containing the parental letter of information and either the BSD or TS parental survey (see attached). Those students who are known to meet our exclusion criteria will not have a package sent home. This includes any students who: go home for lunch daily; are on a therapeutic diet; or who have a chronic or debilitating condition which may impact their food intake, metabolism, or growth (e.g. Prader-Willi syndrome, diabetes, phenylketonuria). Parents and their child will be asked to read the letter of information / consent form and if they are agreeable to taking part in the study, they will complete the survey and return both in the envelope provided. In order to increase the response rate for consent and survey completion, a reminder flyer will be provided which can be sent to non-responders 1 to 2 weeks later, unless they have already indicated they do not wish to participate.

Upon receipt of informed consents, we will make arrangements with you to have our trained observers observe student's food intake during school recesses and lunch breaks. Our observers will also collect student's heights and weights using our equipment in a private room within the school. We will not provide the results of these measures to the students or their parents as this is considered the best practice. . Observers will arrive at the school prior to the first break or recess to ensure that they are observing any food intake that occurs during the morning. Participating students will be called individually by the secretary to a private room where height and weight measurements will be taken. At each recess/lunch break, each observer will simultaneously observe two or three students, estimating the type and amounts of all foods consumed, taking into account food traded, given away, discarded, and remaining at the end of the snack/meal. Observers will be located inconspicuously several feet from the lunch table, minimizing any interaction with students. Our observers will be supervised by a dietetic intern or dietitian. Upon completion of all components of the study (i.e. letter of information, parental survey, height and weight measurements, and food observation) another envelope addressed to the parents, with a $25 gift certificate for a local grocery store, will be provided to the teacher to be sent home with the student.

From the information that we gather, we will have a better understanding of the food intake of students in the BSD and TS. This information will be useful for schools when deciding to make a change to the BSD schedule.

Estimate of Principal's and Teachers' Time
The principal will be asked to complete a survey on behalf of the school that will take approximately 15 minutes and contains questions about the school food and activity environment. Teachers of the selected classrooms will be asked to distribute and collect the envelope packages which will be sent home to parents (original package, reminder, and thank you honorarium). The teachers will not be required to assist in the observations or to remain in the classroom during observations. This method places minimal burden on teachers and is less disruptive to the classroom environment than alternative food intake methodologies.

Risks/Benefits
There are no known risks or benefits to you, or your school's faculty or students in taking part in this study. However, this study may yield important findings on the impact of the BSD on

food intake during school hours and will provide useful information for schools when implementing a change to the BSD schedule.

Voluntary Participation
Participation in this study is voluntary. You may refuse to participate, refuse to answer any questions or withdraw your school from the study at any time with no effect to you, your faculty or students.

Privacy & Confidentiality
The confidentiality of you, your school, faculty and students will be respected. If the results of this study are published, no school or individual names will be used without the consent to do so. Data collection forms for individual students will not include names, but will be identifiable only by a code. The code will be stored on a separate password-protected computer located in a locked office at Brescia University College.

If you have any questions regarding the study, please feel free to contact the Principal Investigator, Paula Dworatzek at [redacted]

If you have any questions about yours rights as a research participant, you can contact the Office of Research Ethics of the University of Western Ontario at [redacted] Research Ethics Office at the University of Western Ontario may contact you directly to ask about your participation in this study.

Your school will not be paid to take part in this study; however, we will provide an honorarium of $150 or offer you a nutrition presentation for teachers, parents, or students.

CONSENT

I have read the Information/Consent document, have had the nature of the study explained to me and I agree to participate. All questions have been answered to my satisfaction.

_____
School Name

_____	_____	_____
Date	Principal's Name	Principal's Signature

_____	_____	_____
Date	Researcher Obtaining Consent	Signature

Please sign both copies. Return one and keep one for your records.

BSD Version
Attach label with school name

School Questionnaire

School Characteristics:

1. Please indicate (✓) the grade demographic of your school.

   ○ JK-grade 6 ○ JK-grade 8 ○ Other, please specify: _____

2. How many students are enrolled at your school? _____

3. Please fill in the following table to indicate the enrollment size of each grade 3 and grade 4 class in your school.

	Number of students		
	class one	class two	class three
Grade 3			
Grade 4			
Grade 2/3 split			
Grade 3/4 split			
Grade 4/5 split			

Implementing the Balanced School Day Schedule:

4. When was the balanced school day schedule implemented at your school? _____ MM/ _____YY

5. Please indicate (✓) whether your school provided any nutrition resources related to the Balanced School Day prior to or during its implementation, for each of the following types of resources and target audiences?

	Teachers	Parents	Students	No	Unknown
5.1. Print resources	○	○	○	○	○
5.2. Online resources	○	○	○	○	○
5.3. Presentations	○	○	○	○	○
5.4. Newsletter tips	○	○	○	○	○
5.5. Discussion / forum	○	○	○	○	○
5.6. Other: _____	○	○	○	○	○

6. For each resource that you used, please indicate the source (e.g. name of public health unit, school board, organization, or ministry), and the name of the resource (please attach copies if possible):

   6.1. Source: _____
   Name of resource: _____

   6.2. Source: _____
   Name of resource: _____

   6.3. Source: _____
   Name of resource: _____

11. Please fill in the following table with start and finish times for each break for both Grades 3 and 4.

		Grade 3		Grade 4 (if different)	
		Start Time	Finish Time	Start Time	Finish Time
Break #1	Nutrition				
	Physical Activity				
Break #2	Nutrition				
	Physical Activity				

12. In thinking about opportunities for implementing healthy nutrition initiatives (e.g., milk programs), how has the Balanced School Day schedule impacted these opportunities? Please ✓

○ Increased ○ Decreased ○ No change ○ Do not know

12.1. Please comment: _____

_____

_____

_____

School Food Environment:

13. Does your school have a cafeteria? ○Yes ○No

14. Does your school have a canteen or tuck shop? ○Yes ○No

15. Does your school have a policy or procedure in place to address anaphylaxis? ○Yes ○No

16. Does your school have any of the following food programs?

If yes, please write the frequency per day for each day of the week.

16.1. Milk Program ○Yes ○No

Day of the week	Mon.	Tues.	Wed.	Thurs.	Fri.
Frequency per day					

16.2. Snack Program ○Yes ○No

Day of the week	Mon.	Tues.	Wed.	Thurs.	Fri.
Frequency per day					

For the following programs, if yes, please indicate (✓) the days of the week the program is implemented.

