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NUTRIENT COMPOSITION OF CHILDREN'S LUNCHES: THE ASSOCIATION BETWEEN THE SCHOOL FOOD ENVIRONMENT, DIETARY INTAKE AND WEIGHT STATUS OF ELEMENTARY SCHOOL CHILDREN

BY:

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ABSTRACT

There is increased interest in the role of schools in improving children's eating habits and reducing childhood obesity through the implementation of healthy eating policies. In this study, I assessed the nutritional quality of lunchtime food consumption among Grade 5 and 6 English speaking children on Prince Edward Island, and the level of school adherence to the policy (defined as the proportion of foods offered at lunch which were prohibited by the policy expressed as tertiles). Differences in nutritional quality according to level of school nutrition policy (SNP) adherence were also assessed.

A descriptive survey was used to assess principal's perceived adherence to key SNP components and food availability. Adherence to the SNP food list was assessed objectively by comparing specific foods offered in the school lunch programs, vending machines, and canteens to those allowed by the SNP. Students (n=1966) completed a lunchtime food record during an in-class survey. Nutrient intakes were generated using the Canadian Nutrient File. Dietary adequacy was assessed by comparing micronutrient intakes with one third of the EAR; macronutrient intakes were compared to the Acceptable Macronutrient Distribution Ranges. Descriptive statistics (medians and percentiles) for calories and all nutrients assessed were generated for each child according to sex and grade. Chi-square tests of association were used to assess the association between the level of adherence of the SNP and the proportion of children meeting recommended nutrient intakes. The Wilcoxon Rank Sum Test was used to assess differences in nutrient intakes according to grade, sex, source and day of recording.

The survey of principals indicated that elementary schools are making some progress in adhering to the policy, with some components being easier to implement than others. Most principals reported that they were using healthy foods or non-food items for fundraising purposes but fewer indicated that they were involving students in planning foods offered at school. Objective assessments of foods offered at school indicated that 74% of all foods and beverages served at lunch were considered "allowed" by the PEI SNP indicating that principal's perceptions were in good accord with the actual pattern. However, 68.3% of schools still offered at least one prohibited food. There was support for the study hypothesis that students attending schools with lower levels of adherence to the SNP will report higher fat intakes at lunch. However, the hypothesis that students attending schools with lower levels of adherence to the SNP will report higher sugar and sodium intakes was not supported.

Children attending schools with closer adherence to the SNP were more likely to consume fat intakes within the recommended range compared to those from schools who adhered to the SNP less closely ($p<0.002$). Two thirds of the food consumed by the students came from home sources, so home sources must be taken into account when assessing school nutrition programs. The overall nutritional quality of lunches was poor, regardless of food source.

This is the first study in Canada, and one of the first worldwide, to evaluate the dietary quality of lunch-time foods consumed by elementary students which considers the source of the food (home versus school) and the level of adherence to a SNP. Comparing the dietary quality of children's lunch's items purchased from school versus items brought from home can help us understand the role of schools in enabling children to consume school lunches which are high in nutrient quality.

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LIST OF ABBREVIATIONS

School Nutrition Policies (SNP)

Milk and Alternatives (MA)

Vegetables and Fruit (VF)

Eastern School District (ESD)

Western School Board (WSB)

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CHAPTER ONE

1.0 INTRODUCTION

Childhood obesity is a major public health problem that is reaching epidemic proportions in Canada and around the world (Birch & Fisher, 1998; Lino et al., 2002; Sallis et al., 2003; Willms et al., 2003; Taylor et al., 2005), and one which has caught the attention of both public health officials and those working in school health. Unhealthy dietary habits and physical inactivity are contributing to an alarming increase in the prevalence of childhood obesity (Johnson & Nicklas, 1999; Malina, 2001; Raine, 2004), defined as a condition of excess body fat (Himes & Deitz, 1994; Schonfeld-Warden & Warden, 1997). Schools have the potential to influence students' eating habits and weight status through healthy eating policies and programs offered (Health and Welfare Canada, 1996; Centers for Disease Control & Prevention, 1997; Veugelers & Fitzgerald, 2005). However, many school-aged children in Canada are faced with readily available foods that are high in fat, sugar and/or sodium but contain few nutrients (e.g. french fries, candy, soft drinks, chocolate bars, potato chips (BC Ministry of Education & Ministry of Health, 2005; Taylor et al., 2005; Government of Manitoba, 2006). The increased overconsumption of these foods is a major barrier impacting children's dietary habits while in the school environment (Kubik et al., 2003; Taylor et al., 2005; Hanning et al., 2007).