16.3. Breakfast Program ○Yes ○No

○ Mon. ○ Tues. ○ Wed. ○ Thurs. ○ Fri.

16.4. Litterless Lunch ○Yes ○No

○ Mon. ○ Tues. ○ Wed. ○ Thurs. ○ Fri.

16.5. Boomerang Program, i.e. carry in/ carry out (uneaten food is returned home) ○Yes ○No

○ Mon. ○ Tues. ○ Wed. ○ Thurs. ○ Fri.

16.6. A private hot lunch program (e.g. the Lunch Lady) ○Yes ○No

○ Mon. ○ Tues. ○ Wed. ○ Thurs. ○ Fri.

16.7. Hot or catered lunch ○Yes ○No

Please specify each hot or catered lunch that is served, including all foods available for purchase, the frequency per year, and the day of the week it is typically served. An example is provided.

	E.g.	Lunch 1	Lunch 2	Lunch 3	Lunch 4
Type of lunch:	Pizza				
Additional items:	Cookies, Milk				
Times per year:	10 days				
Day of the week:	Wed				

16.8. Are other foods available for sale at any time during the school year, e.g. fundraising?

○Yes ○No

Please specify the event, each food item that is available for purchase, the frequency per year, and the day of the week it is typically served. An example is provided.

	E.g.	Event 1	Event 2	Event 3	Event 4
Type of event:	Fundraising				
Food items:	Freezies, Ice cream				
Days per year:	6 days				
Week day:	Thurs				

16.9. Healthy Champions (A health unit initiative) ○Yes ○No ○Not aware of this program

16.10. Please describe the initiatives in your school: _____

_____

_____

16.11. Please describe any other nutrition programs or policies at your school:

_____

_____

_____

_____

TS Version
Attach label with school name

School Questionnaire

School Characteristics:

1. Please indicate (✓) the grade demographic of your school.

   ○ JK-grade 6 ○ JK-grade 8 ○ Other, please specify: _____

2. How many students are enrolled at your school? _____

3. Please fill in the following table to indicate the enrollment size of each grade 3 and grade 4 class in your school.

	Number of students		
	class one	class two	class three
Grade 3			
Grade 4			
Grade 2/3 split			
Grade 3/4 split			
Grade 4/5 split			

4. Please fill in the following table indicating (✓) (i) where the grade 3 and 4 students eat and (ii) who supervises them during scheduled breaks.

		Where do the students eat?	Who supervises the students?
Break #1	Grade 3	○ Classroom ○ Lunchroom ○ Gymnasium ○ Other: _____	○ Teacher ○ Lunchroom supervisor ○ Older student ○ Other: _____
	Grade 4	○ Classroom ○ Lunchroom ○ Gymnasium ○ Other: _____	○ Teacher ○ Lunchroom supervisor ○ Older student ○ Other: _____
Break #2	Grade 3	○ Classroom ○ Lunchroom ○ Gymnasium ○ Other: _____	○ Teacher ○ Lunchroom supervisor ○ Older student ○ Other: _____
	Grade 4	○ Classroom ○ Lunchroom ○ Gymnasium ○ Other: _____	○ Teacher ○ Lunchroom supervisor ○ Older student ○ Other: _____

11.6. A private hot lunch program (e.g. the Lunch Lady) ○Yes ○No

○ Mon. ○ Tues. ○ Wed. ○ Thurs. ○ Fri.

11.7. Hot or catered lunch ○Yes ○No

Please specify each hot or catered lunch that is served, including all foods available for purchase, the frequency per year, and the day of the week it is typically served. An example is provided.

	E.g.	Lunch 1	Lunch 2	Lunch 3	Lunch 4
Type of lunch:	Pizza				
Additional items:	Cookies, Milk				
Times per year:	10 days				
Day of the week:	Wed				

11.8. Are other foods available for sale at any time during the school year, e.g. fundraising?

○Yes ○No

Please specify the event, each food item that is available for purchase, the frequency per year, and the day of the week it is typically served. An example is provided.

	E.g.	Event 1	Event 2	Event 3	Event 4
Type of event:	Fundraising				
Food items:	Freezies, Ice cream				
Days per year:	6 days				
Week day:	Thurs				

11.9. Healthy Champions (A health unit initiative) ○Yes ○No ○Not aware of this program

11.10. Please describe the initiatives in your school: _____

_____

_____

11.11. Please describe any other nutrition programs or policies at your school:

_____

_____

_____

_____

12. Do teachers allow in-class snacking? ○Yes ○No

13. Do teachers allow students to drink water during class? ○Yes ○N

14. Does the person(s) acting as lunch supervisor(s) provide any prompts to students? E.g. please eat your vegetables or fruit, or please eat your lunch before your snacks/desserts? ○Yes ○No

14.1. Please explain: _____

15. Are there any additional opportunities for students to eat meals or snacks during the day in addition to lunch? ○Yes ○No

15.1. If yes, please describe: _____

16. Does your school have a policy about in-class snacking? ○Yes ○No

16.1. If yes, please describe: _____

17. Does your school have a vending machine available to students? ○Yes ○No

17.1. If yes, please list the items available in the vending machine.

18. Please indicate (✓) whether your school has provided any nutrition resources related to bag lunch preparation, for each of the following types of resources and target audiences?

		Teachers	Parents	Students	No	Unknown
18.1.	Print resources	○	○	○	○	○
18.2.	Online resources	○	○	○	○	○
18.3.	Presentations	○	○	○	○	○
18.4.	Newsletter tips	○	○	○	○	○
18.5.	Discussion / forum	○	○	○	○	○
18.6.	Other: _____	○	○	○	○	○

Appendix C: Parental Consent form, Child Assent form and Abridged Versions of the Schedule Specific Parental Surveys (BSD and TS)

PARENT LETTER OF INFORMATION/CONSENT

Invitation
You and your grade 3 or 4 child are being invited to take part in a research study where observers will view their food intake while at school. The purpose of this letter is to give you the information you need to make an informed decision on joining this research study.

Title: LUNCHES - Let's Understand Nutrition and Children's Health in Elementary Schools

Principal Investigator: Dr. Paula Dworatzek, PhD RD, Assistant Professor, Brescia University College, Division of Food & Nutritional Sciences, [redacted]
Co-investigators: Dr. Marina Salvadori, MD, Pediatrician, Associate Professor, University of Western Ontario, Faculty of Medicine & Dentistry [redacted]
Ms. Lesley Macaskill, MHSc, RD, Lecturer, Brescia University College, Division of Food & Nutritional Sciences, [redacted]
Student Researchers: Lisa Martin, HBSc, MScFN Candidate, Brescia University College, Jonathan Luk, HBSc, MScFN Candidate, Brescia University College, Navreeti Sharma, HBSc, MScFN Candidate, Brescia University College

Purpose of the study
The Balanced School Day (BSD) schedule is a school day with different breaks to the Traditional Schedule (TS). Instead of two recesses and one lunch break, there are two breaks for 45 minutes each. We plan to view what students are eating in each of the two school schedules. Our main goal is to compare grade 3 or 4 students' packed lunch contents and intake in the BSD vs. the TS by observing what they are eating. Our other goals are to identify reasons which may impact how students eat (e.g. picky eating, physical activity) or how parents pack a lunch (e.g. concerns about health, information or skills, income); and to compare the rate of overweight by Body Mass Index-for-age in the two school schedules.

What Will Happen in the Study?
We hope to have 25-30 grades 3 or 4 students join the study from each of 12 schools (6 BSD and 6 TS) in the Thames Valley District School Board (TVDSB) during the 2012-2013 school year. We would ask that you and your child do NOT join if your child goes home for lunch daily; is on a special diet; or has a health condition which may impact their food intake, metabolism, or growth (e.g. Prader-Willi syndrome, diabetes, phenylketonuria).

If you do take part in this study you and/or your child will be asked to do the following: (i) you will complete the attached survey; (ii) your child will have his/her height and weight taken in school, but they will not be given the results; and (iii) your child's packed lunch contents and food intake will be observed and recorded for one day at some point during the school year. If you choose to join, please complete the consent form, the child's consent form, and the

attached survey and return them to your child's teacher in the envelope provided. If you choose not to join you can indicate this on the form and return it, but you do not have to. If we get your signed form agreeing to join, we will arrange with your school to have our trained observers collect your child's height and weight using our equipment in a private room in the school. We will take your child's height three times because this is the best way to get an accurate measurement. We will also arrange to observe your child's food intake during school recesses and breaks. Observers will estimate the type and amounts of all foods eaten, taking into account food traded, given away or thrown out, and left over at the end of the snack/meal. Observers will be located several feet from the lunch table, standing quietly and not bothering or talking to your child or the other students.

How Much of Your Time is Needed?
The survey will take about 15 minutes to complete and has questions about your child's packed lunch, food intake, and physical activity. Also, we will ask questions about information you may have received from your school about packing a lunch and other information such as income ranges to help us understand the data. Your child will also spend about 10 minutes having their height and weight taken; however, there will be no other time needed from them as the viewing of the food they eat will take place during their normal school breaks.

Risks/Benefits
There are no known risks or benefits to you or your child in taking part in this study. It is possible that some children may feel anxiety when observed while eating or having their weight taken. To limit this, observers will be located several feet from the lunch table and will not interact with the children directly and heights and weights will be taken according to recommended standards of practice to minimize any potential impact on the children. However, this study may provide important findings on the impact of the BSD on food intake during school hours. It may also give useful information for schools when considering a change to the BSD.

Voluntary Participation
Participation in this study is voluntary. You or your child may choose not to participate, choose not to answer any questions or quit the study at any time with no effect to you, or your child, or their school marks.

Privacy & Confidentiality
The confidentiality of you and your child will be respected. If the results of this study are published, no school or individual names will be used without the consent to do so. Data collection forms will not include names, but will be identifiable only by a code. The code will be stored on a separate password-protected computer located in a locked office at Brescia University College.

If you have any questions regarding the study, please feel free to contact the Principal Investigator, Dr. Paula Dworatzek at [redacted]

If you have any questions about yours rights as a research participant, you can contact the Office of Research Ethics of the University of Western Ontario at [redacted] The Research

Ethics Office at the University of Western Ontario may contact you directly to ask about your participation in this study.

You will not be paid to take part in this study; however, we will thank you by giving you a $25 grocery store gift card after all parts of the study are completed. This includes the consent forms for you and your child, survey, height and weight measurements, and food observation.

If you decide to join this study, please talk about it with your child and tell them that they will be asked to have their height taken three times and their weight taken once and that someone will watch what they eat one day at school.

CONSENT

I have read the Information/Consent document, have had the nature of the study explained to me and **I agree** to participate. All questions have been answered to my satisfaction.

Date	Parent's/Guardian's Printed Name	Parent's/Guardian's Signature

Date	Researcher Obtaining Consent	Signature

OR

I do **NOT agree** to participate.

Date	Parent's/Guardian's Printed Name	Parent's/Guardian's Signature

Please sign both copies. Return one and keep one for your records.

CHILD ASSENT FORM

Short Title: LUNCHES - Let's Understand Nutrition and Children's Health in Elementary Schools.

Researchers: Dr. Paula Dworatzek. Assistant Professor. Brescia University College, Division of Food & Nutritional Sciences [redacted]
Dr. Marina Salvadori, MD, Pediatrician, Associate Professor, University of Western Ontario, Faculty of Medicine & Dentistry [redacted]
Ms. Lesley Macaskill, MHSc, RD, Lecturer, Brescia University College [redacted]

What is the study about?
We will be watching grade 3 and 4 students eat so we can see what food boys and girls bring to and eat at school. We will also measure their height and weight to see how they are growing.

What will happen to you?
If you want to be in the study two things will happen:
1. We will be looking at the food you eat one day while you are at school.
2. We will take your height three times and weight once, but we cannot tell you the numbers.

Will there be any tests?
There will not be any tests or any marks on your report card.

Will the research hurt?
It will not hurt to be watched while eating at school or to have your height or weight taken.

Will the study help you?
No, this study will not help you directly but it may help the researchers understand what boys and girls are eating at school and how they are growing.

What if you have any questions?
You can ask questions any time, now or later. You can talk to the researchers, your family, your teacher, your principal or someone else.

Do you have to be in the study?
You do not have to be in the study, if you do not want to do it, just say so. No one will be mad at you. Even if you say yes now you can change your mind later. It is up to you.

I want to participate in this study.

_____	_____	_____	_____
Name of Child	Signature of Child	Age	Date

_____	_____
Signature of Researcher Obtaining Assent	Date

Please sign both copies. Return one and keep one for your records.