Improving the nutritional quality of foods offered at school can have a positive impact on children's eating habits (Veugelers et al., 2005; Foster et al., 2008; Jaime & Lock, 2009). However, there has been little research assessing the specific impact of

school nutrition programs and policies (Jaime & Lock, 2009), and even less in Canada, where 9/10 provinces have recently implemented policies (Jeffery & Leo, 2008, Dietitians of Canada, 2008). Few Canadian studies have assessed whether schools that follow SNP are more likely to have children with healthy diets. For example, although there is evidence that SNP have a positive impact on children's combined dietary intake from home and school (Cullen et al., 2007), few studies have examined the impact of SNP on children's food intake at school. Since children spend approximately six hours a day at school and consume at least one meal and one to two snacks while at school (Dietitians of Canada, 2008), it is important to examine the nutritional composition of children's lunch-time food intakes. This is particularly important, since foods purchased from school lunch programs are most likely to be affected by changes in the school food environment associated with the implementation of SNP. A recent Korean study (Kim et al., 2006) compared the nutritional adequacy and quality (nutrient density) of Korean children's lunches from home versus school. While definitions of nutrient density vary, is it often defined as the nutrient content (in grams or mg) of a food or meal divided by the total energy content (expressed in kilocalories) (Drewnowski, 2005). It was concluded that lunches from school were of higher dietary quality than lunches from home, and the lunch program was contributing to improving the nutritional quality of Korean children's diets. These authors also noted the importance of examining the dietary quality of foods according to their source since foods purchased from school may be healthier than those brought from home (Kim et al., 2006).

Another critical but often neglected aspect of policy evaluation is the level of school adherence to the policy (Dietitians of Canada, 2008). It is not possible to assess

whether a policy is effective in improving children's dietary intakes and weight status without first determining if the policy is indeed being followed by schools. No Canadian studies have attempted to assess to what degree Canadian schools are adhering to the newly introduced SNP. Studies have only surveyed the school food environment (BC Ministry of Education & Ministry of Health, 2005; Government of Manitoba, 2006), without comparing it to the foods specified as allowed by the policy.

Although Canadian SNP often vary in terms of their specific guidelines, they share a common goal of improving the dietary habits of school-aged children. A nutrition policy for elementary schools in Prince Edward Island was adopted province-wide in 2006 (Eastern School District, 2005; Western School Board, 2005) and addresses issues such as the quality of food available in the school environment, student access to food, food used in school fundraising initiatives, food safety, and nutrition education. The recent province-wide adoption of the nutrition policy for elementary schools in PEI provides an opportunity to conduct a comprehensive evaluation of the policy, including an assessment of school adherence to the policy and the quality of foods consumed at school.

Research Aims and General Hypothesis

This research will address the following research aims:

1. To assess the extent to which PEI elementary schools are following the recently implemented nutrition policies;
2. To determine if there is an association between school policy adherence and adequacy of lunch-time food intake in PEI grade five and six children;

3. To describe the dietary quality of children's lunch time intakes;
4. To assess differences in dietary quality between foods purchased at school versus brought from home;
5. To determine if there is an association between school policy adherence and the prevalence of overweight and obesity in PEI grade five and six children.

Specific objectives are:

1. To describe principal's self reported adherence to recently implemented PEI SNP in each school;
2. To assess the extent to which actual foods offered at lunch, in vending machines and canteens, are consistent with the policies;
3. To assess the prevalence of dietary inadequacies among PEI grade five and six children;
4. To describe the prevalence of overweight and obesity among PEI grade five and six children;
5. To describe the percentage of foods purchased at school versus brought from home;
6. To compare dietary quality of foods purchased at school versus foods brought from home.

Hypotheses:

1. Foods purchased at school will have higher nutrient density than those brought from home;

2. Students attending schools with higher levels of adherence to the nutrition policies will consume less fat, sugar and sodium compared to students attending schools with lower levels of adherence; and
3. There will be a lower rate of overweight and obesity among students attending schools with higher levels of adherence to the SNP compared to those schools which are not following the nutrition policy as closely.

In answering these questions, this research will contribute to the knowledge base regarding the impact of the school food environment on eating habits of children while at school and the role of SNP adherence and source of foods consumed in the nutritional quality of foods consumed at school, and children's weight status.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1. Childhood Obesity: The Epidemic

Childhood obesity is considered a major public health epidemic in North America (Willms et al., 2003; Ogden et al., 2006; IOM, 2006a). Obesity is defined as a condition of excess body fat (Himes & Deitz, 1994; Schonfeld-Warden & Warden, 1997). The Body Mass Index (BMI) is a commonly used method of assessing or estimating an individual's risk of developing weight-related health issues and can be related to obesity and overweight indicators. The BMI is determined from the following equation (Deitz & Bellizzi, 1999):

$$BMI = \frac{wt}{ht^2} \qquad (1)$$

where wt is the weight in kilograms and ht is the height in meters. However, body mass indicators vary between adults and children, so this standard equation must be modified for use with children. There are two main methods for determining overweight and obesity from BMI values among children, "BMI-for-Age" and "International cut off points" methods. Both methods include corrections to account for significant growth changes in children during the developmental years (Hammer et al., 1991; Pietrobelli et al., 1998).

Calculating BMI-for-Age involves using the standard BMI calculation for adults and then plotting the child's BMI on a percentile chart that is specific for children of a similar age and sex (Hammer et al., 1991; Pietrobelli et al., 1998; Nihiser et al., 2007).

Children with a BMI-for-Age greater than the 95th percentile are considered obese while children with values between the 85^{th} and 95^{th} percentile are considered overweight (Tremblay & Willms, 2003). If historical patterns are analyzed using this method, the prevalence of obesity in Canadian children has risen 424% since 1996 (Tremblay & Willms, 2003).