BSD Student ID: _____
Date: _____

Parent Survey Regarding Packed Lunches

As the person who prepares your child's packed lunch, your participation in this survey is very helpful, but completely voluntary. This survey will take about 15 minutes to complete. There are no right or wrong answers. Please provide responses as honestly and accurately as possible. Your responses will be kept in confidence and all results will be presented as grouped data only. When all components of the study have been completed we will send you a $25 grocery store gift certificate. If you have any questions please contact Lisa Martin at [redacted] or Dr. Dworatzek at [redacted]

1. How many children (under age 18 years) do you prepare a packed lunch for? Please √.

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 or more

2. How many packed lunches do you prepare on an average day for all members of the household?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 or more

Please answer the rest of the questions only for the child (in grade 3 or 4) that brought this survey home.

3. What is the date of birth for the child that brought this survey home? ____DD/____MM/_____YY

4. What is the child's sex? ○F ○M

5. How long has your child been on the balanced school day schedule?

○ Less than 1 year	○ 1 year	○ 2 years	○ 3 years	○ 4 or more years

6. How would you rate your child's eating habits, e.g. eats regular meals, likes a variety of food?

○ Excellent	○ Very good	○ Good	○ Less than good	○ Poor	○ Do not know	○ Decline to answer

7. How would you rate the nutritional quality of your child's diet, e.g. follows Canada's Food Guide?

○ Excellent	○ Very good	○ Good	○ Less than good	○ Poor	○ Do not know	○ Decline to answer

8. In a typical 5-day school week, how many days does your child eat breakfast before school?

   ○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

9. How would you describe your child's weight status?

○ Very Overweight	○ Overweight	○ Healthy/ Average	○ Underweight	○ Very underweight	○ Do not know	○ Decline to answer

25. Please indicate (√) your degree of agreement with each of the following statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
25.1. I find it difficult to **plan** nutritious meals and snacks for my child to bring to school.	○	○	○	○	○
25.2. I find it difficult to **prepare** meals and snacks for my child to bring to school.	○	○	○	○	○
25.3. Now that my child has two breaks in the balanced school day schedule, I send more food to school in his/her lunch.	○	○	○	○	○
25.4. The balanced school day allows my child to eat more of the meals and snacks that I send to school.	○	○	○	○	○
25.5. Now that my child has two breaks in the balanced school day schedule, I split the lunch into two meals.	○	○	○	○	○
25.6. I find it difficult to know how to split the meals into two.	○	○	○	○	○
25.7. Preparing a packed lunch for my child takes more time and/or effort now that we have the balanced school day schedule.	○	○	○	○	○
25.8. My child has enough time to eat his/her meals or snacks while at school.	○	○	○	○	○
25.9. My child has more time to eat his/her meals or snacks on the balanced school day compared to the traditional schedule.	○	○	○	○	○
25.10. Now that we have the balanced school day my child wants two lunches on weekends.	○	○	○	○	○
25.11. Food safety concerns me because my child may eat his/her lunch in the second break.	○	○	○	○	○
25.12. I ask my child to eat the foods that could go bad, in the first break.	○	○	○	○	○
25.13. My child participates in more physical activity at school now that he/she is on the balanced school day.	○	○	○	○	○
25.14. The balanced school day has had a positive impact on my child's eating.	○	○	○	○	○

26. Have you received any nutrition-related information from your child's school about packing lunch for the balanced school day schedule? ○Yes ○No

Please describe:_____

27. If yes, how useful were these nutrition-related resources?

○ Not applicable ○ Very useful ○ Somewhat useful ○ Neither ○ Useless ○ Very useless

32. Please provide your opinion about the balanced school day and its impact on your child's food intake.

33. Please provide your opinion about the balanced school day and its impact on your child's physical activity levels.

34. Please indicate (√) your relationship with this child.

- ○ Parent
- ○ Guardian
- ○ Sibling
- ○ Grandparent
- ○ Babysitter or Caregiver
- ○ Other relative

35. Please indicate your sex.

- ○ Male
- ○ Female
- ○ Decline to answer

36. What age category do you fall into?

- ○ 20 to 29 years
- ○ 40 to 49 years
- ○ Decline to answer
- ○ 30 to 39 years
- ○ 50 years or over

37. What is your current marital status?

- ○ Married
- ○ Widowed
- ○ Common-law or living with partner
- ○ Separated
- ○ Single
- ○ Divorced
- ○ Decline to answer

38. What is the highest level you have completed in school?

- ○ Less than high school
- ○ College or Trade school graduate
- ○ Some high school
- ○ University degree
- ○ High school graduate
- ○ Decline to answer

39. What is your yearly total household income, before taxes?

- ○ less than $25 000
- ○ $100, 000 - $ 119, 999
- ○ $ 25 000 - $ 49 999
- ○ More than $ 120, 000
- ○ $ 50 000 - $ 79 999
- ○ Do not know
- ○ $ 80 000 - $ 99 999
- ○ Decline to answer

40. How many people are supported by this income? _____ Adults _____ Children

Please place **this survey in the enclosed envelope, seal it and return to your child's teacher.** 8

THANK YOU FOR COMPLETING THIS SURVEY!

TS Student ID: _____
Date: _____

Parent Survey Regarding Packed Lunches

As the person who prepares your child's packed lunch, your participation in this survey is very helpful, but completely voluntary. This survey will take about 15 minutes to complete. There are no right or wrong answers. Please provide responses as honestly and accurately as possible. Your responses will be kept in confidence and all results will be presented as grouped data only. When all components of the study have been completed we will send you a $25 grocery store gift certificate. If you have any questions please contact Lisa Martin at [redacted] or Dr. Dworatzek at [redacted]

1. How many children (under age 18 years) do you prepare a packed lunch for? Please √

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 or more

2. How many packed lunches do you prepare on an average day for all members of the household?

   ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 or more

Please respond to the rest of the questions for only the child (in grade 3 or 4) that brought this survey home.

3. What is the date of birth for the child that brought this survey home? ____DD/____MM/_____YY

4. What is the child's sex? ○F ○M

5. How would you rate your child's eating habits, e.g. eats regular meals, likes a variety of food?

○ Excellent	○ Very good	○ Good	○ Less than good	○ Poor	○ Do not know	○ Decline to answer

6. How would you rate the nutritional quality of your child's diet, e.g. follows Canada's Food Guide?

○ Excellent	○ Very good	○ Good	○ Less than good	○ Poor	○ Do not know	○ Decline to answer

7. In a typical 5-day school week, how many days does your child eat breakfast before school?

   ○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

8. How would you describe your child's weight status?

○ Very Overweight	○ Overweight	○ Healthy/ Average	○ Underweight	○ Very underweight	○ Do not know	○ Decline to answer

9. Does your child participate in a milk program at school? ○Yes ○No

15. For each of the following food types, please indicate (√) how often your child brings home these foods from his/her packed lunch?

	Never	Sometimes	Often	Always	Not applicable
15.1. Fruit (e.g. canned, fresh, dried)	○	○	○	○	○
15.2. 100% Fruit juice	○	○	○	○	○
15.3. Fruit drinks (e.g. Five Alive™, Kool-aid Jammers™, Iced tea, Sunny D™)	○	○	○	○	○
15.4. Vegetables (e.g. veggie sticks, salad, V8™)	○	○	○	○	○
15.5. Grains (e.g. bread, rice, pasta, crackers)	○	○	○	○	○
15.6. Milk and alternatives (e.g. milk, cheese, yogurt)	○	○	○	○	○
15.7. Meat and alternatives (e.g. meat, baked beans, eggs)	○	○	○	○	○
15.8. Snacks (e.g. chips, cookies, cakes, granola bars, pudding, or candy)	○	○	○	○	○

16. How often do the following factors affect your ability to provide a packed lunch for your child?

	Never	Sometimes	Often	Always
16.1. Having enough money to buy food.	○	○	○	○
16.2. The time it takes to prepare the lunch.	○	○	○	○
16.3. Having transportation to food stores.	○	○	○	○
16.4. Stores in my neighborhood do not sell fresh produce.	○	○	○	○
16.5. I don't know which foods are healthiest.	○	○	○	○
16.6. My child will eat only certain foods.	○	○	○	○
16.7. I use the tips I read in pamphlets or articles.	○	○	○	○
16.8. I watch what other children bring for lunch.	○	○	○	○

17. Please describe anything else which hinders your ability to provide a packed lunch for your child:

_____

_____

18. Please describe anything else which helps you in providing a packed lunch for your child:

_____

_____

23. Please indicate (√) your degree of agreement with each of the following statements.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
23.1. My child is a picky eater.	○	○	○	○	○
23.2. If my child doesn't know what is in a food, he or she won't try it.	○	○	○	○	○
23.3. My child is afraid to eat things he or she has never had before.	○	○	○	○	○
23.4. My child is very particular about foods he or she will eat.	○	○	○	○	○
23.5. My child will eat almost anything.	○	○	○	○	○
23.6. I would like my child to eat more vegetables and fruit.	○	○	○	○	○
23.7. I would like my child to have more milk and milk products.	○	○	○	○	○
23.8. I would like my child to eat more food in general.	○	○	○	○	○
23.9. I would like my child to eat less snack foods.	○	○	○	○	○
23.10. I would like my child to eat less food in general.	○	○	○	○	○
23.11. I think my child eats the right amount of food for him/her.	○	○	○	○	○
23.12. I expect my child to eat all of the food on his/her plate.	○	○	○	○	○

24. How often do you obtain nutrition information from the following sources?

	Never	Sometimes	Often	Always
24.1. Internet websites	○	○	○	○
24.2. Media (television, radio, magazines, or newspapers)	○	○	○	○
24.3. Family or Friends	○	○	○	○
24.4. Educational pamphlets, booklets, videos	○	○	○	○
24.5. Formal Education (lectures, textbooks, journals)	○	○	○	○
24.6. Resources sent home from school	○	○	○	○
24.7. Health organizations e.g. Heart & Stroke Foundation	○	○	○	○
24.8. Public health unit	○	○	○	○
24.9. Health professionals	○	○	○	○
24.10. Other: _____	○	○	○	○

Appendix D: Food Intake Observation Form (OF)

Food Intake Observation Form

School ID#: _____ Observer ID#: _____ Date: _____ Student ID#: _____ Shirt Colour: _____ Time: R1 L R2 NB1 NB2 Gender: M F Grade: 3 4

Start time: _____ Finish time: _____ Lunchtime Activities: _____

Food Item	Packed (N or R)*		Eaten		Descriptions		
	Portion Size (g, mL)	Number or Amount	% Eaten	Number or Amount	Detailed description: Brand? Label Information? Dimensions? Preparation?	(C) Commercially Packaged (H) Home-packaged (S) Provided by school	
Sandwich/ Entrée							Meat: deli/leftovers Cheese: processes slices /hard Bread: white/whole wheat/multigrain Pasta/rice/other grains -Cooking method?
Milk and Alternatives							Skim/1%/2%/homo/chocolate Is the milk from a Milk Program? Cheese: processed slices/string/hard Yogurt: cup/tubes/yogurt drink Soy/rice beverage / pudding
Beverages							100% juice/fruit drink (specify) Pop/sports drinks/water
Fruit							Canned/whole/dried
Vegetable							Raw/cooked Salad dressing/dip
Baked goods							Cookies/granola bars/muffins/ Croissants/cakes/packaged treats E.g. twinkies/bear paws Added nuts? Icing?
Chips							Popcorn/pretzels/ tortilla chips/crackers
Candy							Chocolate/gummy candy Jello
Other							Fats, condiments

* Identify packed items as N for newly observed and R for remaining from previous observation.

Canada's Food Guide Servings of Foods and Beverages Packed & Consumed
Transfer food/beverages and amounts from observation form into this table

Category/Food Group	Food/Beverage Observed	Amount packed	Total # of CFG Servings packed (circle one)	Amount Consumed	Total # of CFG servings consumed (circle one)	(C), (H), (S), (F)
Grain Products			.5 1 1.5 2 2.5 3 ___		0 .5 1 1.5 2 2.5 3 ___	
Milk & Alternatives			.5 1 1.5 2 2.5 3 ___		0 .5 1 1.5 2 2.5 3 ___	
Meat & Alternatives			.5 1 1.5 2 2.5 3 ___		0 .5 1 1.5 2 2.5 3 ___	
Fruit			.5 1 1.5 2 2.5 3 ___		0 .5 1 1.5 2 2.5 3 ___	
Vegetables			.5 1 1.5 2 2.5 3 ___		0 .5 1 1.5 2 2.5 3 ___	
100% Fruit/Veg. Juice			.5 1 1.5 2 2.5 3 ___		0 .5 1 1.5 2 2.5 3 ___	
Sweetened Beverages						
Snacks						

* Snacks include food items that do not belong in a food group, such as: cookies, baked goods, chips, candy, fruit gummies, etc.
For snack food items **only**, indicate whether the item was (C) commercially packaged, (H) home-packaged, (S) provided by school, or (F) from a friend