The international cut-off points method developed by Cole et al. (2000) provides an alternative method to define overweight and obesity in children. Rather than plotting BMI data onto a percentile chart, specific cut off points are used to distinguish between overweight and obesity in children and are defined for each sex for children and youth aged 2-18 years. By age 18 the cut point passes through the adult BMI cut points of 25 kg/m^2 and 30 kg/m^2 for overweight and obesity, respectively. The international cut off points were obtained by averaging data collected between 1963 and 1993 from six large cross sectional surveys on growth from Brazil, Great Britain, Hong Kong, Netherlands, Singapore and United States. Each survey consisted of over 10,000 subjects ranging from birth to 25 years. This method of assessing overweight and obesity in children and youth is recommended by Dietitians of Canada, the Canadian Pediatric Society, the College of Family Physicians of Canada, and Statistics Canada for use in group comparisons, as the method takes into account the timing of puberty which has a major influence on body fat (Flegal et al., 2001; Dietitians of Canada et al., 2004). For example, a 13-year-old girl who is five feet and two inches (157cm) tall would be considered overweight (BMI=25) if she weighed 140lbs (64kg) (Appendix A).

According to the 2004 Canadian Community Health Survey (CCHS), 8% of Canadian children are considered obese, representing more than a 200% increase since

1979 with even higher increases being observed in Atlantic Canada (Statistics Canada, 2004a). The CCHS used the international Cole cut-off points method to classify overweight and obesity, with cut-offs of 25 and 30 used for overweight and obesity, respectively (Cole et al., 2000; Appendix A). Although childhood obesity is increasing across Canada, children in the Atlantic Provinces are more much more likely to be considered overweight compared to children in the Prairie Provinces. For example, rates of overweight are 30.2% in Prince Edward Island compared to 24.4% in the Prairies (Willms et al., 2003). This pattern is not a new one; historical data indicate that Prince Edward Island had the second highest rate of childhood overweight in Canada in 1996 and the third highest increase in overweight from 1981 to 1996 (Tremblay & Willms, 2003). The most recent data collected from the CCHS (Statistics Canada, 2004a) shows that PEI youth age 2-17 have the second highest rates of overweight (22.4%).

The negative impact of childhood obesity on the present and future health of children is well documented and includes both social and direct health impacts (Veugelers & Fitzgerald, 2005). Obese children are more likely to experience bullying and rejection from peers, which can negatively affect children's confidence and self-esteem and lead to feelings of isolation and depression (Daniels et al., 2005). There is strong evidence that obesity in childhood is associated with early onset of Type II diabetes, as well as elevated levels of serum cholesterol and hypertension (Goran et al., 2003; Raine, 2004). Furthermore, schools are observing an increase in children with multiple health related issues caused by obesity, such as hypertension, type II diabetes and asthma (US Department of Health and Human Services, 2009). Overweight children also tend to grow up to be overweight adults (Freedman et al., 1999; Boynton-Jarrett et

al., 2003). A longitudinal study of children in the United States (Nader et al., 2006) found that the longer a child remained in the lower range of a normal BMI, the less likely they would become overweight by early adolescence. Similarly, the more times a child had a BMI higher than the 85th percentile, the more likely that the child would remain overweight into adolescence and adulthood. Singh et al. (2008) reviewed 25 published articles involving childhood overweight and obesity continuing on into adolescence. All studies concluded that children who are overweight or obese are at a high risk of becoming overweight or obese adults. These findings are of concern since obesity in adulthood is associated with increased overall mortality (Katzmarzyk & Ardern, 2004), as well as increased chronic disease including cardiovascular disease (Berenson et al., 1998), hypertension, type II diabetes and certain types of cancer (Dietz 1998; Boynton-Jarrett et al., 2003), high blood pressure, gallbladder disease and respiratory problems. The epidemic increases in childhood obesity in recent years and the associated risk of developing a whole host of these potentially fatal health conditions as obese children mature into obese adults increases the need to identify determinants of, and prevent, childhood obesity as early as possible (Hills & Parizkova, 2005). Children's dietary intake has been identified as a key determinant of childhood obesity, and is discussed below.

2.2. Children's Dietary Intake

Unhealthy eating habits have been identified as important contributing factors to the increasing prevalence of childhood obesity (Malina, 2001; Raine, 2004). Dietary intakes of school-aged children have changed over the past two decades, and now consist

of many unhealthy food choices (Taylor et al., 2005). School-aged children in the United States (Jahns et al., 2001; Nicklas et al., 2004) are decreasing their consumption of milk and alternatives (MA), vegetables and fruit (VF), whole grains, and eggs. Concurrently, children are increasing their intake of "other foods" (fruit drinks, soft drinks, salty snacks, and cheese) (Jahns et al., 2001; Nicklas et al., 2004). An Ontario report suggests that students in grades six, seven and eight are eating meals that fall below recommendations set by Canada's Food Guide to Healthy Eating (CFGHE) for all food groups except meat and alternatives (Hanning et al., 2007). This same study also reported that "other foods" were providing 25% of the students total energy intake and that this pattern of intake is a key factor in the increased overweight and obesity rates affecting both children and adolescents. The term "other foods" previously represented a category of "less healthy food choices" that did not fit into any of the four main food groups. The "other foods" category has since been removed from the latest version of Canada's Food Guide which was released in 2007.

In Prince Edward Island (PEI), nutrition related concerns in school children and youth include low consumption of MA and VF (Evers et al., 2001), and PEI students are more likely than Ontario students to have high fat snack foods such as french fries, chips, cakes, cookies, candy and soft drinks on a daily basis (Evers et al., 2001). Approximately 40% of PEI students in grades 4-9 reported consuming these foods at least three times a day (Evers et al., 2001).

It is clearly important to conduct accurate assessments of childrens' food intakes in order to identify key areas for intervention. Methods of assessing diet in children, and challenges in conducting dietary assessments in children, are discussed below.

2.3. Dietary Assessment Methods Used in Children

Many different methods can be used for assessing children's dietary intake. Three of the most common methods used are food frequency questionnaires (FFQ), 24-hour recalls and food records. All methods have their strengths and weaknesses, making it the responsibility of the researcher to determine which method is most appropriate for the study population being assessed, always taking into account the objectives and purpose of the study (Dwyer, 1994).

A FFQ is a checklist of foods and beverages with a frequency response section for subjects to report how often each item was consumed over a specific period of time (Willett, 1990; Rockett & Colditz, 1997; Subar et al., 2001). The FFQ can be self-administered and is often computerized, which allows for data to be quickly and efficiently scanned. This reduces the cost and, more importantly, the chance for errors often associated with manual data entry (Rockett et al., 1997; Subar et al., 2001).

The 24-hour recall is a simple yet widely used dietary assessment method which captures a snapshot of an individual's dietary habits by asking an individual to remember what they have eaten during a 24-hour period (Willett, 1990; Rockett et al., 1997). The 24-hour recall relies heavily on the participant being both motivated and literate (Domel, 1997). Usually, the data are collected through a personal interview which may occur in person or via telephone. The interviewer must be trained to probe the participant for additional food details in the hopes of collecting the most complete and accurate dietary data (Domel et al., 1994). Food models and descriptions of standard portion sizes are often used by the interviewer during the recall to aid in the accuracy of participant responses (Matheson et al., 2002).

A food record is a detailed description of both the type and amount of foods and beverages consumed over a specific period of time (Domel, 1997; Rockett et al., 1997). Most food records follow an open-ended design and consist of lists or forms that are completed by the participant, demanding a certain level of literacy and motivation to obtain accurate data (Domel et al., 1994). At the end of the recording period, a trained interviewer will review the foods and portions documented for accuracy. The information that is gathered will depend on the nature of the study, and may include the meal source, time of day and exact location eaten (Domel et al., 1994). Some researchers have adapted this method to assess food intake at a single meal. For example, Cullen and colleagues developed a lunch food record to assess the impact of changes from the school food policy on student lunch consumption in middle schools (Cullen et al., 2006). This method involved students listing each food and amount consumed on a separate line as well as the source of each food item (school lunch, snack bar, home, vending, other source). Previous research suggests that this is a valid method of dietary assessment in children (Domel et al., 1994).

2.3.1 Challenges in Assessing Dietary Intake in Children

Sources of error in dietary intake assessment are well recognized and these challenges can be even more difficult when dietary intakes of children are assessed than for adults (Beaton et al., 1997; Rockett et al., 1997; Livingstone et al., 2004). Key issues identified by Rockett et al. (1997), and described below, include children's cognitive ability to record or remember what they ate, their lack of knowledge of food and food

preparation, literacy level, social desirability bias and the fact that older children consume food both at home and at school which must be accounted for.

There is considerable interest in the age at which children can provide researchers with accurate dietary information. By age 10 children are thought to have the cognitive processes allowing them to accurately remember what they have eaten (Baranowski & Domel, 1994). Memory of foods eaten and estimating portion sizes are particularly important concerns in assessing children's dietary intake. The time span from consumption to recall of children's dietary intakes can be critical (Foster et al., 2008), and reducing this has been shown to increase the validity of self reported data (Smith et al., 1991; Baxter et al., 1997; Foster et al., 2008). Children also may have trouble estimating portion sizes, and portion size estimation is also related to the time span between consumption and recall. For example, Crawford et al. (1994) validated portion size estimates from 9-10 year old students against direct observer assessments and concluded that children were able to better estimate their portion sizes using the 24 hour recall than in a three or five day food frequency questionnaire. Therefore, experts suggest that children and adolescents are able to provide valid dietary data when dietary reports are collected within 24-hours of consumption (Crawford et al., 1994; Foster et al., 2008). Domel et al. (1994) determined that fourth and fifth grade students were able to provide reasonably accurate dietary data, but they noted that accuracy increased when students had assistance from teachers or classmates and when they were prompted with cues to aid in memory recall. Examples of memory cues included having the lunch menu available in the classroom or providing pictures of food items to help them remember what was consumed. This process limits omissions and wrongly identified items, all of

which have proven to be issues when conducting dietary assessments with children (Knuiman et al., 1987).

Literacy can also be a concern, especially for young children, as can concentration issues (Smith et al., 1991; Hanning et al., 2007). Both direct supervision as well as assisting children with literacy issues when needed are key approaches that can help researchers obtain accurate dietary data when working with children. The level of direct supervision which can be provided will depend on the scope of the study, the available funding and the degree of accuracy required (Domel et al., 1994).

Social desirability bias can also influence the accuracy of children's assessment. Dietary intake data is self-reported, thus, children may be more likely to provide a perceived "correct" response, which is normally a healthier choice than a known unhealthy food (Brener et al., 2003). Social desirability bias occurs when individuals report foods that they believe would be viewed more positively by the investigator, and is especially important when adherence to social norms are being questioned (Hebert, 1995). For example, when children are asked to report their dietary intake, they may fail to report certain foods due to a concern of being viewed negatively for reporting consumption of less healthy foods (i.e. candy or soft drinks). Alternately, they may over-report foods they think are healthy, such as vegetables or milk. Researchers must consider all these potential sources of error when designing a study and use methods such as training, careful data checking and documentation to combat these limitations regardless of the dietary assessment method chosen (Domel et al., 1994).