Completed by: _____ Date: _____

Reviewed by: _____ Date: _____

Appendix E: Training Manual- Abridged Version

Container Capacities

A. Plastic Liquid Bottles

1. Rubbermaid Juice Box with Straw (small)

Size: 250 mL/1 cup

Pictured: 250 mL of 100% Orange Juice

2. Walmart Sipper Juice Box with Straw

Size: 300 mL

Pictured: 300 mL of Pineapple-Orange Banana Juice

3. Rubbermaid Juice Box with Straw (large)

Size: 473 mL/16 oz

Pictured: 473 mL of 100% Orange Juice

18. Ziploc Snap and Seal Blue Lid Round Single Serve Container

Size: 236 mL
Pictured: ½ cup 15 grapes


19.Rubbermaid Red Top Twist & Seal Container

Size: 284 mL/ 1.2 cups
Pictured: ½ cup 15 grapes


20. Ziploc Snap and Seal Blue Lid Round Container

Size: 415 mL/ 14 oz
Pictured: 1 cup minestrone soup


Prepackaged Food Items

Milk Products

Item	Brand	Milk Fat (M.F)	Container /Package Description	Portion
White Milk	Sealtest	Skim	Small carton	250 mL
Chocolate Milk	Milk 2 Go	1%	Large bottle	500 mL
Yop Drinkable Yogurt	Yoplait	1.5%	Small bottle	200 mL
Activa Drinkable Yogurt	Danone	1.5 %	Small bottle	100 mL
Blue Menu Drinkable Yogurt	PC	0 %	Small bottle	93 mL
Blue Menu Drinkable Yogurt	PC	0 %	Large bottle	250 mL
DanActive/ "Danino Go" Drinkable Yogurt	Danone	1.5 %	Small bottle	93 mL
Bio Best Smoothie	Astro	1.5 %	Small bottle	200 mL
Bio Best Max Immunite	Astro	1.5 %	Small bottle	94 mL
Silhouette (adult size)	Danone	0%	Medium cup	100 g
Minigo Yogurt	Yoplait	3%	Small cup	60 g
ALL Yogurt Tube	Various	2.5%	Tube	60 g
Crush Yogurt Cups	Danone	2.5 %	Medium cup (red)	100g
Greek Yogurt Cups	PC	3.5%	Medium cup	142 g
Danino	Danone	1.5%	Small cup	60 g
Cheestrings/Mooza Twists	Black Diamond/Kraft	18%	Stick	21 g
Fun Cheez	Black Diamond	18%	Pouch	21 g
Babybel Cheese	Babybel	24%	Round	20 g
Cheese Slices	Various	Various	Individual Slice	21 g

Single Serve Snacks

Item	Brand	Container/Package Description	Portion
Doritos Single Serve Nacho Cheese Chips	Frito Lay	Individual cup	21.2 g
Chips Ahoy! Thinsations	Christie	'100 calorie' pack	23 g
Snak Paks (oreo, Ritz, etc.)	Christie	Small bag	30 g
Flavoured (Cheddar/Caramel, etc.) Crispy Minis	Quaker	'90 calorie' pack	20 g
Cheetos Puffs	Frito Lay	Small bag	35 g
Hot Rod Original Sausage Snack	Schneiders	Stick	8 g
'School Safe' Banana Chocolate Chip Mini Loaf	Treasure Mills	Bar	40 g
Bear Paws Soft Cookies	Dare	Pack of 2 cookies	50 g
'Mini' Bear Paws Soft Cookies	Dare	Small bag	35 g
Pringles Baked Snack Stix	Pringles	'90 calorie' pack	19.3 g
Pringles (Individually Packaged)	Pringles	Small pack	21 g
Goldfish Snack Crackers	Pepperidge Farms	Pack	28 g

Visual Identification & Portion Estimation
Non-packaged Foods

A. PIZZA

1. Take-out pizza from Boston Pizza® restaurant

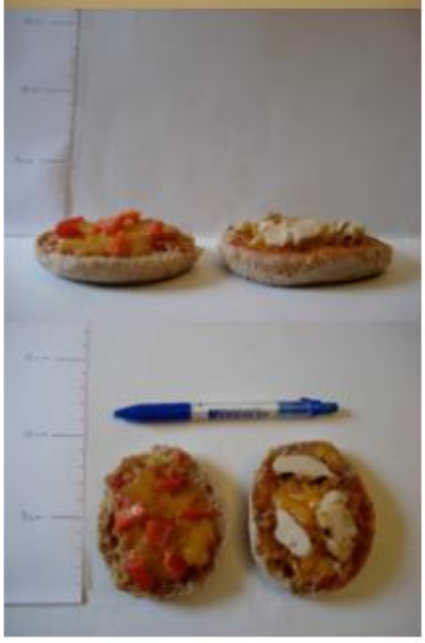
Pictured: 2 slices of an individual sized (20 cm diameter) pizza topped with tomato, green pepper and chicken

2. Mini pizzas on an english muffin

Pictured: 1 (57 g) 100% whole wheat english muffin sliced in half

(left): ½ english muffin, 1 tbsp tomato sauce, 1 tbsp cheddar cheese, 1 tsp chopped red pepper

(right): ½ english muffin, 1 tbsp tomato sauce, 1 tbsp cheddar cheese, 1 tbsp sliced chicken



B. Cooked Pasta & Rice

3. Elbow macaroni with tomato sauce

Container capacity: 415 mL/14 oz

Pictured: 1 cup cooked white macaroni noodles with ¼ cup tomato sauce

Thermos capacity: 300 mL/10 oz

4. Whole wheat spaghetti

Container capacity: 280 mL

Pictured: ½ cup cooked 100% whole wheat spaghetti noodles

Thermos capacity: 300 mL/10 oz

5. Brown rice

Container capacity: 236 mL

Pictured: ½ cup cooked brown rice

Thermos capacity: 300 mL/10 oz

12. Chicken wrap

Pictured: 1 whole wheat tortilla (34 g),
1 shredded romaine lettuce leaf,
¼ cup cooked chicken strips (20 g)

H. Thermos Items

13. Brown beans and hot dog wiener

Container capacity: 350 mL/12 oz

Pictured (left):
1 chopped beef hot dog wiener (37 g),
¼ cup canned brown beans in tomato sauce

14. Pasta in tomato sauce

Container capacity: 300 mL/10 oz

Pictured (right):
1 cup canned character shape pasta in tomato sauce

I. Chicken Nugget Meal

15. Chicken nuggets and fries

Pictured:
5 breaded chicken nuggets,
1/3 cup french fries

Anthropometric Measurement Techniques

Proper Measure of Standing Height

- Communicate with the child in a sensitive, non-frightening way. Explain the height measuring procedure to the child. That is, three measures of height will be taken to increase the accuracy of the measure. The order of height and weight measures are: height, weight, height, height.