In spite of these identified challenges in conducting dietary assessments in children, a number of dietary concerns have been identified. For example, high intake of

soft drinks and snack foods, and low intakes of MA and VF among children and youth are major concerns and that this dietary pattern is associated with increased risk of short and long-term health conditions, such as childhood obesity, early onset of type II diabetes and heart disease (Centers for Disease Control & Prevention, 1997; Raine, 2004). Therefore, it is important to explore means of improving poor eating habits and reducing childhood obesity in school-aged children. One key factor that has garnered increased attention in the past decade is the school environment.

2.4 Foods Available at School

Children face a variety of challenges while trying to "eat healthy" while at school. One of these is the ubiquity of high fat, high sugar foods (e.g. fries, chips, chocolate bars, candies or soft drinks) in or near schools (Brescoll, 2008; Jaime & Lock, 2009). Over-consumption of these foods is a major barrier to healthy eating which, in turn, impacts the health of North American school-aged children today (Centers for Disease Control & Prevention, 1997; Taylor et al., 2003; Kubik et al., 2003; Government of Manitoba, 2006; Vecchiarelli et al., 2006). There are several Canadian reports of high proportions of unhealthy foods and beverages being offered in school vending machines (Fieldhouse, 2002; BC Ministry of Education & Ministry of Health, 2005; Taylor et al., 2005). The ready accessibility of these foods has reduced children's fruit intake as vending snacks of low-nutrient density are often chosen over fruit (French & Wechsler, 2004). Also, when children are exposed to unhealthy choices at school, they do not compensate for this by choosing more healthful choices when away from school (Kubik et al., 2003). Further, when schools allow foods with little or no nutrition value to be

offered to students, it undermines what the children are taught in the classroom about healthy eating (Centers for Disease Control & Prevention, 1997). Experts agree that having healthy foods available to children while at school enables healthy eating habits (Centers for Disease Control & Prevention, 1997; Wojcicki & Heyman, 2006; World Health Organization, 2008). The most common approach to combat the influence of unhealthy eating choices is to reduce or remove access to unhealthy foods at the school level (Vecchiarelli et al., 2006) through SNP.

2.5 School Nutrition Policies

The school environment can have a powerful impact on children's food choices and can play a key role in influencing positively students' eating habits through healthy eating programs and policies (Centers for Disease Control & Prevention, 1997; Dietitians of Canada, 2008). SNP provide a framework for regulating the type of and quantity of foods served to school-aged children as well as improving children's dietary behaviours and increasing nutrition knowledge (Keirle & Thomas, 2000; Wechsler et al., 2000; McKenna, 2003; World Health Organization, 2008). Further, SNP are believed to be critical for preventing childhood obesity and reducing the future prevalence of chronic disease (Centers for Disease Control & Prevention, 1997; Raine, 2004; Veugelers & Fitzgerald, 2005) and financial burden on the health system (Burgess-Dowdell & Santucci, 2004). Policies must be established to create supportive nutrition environments in schools which can help provide students with the skills, opportunities, and support they need to adopt and maintain healthy eating habits (Kubik et al., 2003). Such policies not

only impact individuals, but also influence broad changes within the greater school community (Vecchiarelli et al., 2006).

SNP have been proposed for Canada for the past two decades, but implementation and assessment of the policies is relatively recent. In 1990, Health and Welfare Canada recommended that provincial and municipal governments unite to develop and implement comprehensive and coordinated school nutrition guidelines (Health and Welfare Canada, 1990). These recommendations were revised in 1996 to include more in-depth and comprehensive guidelines for the regions (Health and Welfare Canada, 1996). Interest in SNP has continued to grow, resulting in the recent adoption of SNP in most provinces across Canada (Jeffery & Leo, 2008).

In Prince Edward Island (PEI), SNP development has been led by the PEI Healthy Eating Alliance (HEA), a multi-sectored group working to improve eating habits and reducing childhood overweight in the province (www.peihealthyeating.ca). In the fall of 2003, the HEA invited 10 "lead" elementary schools on PEI to participate in the development of SNP for each school district. Lead schools were identified as schools that were already making positive changes at that time, had an interest in nutrition issues, and already showed a keen interest in the development of SNP at the school level (Freeze, 2006). All elementary (Grades 1-6) and consolidated (Grades 1-8) schools without cafeterias in the Eastern School District and Western School Board of PEI adopted virtually the same policy the next year, with full implementation in 2006 (MacLellan et al., 2008). In this thesis, these similar district level policies will be referred to as the PEI School Nutrition Policy (PEI SNP). The aim of the PEI SNP is to establish healthy eating behaviours in childhood by addressing issues such as the quality of food available

in the school environment, student access to food, food used in school fundraising initiatives, food safety, and nutrition education (Western School Board, 2005; Eastern School District, 2005). The policy regulations include food lists which classify specific food items such as french fries, pizza etc. according to the allowed frequency of consumption, "every day", "sometimes", and "once in a while" foods. Specific nutrient criteria are not included in the food lists; instead food descriptions such as "low fat hot dogs" or "lower sodium soups" are included.

Evaluation of SNP is essential for monitoring progress towards goals, assessing effectiveness, providing accountability to stakeholders and to secure future funding for school nutrition programs (Schmid et al., 1995; McGraw et al., 2000; Canadian Association of School Health, 2007). Despite the increasing number of provinces adopting SNP and their recognized potential to improve children's food intake and weight status, there has been little formal evaluation of SNP in Canada and elsewhere (Sallis et al., 2003; Taylor et al., 2005; Jaime & Lock, 2009). Previous research has measured foods offered to children at school, but has not assess SNP effectiveness (BC Ministry of Education & Ministry of Health, 2005; Government of Manitoba, 2006). More recent studies have focused on evaluating the effectiveness of SNP in increasing healthy foods at school. These studies test the hypothesis that changing the food environment, as a school based program, can achieve changes in the dietary intake of school-aged children (McGraw et al., 2000; French et al., 2003). For example, a Belgian study reported that "rules" for the consumption and limits on the availability of foods such as soft drinks and sweets at school result in lower consumption of these foods among primary and secondary students (Vereecken et al., 2005). In one San Francisco

middle school, a progressive nutrition policy in the school district increased the availability of healthful food options and decreased the availability of unhealthy options (Wojcicki & Heyman, 2006). The few Canadian studies which have evaluated SNP support the findings from international studies, though not all studies have specifically addressed the question of effectiveness. For example, McKenna (2003) used a qualitative approach to examine challenges associated with the implementation of the New Brunswick SNP which was introduced in 1991. The four main factors that affected implementation of SNP were 1) whether food was offered for profit (i.e. are unhealthy foods being offered at school to generate revenue) 2) how much choice students had with regards to what foods were available at school, 3) the school's interpretation of the policy (i.e. should the policy be followed exactly as written or is there room for flexibility?), and 4) the approach used for policy implementation (i.e. are parents, teachers, and food service workers provided with education and support to properly implement the policy?). McKenna (2003) concluded that more work is required to properly identify effective approaches to policy implementation. In contrast, a Nova Scotia study did evaluate effectiveness, assessing how school-based policies and programs affected eating behaviours, physical activity, and weight status of more than 5000 grade five students from 282 (Veugelers et al., 2005; Veugelers & Fitzgerald, 2005). Children attending health-promoting schools were less likely to be classified as overweight and more likely to consume vegetables and fruit and have an overall better quality diet compared to schools that did not offer a health promotion program. Results from this study suggest that comprehensive health promotion efforts in Canadian schools can have positive

benefits regarding improving student eating habits and reducing the rates of overweight and obesity among school-aged-children (Veugelers & Fitzgerald, 2005).

In PEI, several factors have been identified as enablers or barriers to the development and early implementation of SNP in elementary and consolidated schools (Freeze, 2006; MacLellan et al., 2009). School principals are critical individuals for enabling and facilitating the development of SNP so their co-operation is important. The sale of food for profit and competing issues were both identified as barriers or limitations to the development and early implementation of SNP on PEI (Freeze, 2006). Using food as a means of fundraising has become a norm in most schools, with low cost, often unhealthy, food choices (i.e. chocolate bars, chips) being used to generate significant revenue as part of school fundraisers. Schools expressed concern that revenues would be lost when SNP were implemented as a result of policy mandated restrictions on the sale of unhealthy foods for fundraising (Freeze, 2006). Competing issues (i.e. the amount of time available to devote to the issue of policy implementation) were also identified as barriers to policy implementation: school principals may not see the importance of focusing on the issue of SNP when they have many other pressing issues on their plate (i.e. bullying policies, literacy issues) (Freeze, 2006; MacLellan et al., 2009).

The recent province-wide adoption of the nutrition policy for elementary schools in PEI provides an opportunity to conduct a comprehensive evaluation of the policy, including an assessment of school adherence to the policy and the quality of foods consumed at school.

2.6 Policy Adherence

A major impediment to evaluating nutrition policies in schools is the lack of information on SNP adherence. It is not possible to assess whether a policy is effective in improving dietary intakes and weight status without first determining if it is indeed being followed by schools (Dietitians of Canada, 2008). Despite the increasing number of provinces adopting and implementing nutrition policies across Canada (French et al., 2003; Sallis et al., 2003; Taylor et al., 2005), no studies have compared the foods served at school against those permitted by the SNP.

In PEI, adherence to the SNP was assessed in 2006 through a survey of elementary school principals. The results of the survey suggest that principals perceive that their schools are adhering well to the SNP with a mean perceived policy adherence score of 77.5% for all schools that participated (Taylor & Brown, 2007). It was possible, however, that the relatively high score may have been partly due to social desirability bias (Herbert et al., 1995). This would occur if the principal reported his or her school as adhering more closely to the SNP than was actually true because he or she assumed that this would be seen more positively by researchers and/or school district administration. To determine the level of social desirability bias, adherence would have to be assessed more objectively through school visits, which is resource intensive, beyond the scope of most studies and may be considered invasive by some schools. The survey data can be used for evaluation as long as the potential bias is considered in the interpretation. Adherence monitoring must continue in order to assess the degree to which schools are following the SNP, to monitor progress towards goals, and to determine barriers and

enabling factors to implementing SNP (Schmid, Pratt & Howze, 1995; MacLellan et al., 2009).