- Prior to measurements, students should be asked to take off his/her shoes as well as all heavy clothing (coats, sweaters, jackets, etc.). For any child not wearing socks a disposable barrier of some type (i.e. paper towel) should be used to prevent direct contact between their skin and the equipment.

- Student should be asked to empty their pockets of any heavy items: wallets, coins, key chains, toys, etc.

- If hair ornaments or head dresses are interfering with the measurement and they could be easily adjusted, ask the child to do so themselves. Do not undo any hairstyles such as braids yourself. If hair ornaments or turbans cannot be removed, this should be noted on the data collection form.

- Ask the child to stand erect against the height rod of the stadiometer with the body weight evenly distributed and both feet flat on the stadiometer platform (Appendix 2).

- The child's feet should be positioned with the heels together and toes pointed slightly outward at approximately a 60^0 angle.

- Check to be sure that the back of the head, shoulder blades, buttocks and heels make contact with the height rod of the stadiometer.
  - Note: depending on the overall body conformation of the child all four contact points-head, shoulders, buttocks, and heels – may or may not touch the stadiometer height rod.

- Stature measurements are made with the head aligned in the Frankfort horizontal plane.
  - The head is in the Frankfort plane when the horizontal line from the ear canal to the lower border of the orbit of the eye is parallel to the floor and perpendicular to the vertical height rod.

- You may need to ask the child to tilt his/herhead up or down to achieve the proper alignment. Do not touch the child.

- Instruct the child to look straight ahead.

- Once positioned, lower the stadiometer headpiece so that it rests firmly on top of the child's head, with sufficient pressure to press the hair.

- Instruct the child to stand as tall as possible, take a deep breath, and hold the position. Taking a deep breath helps straighten the spine to yield a more consistent and reproducible stature measurement. The inhalation will cause the headpiece to rise slightly.

Appendix F: Height and Weight Data Collection Form

Height and Weight Record Sheet

Name of School:	Date:
Schedule:	

Student ID:	Height (cm)	Weight (kg)	Height (cm)	Height (cm)	Notes

Appendix G: Snack Categories- Health Canada's Bureau of Nutritional Sciences (BNS) Food Group Classifications

Sweet

Broad Category	***Sub-Categories***	***Individual food items***
Sweets and Sugars	Candies	Butterscotch/Caramel, Chocolate covered, Sweetened with sorbitol, Fudge, Gumdrops, Hard candy, Jellybeans, Licorice, Marshmallows, Skittles, Toffee, Chewing gum, Fruit leather, and Fruit Gummies
	Chocolate bars	All varieties
	Frozen desserts	Ice cream, Frozen yogurt, Sherbet, Soft Serve and popsicles (all varieties)
	Other desserts	Chocolate mousse, and Gelatin dessert
Crackers and Cereal	Read-to-eat breakfast cereals	All varieties
	Crackers	In addition to main entrée Cheese crackers, milk crackers, rusk toast, rye wafers, saltine, standard-type, standard-type reduced sodium, wheat crackers, low-fat wheat crackers, whole wheat crackers, and crackers packaged with spreadable cheese
Baked Goods	Biscuits, croissants, and muffins	Biscuit (all varieties), croissant, and muffin (blueberry, bran, carrot, chocolate chip, fruit)
	Cookies, Granola Bars and Other Bars	Cookies (all varieties), Animal crackers, Arrowroot, Social tea, Granola and breakfast bars (all varieties), and Cookies packaged with icing
	Cakes and Pies	Cake (all varieties), Banana bread, Brownies, and Pies (all varieties, even mincemeat)
	Other Baked Goods	Crisps (all varieties), Danish, Bread pudding, Doughnuts, éclairs, Toaster pasties, and Rice Krispie Squares™, commercial and homemade
Dairy Products	Pudding	All varieties, Tapioca, Rice pudding
	Yogurts	All single servings of yogurts not part of main entree
	Cheese	All single servings of cheese not part of main entrée

Savory

Broad Category	***Sub-Categories***	***Individual food items***
Popcorn and Chips	Popcorn	Air-popped, Caramel coated, Microwave, and Oil popped
	Chips	Corn-based puffs or twists, cheese, Potato chips, and Tortilla chips
Nuts and Seeds	Peanuts	All varieties; shelled, oil-roasted, salted and un-salted
	Nuts	Almonds, Brazil nuts, Cashews, Hazelnuts, Macadamia nuts, Mixed nuts, Pecans, Pine nuts, Pistachios, and Walnuts
	Seeds	Flaxseeds, Pumpkin and squash seeds dried, and sunflower seeds roasted salted
Other Snacks	Other Snacks	Banana chips, Beef Jerky, Beer nuts, Bits and bites snacks, Pretzels (hard), Rice Cakes, Sesame sticks, Soybeans, Trail mix, Sweetened Applesauce, and Fruit cup

Appendix H: Sample Size Calculation

Note: Dr. Paula D.N. Dworatzek created and submitted this sample size calculation as part of a grant proposal submission to CIHR.

Sample size was calculated using a cluster randomized trial design to account for variation between clusters (schools) in addition to the standard variation among individuals within the cluster (1). This avoids the assumption that the outcome for an individual student is unrelated or independent of the outcome for other students within the same cluster (i.e. taking into account that the school environment could have an influence on students' food intake). This requires that the standard sample size calculation be multiplied by a design effect formula, which includes the variable, ICC or intracluster correlation coefficient. The ICC takes into account both the between-cluster variation and the within-cluster variation (1). The primary outcome measure in the observation of packed lunch intake will be kilocalories (kcal) for the purposes of this calculation.

Step 1: Base sample size calculation

$$n = \frac{2SD^2 (Z_{1-!} + Z_{1-"/2})^2}{(Mean_2 - Mean_1)^2}$$

Where $Z_{1-!} = 1.28$, if ! = 0.10 (power = 90%)
and $Z_{1-"/2} = 1.96$, if " = 0.05.

This simplifies to:

$$n = \frac{10.5 \times 2\ SD^2}{d^2}$$

Where SD is the standard deviation of the outcome measure, and 'd' is the difference in the outcome measure that would be of importance to detect.