Another gap in our understanding of how nutrition policies affect dietary health of school children is the actual nutrient composition of food choices consumed at school lunch, and how this is influenced by the source of the child's lunch (bringing lunch from home versus purchasing lunch at school). Most evaluations of SNP have assessed their impact on children's daily or monthly dietary intake from both home and school. Few studies have examined the specific effects of improving the school nutrition environment on the nutrient composition of children's combined lunch time food intake from home and school (Cullen et al., 2007); only one study (Cullen et al., 2006), focused specifically on the impact of SNP in children's lunch consumption at school. Lunch consumption is of interest since it is most likely to be affected by changes in the school food environment associated with the implementation of SNP (i.e. providing healthy choices at lunch). Cullen et al. (2006) assessed approximately 2790 sixth to eighth grade students from three middle schools in Texas. Statistically significant changes in dietary intakes were seen following the policy change, but not all changes were positive in nature. For example, dietary intakes of vitamin A, calcium, and milk increased following the change in policy, but fat, saturated fat and sodium also increased, all of which are associated with health concerns (Raine, 2005; LaFontaine, 2008). Consumption of soft drinks declined, but so did consumption of vegetables following policy change. This study shows that it is important to not only examine children's lunch time food intakes but also the source of children's lunch foods (home versus school program), since children may bring less healthy choices from home in spite of the presence of a healthy lunch program.

Therefore, a comprehensive evaluation of SNP effectiveness must include information on nutritional quality of food choices offered at lunch time as well as information on the sources of these foods and the level of school adherence to the policy. To date, no Canadian study has considered these important aspects of SNP evaluation.

The first research aim is to assess the extent to which PEI elementary schools are following the recently implemented nutrition policies. The second and third research aims are to describe the dietary quality of children's lunch time intakes and to assess differences in dietary quality between foods purchased at school versus brought from home, respectively. The fourth research aim is to determine if there is an association between school policy adherence and adequacy of lunch time food intakes in PEI grade five and six children. Finally, the fifth research aim is to determine if there is an association between school policy adherence and the prevalence of overweight and obesity in PEI grade five and six children. This research will contribute to the knowledge base regarding the impact of the school food environment on eating habits of children while at school and the role of SNP adherence and source of foods consumed in the nutritional quality of foods consumed at school, and children's weight status.

CHAPTER THREE

3.0 Nutrition Policy Adherence in Prince Edward Island Elementary and Consolidated Schools

3.1 Introduction

Because of the alarming increases in childhood obesity in Canada (Willms et al., 2003; Statistics Canada, 2004a) and elsewhere (WHO, 2008; Jaime & Lock, 2008) and the significant amount of time that children spend in school, the school food environment has come under scrutiny as an important contributor to the childhood obesity epidemic (Robert Wood Johnson Foundation, 2009). SNP have been identified as key to improving the nutritional quality of foods provided at school since they provide a framework for regulating both type and amount of food served to school-aged children and can improve children's dietary behaviours (Lissau & Poulsen, 2005; McKenna, 2003; Wojcicki & Heyman, 2006).

A recent review conducted by Dietitians of Canada (Dietitians of Canada, 2008) indicated that SNP have been adopted in the majority of provinces and territories in Canada. Nutrition policy development in Prince Edward Island was initiated in response to a documented high prevalence of unhealthy food choices in elementary schools and poor eating habits among school-aged children (Evers et al., 2001; Taylor et al., 2005). The PEI Healthy Eating Alliance, a multi-sectored group formed in 2001, worked closely with elementary (grade 1-6) and consolidated (grade 1-9) schools to develop district level SNP. In the fall of 2005, all schools in the Eastern School District and Western School Board of PEI adopted virtually identical policies, referred to in this chapter as the PEI SNP. The PEI SNP addresses such issues as the quality of food available in the school environment, student access to food, food used in school fundraising initiatives, food safety, and nutrition education.

Although most provinces have indicated that they intend to assess SNP implementation and/or evaluate their SNP (Dietitians of Canada, 2008), there is little current information available regarding the extent to which schools have been able to implement these policies, a key condition for SNP to have a positive impact on children's health (Dietitians of Canada, 2008). A British Columbia (BC) study used self-reported measures to assess which nutrition policies have been implemented in schools, and whether the promotion of healthy eating in schools is linked to nutrition policy initiatives (BC Ministry of Education & Ministry of Health, 2005). Participating BC schools were asked to report whether key elements of the provincial nutrition policies or guidelines were currently in place, under development, or neither, but did not assess details on specific foods offered relative to policy guidelines. Other surveys have assessed the types of foods offered in schools and the nature of nutrition policies and guidelines in place but have not specifically assessed the level of implementation, or adherence to SNP (Government of Manitoba, 2006; Taylor et al., 2007). In Prince Edward Island, all elementary and consolidated school principals were surveyed in 2006 regarding their perceptions of the degree of SNP policy implementation at their school (Taylor & Brown, 2007). The principals felt schools were making an effort early in SNP implementation, but that adherence to individual policy components varied. It is important to assess the perceptions of principals regarding their school's level of adherence to the SNP, since they are key enablers of successful SNP implementation (MacLellan et al., 2009). To date, no study has conducted an independent assessment of the extent to which foods offered at Canadian schools are consistent with SNP. It is important to include both a

subjective assessment of policy adherence and some more objective measure since principal's self reports may be influenced by social desirability bias.