Rationale for estimates:

- SD: Previously published data suggests that the SD of the outcome measure, kcal in bag lunches (for grade 6 students), is **226 kcal/lunch** (2).
- d: The difference that would be considered meaningful to detect is set at **100 kcal/lunch**. This is the amount of kcal that would be found in one extra snack (e.g. the 100 kcal snack packs). This is a realistic amount as it is likely that some parents may respond to the perceived need for increased food by adding in an extra pre-packaged and convenient snack.

  An extra 100 kcal at lunch would equate to an extra 19 400 kcal/year (194 school days (3) per year), which equates to an extra 5.5 lbs (3500 kcal / pound) or 2.5 kg. A 7-year-old boy on the 50th percentile for weight (23kg) and 50th %ile for height (122 cm), would have a BMI-for-age at the 50%ile (15.5 kg/m^2) (4); an increase of 2.5 kg would move him up to a weight of 25.5kg and at the same height he would now be at the 85th %ile for BMI-for-age (BMI=17.1 kg/m^2), which is in the at-risk-for-overweight category. Thus, an extra 2.5 kg in one year could push a child into an at risk category and over subsequent years in elementary school this may have the potential to increase individual and population risk for obesity.

$$n = \frac{10.5 \times 2\ (226)^2}{100^2}$$

= 107 students per group (not taking into account the design effect or loss to follow-up)

Step 2: Design effect

The design effect formula for a cluster, where students are nested in schools (clusters) is:

$D = 1 + (m-1) \times ICC$

Where, m = cluster size
and ICC is the intracluster correlation coefficient of the outcome measure

The ICC is low if the variation within a school is high and the variation between schools is low, and conversely, the ICC will be high if the variation within a school is low and the variation between schools is high (1). He et al. (5) conducted an intervention in Ontario schools and they utilized an ICC of 0.03. In another study by Murray et al. (6) the ICC for 24-hour caloric intake was lower at 0.01; however, the upper confidence bound was 0.06. This study was conducted with older children (mean age 12.8 years) and assessed 24-hour intake. As such, the ICC may be too low because they would likely have a high variation within each school owing to the 24-hour intake and the many factors affecting intake, and the greater independence in food choices of an older child. Thus, we chose an **ICC** of **0.03** as a more conservative estimate. Furthermore, we also want to measure other macro- and micronutrients, vegetable and fruit servings, and number of snack food servings, and in the Murray paper the ICC for other nutrients (except calcium and Vitamin D) was 0.03 or less (6).

The **cluster size** will be assumed to be around **15** students per school, or 7-8 students providing informed consent from each of two classes (grade 3 and 4). This is derived from an estimate of 35% informed consent (unpublished data from our interobserver reliability data) from each of two classes having 20-22 students per class. That is: 22 students x .7 = 15.4 students per class. We recognize that this is on the higher end of the estimate; however, it is also likely that some schools will have more than 2 classes of grades 3 and 4 students and as such it should be feasible to obtain consent for at least 30 students per school.

$D = 1 + [(m-1) \times ICC] = 1 + [(15 - 1) \times 0.03]$
$= \underline{1.42}$

Thus, the sample size in each arm (BSD and TS) would be

Cluster sample size = n x D
= 107 x 1.42
= 152 students per arm or 304 students total

Assuming 10% of children may be inaccessible after obtaining informed consent (e.g., absent from school during observations), the sample size becomes:

$N' = n / (1\text{-Loss}) = (2 \times 152) / (1 - 0.10) = 304 / 0.9$
$N' = \underline{338 \text{ students recruited}}$

Thus, if each cluster (school) has 15 students (as defined):
Number of schools = 338 / 2 (arms) = 169 students per arm
169 students / (15 students / school) = 11 schools per arm

Therefore, sample size will be: 11 schools in the BSD and 11 in the TS for a total of <u>22 schools</u>

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Appendix I: Chapter 4 Supplementary Material

Table A1 Pearson Correlation Coefficients between continuous covariates and energy packed and energy eaten by grade 3 and 4 students (n=321)

		Age	NPH	HEDL	Parental Income	BMI Z-Score	BMI	BMIperage	environscore	SRI	TotCalP	TotCalE
Age	Pearson Correlation		.028	-.034	-.070	.017	.123*	.030	.185**	.046	-.032	-.015
	Sig. (2-tailed)		.623	.554	.209	.759	.028	.605	.001	.414	.569	.784
	N		321	305	321	321	321	308	321	321	321	321
NPH	Pearson Correlation			.105	.083	-.131*	-.129*	-.106	-.072	-.158**	-.048	-.102
	Sig. (2-tailed)			.067	.137	.019	.021	.063	.199	.005	.394	.067
	N			305	321	321	321	308	321	321	321	321
HEDL	Pearson Correlation				.484**	-.072	-.109	-.028	-.256**	-.213**	-.078	-.033
	Sig. (2-tailed)				.000	.212	.057	.632	.000	.000	.172	.569
	N				305	305	305	293	305	305	305	305
Parental Income	Pearson Correlation					.015	-.050	.077	-.284**	-.382**	.045	.072
	Sig. (2-tailed)					.794	.370	.175	.000	.000	.425	.195
	N					321	321	308	321	321	321	321
BMI Z-Score	Pearson Correlation						.924**	.952**	.038	-.043	.263**	.306**
	Sig. (2-tailed)						.000	.000	.500	.438	.000	.000
	N						321	308	321	321	321	321
BMI	Pearson Correlation							.847**	.075	-.031	.213**	.272**
	Sig. (2-tailed)							.000	.182	.584	.000	.000
	N							308	321	321	321	321
BMIperage	Pearson Correlation								-.009	-.032	.238**	.270**
	Sig. (2-tailed)								.868	.576	.000	.000
	N								308	308	308	308
Environscore	Pearson Correlation									.144**	.146**	.109
	Sig. (2-tailed)									.010	.009	.051
	N									321	321	321
SRI	Pearson Correlation										-.070	-.134*
	Sig. (2-tailed)										.209	.016
	N										321	321
TotCalP	Pearson Correlation											.716**
	Sig. (2-tailed)											.000
	N											321

*. Correlation is significant at the 0.05 level (2-tailed); **. Correlation is significant at the 0.01 level (2-tailed); NPH, Food Neophobia Score; HEDL, parental education level; BMIperage, BMI-for-age percentile; Environscore, school environment score; SRI, social risk index; TotCalP, total kilocalories packed; TotCalE, total kilocalories eaten

Curriculum Vitae

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