The purpose of this research was to evaluate PEI elementary schools' adherence to the recently implemented SNP through a survey administered to school principals and an objective assessment of foods that are available. Specific objectives of this chapter are: 1) to assess principals' perceived adherence to key elements of the nutrition policy (subjective assessment) and 2) to assess the extent to which actual foods and beverages offered at lunch, in canteens and vending machines are consistent with the nutrition policy (objective assessment).

3.2 Methods

3.2.1 Design

This study is part of the School Nutrition & Activity Project (SNAP), a five-year evaluation of the effect of SNP on improving the eating habits and weight status of elementary school children on PEI. Here, a cross sectional survey design was used to assess schools' adherence to the recently implemented nutrition policies. To achieve this, a self-administered questionnaire that had been used previously to assess adherence to SNP in PEI (Taylor & Brown, 2007) was adapted to assess specific details regarding foods offered at school, including both a subjective assessment of adherence to the SNP and a more objective assessment of the foods/beverages offered at lunch and in vending machines and canteens. Ethical approval for this study was obtained from the University of Prince Edward Island Research Ethics Board (REB).

3.2.2 Sample

All elementary and consolidated schools (n=44) in the English Eastern School District (ESD) and Western School Board (WSB) of Prince Edward Island were invited to participate in this study. Forty-one of the schools responded to the survey (93.2%).

3.2.3 Instrument

The survey instrument was developed based on a review of the literature with questions adapted from instruments used in similar surveys in Manitoba (Fieldhouse, 2002), Newfoundland and Labrador (Coalition for School Nutrition, 2001), New

Brunswick (New Brunswick Department of Education, 1991) and Nova Scotia (Murton, 2004). Once developed, items were reviewed for content validity and comprehension. One "lead school" principal, a district principal and a manager of policy and planning from the two school districts reviewed the questionnaire for content, clarity and time required for completion. Their suggestions were incorporated into the final version of the questionnaire. "Lead schools" were those that were already making positive changes at that time, had an interest in nutrition issues, and already showed a keen interest in the development of nutrition policies at the school level (Freeze, 2006).

The final instrument consisted of both subjective and objective components. The subjective assessment included a 15 item scale assessing individual principal's perceptions of their degree of adherence to key policy components and the presence of school food programs/facilities (e.g. lunch program, canteen, vending machines). Items had both dichotomous and ordinal responses (Appendix B): Questions 1 to 4 used a dichotomous outcome (1=no, 2=yes), questions 5 and 6 recorded responses on a three point ordinal scale to assess agreement with statements about policy adherence (1=disagree, 2=agree, 3=strongly agree), and questions 7 to 15 used a four point ordinal scale to assess frequency of adhering to policy elements (1= never, 2=sometimes, 3=most of the time, and 4=always). The objective assessment included a) checklists assessing specific types of foods and beverages offered in school vending machines and canteens and b) an open-ended question assessing specific foods offered as part of school lunch programs, including a description of the food (e.g. pepperoni pizza) as well as the food supplier (e.g. Greco®). The objective assessment captured the diversity of specific food

types being offered as part of school lunch programs, which was not assessed in a previous study in 2006 (Taylor & Brown, 2007).

3.2.4 Data Collection

Approval was obtained from each school district before data collection occurred. For each school, principals were sent a preliminary e-mail which provided a brief summary of the project and an invitation to participate. The questionnaire was then faxed within one week of the e-mail with a cover letter explaining the intent of the survey and a consent form, and a request to return the survey within seven days. Completed surveys were returned by fax to the Department of Family and Nutritional Sciences at the University of Prince Edward Island. Schools that did not return questionnaires were contacted by telephone and sent a new questionnaire if necessary. To decrease the potential effect of social desirability bias, principals were assured that their responses would not be identifiable by school board administration, nor would there be any penalty for poor adherence to the policy. Data were collected during the fall of 2007.

3.2.5 Data Entry/Analysis

All data were entered using SAS-FSP (Version 8e, SAS Institute Inc, Cary, North Carolina) and were checked for accuracy against original questionnaires. Schools were re-contacted when necessary to supply information that may have been missing or unclear regarding food and beverage items offered.

Adherence was evaluated by determining the frequency of answers in each category for each survey item, then summarizing these into a policy adherence score.

Frequency counts were generated for all closed ended survey questions, including the subjective "perceived" adherence ratings for individual policy components, as well more objective information on foods and beverages offered in vending machines and in canteens.

Perceived Adherence Assessment

An overall "policy adherence score" was constructed by dividing the raw score by the maximum possible score (45) and multiplying by 100. Mean policy adherence scores were then generated using SAS (Version 9.1, SAS Institute Inc, Cary, North Carolina). A cut off of 75% was chosen as an indicator of "good" adherence as this reflected a natural distribution of the data and was consistent with that used in the 2006 survey of nutrition policy adherence (Taylor & Brown, 2007).

Objective Assessment

All schools on PEI offer a school lunch program to some degree; however, the frequency of which these programs are offered varied. For example, some schools offer a school lunch program 3 days a week, while another school may only offer the lunch program every two weeks, depending on resources and facilities. In contrast, not all schools offer a canteen or have vending machines in place at school. A more objective indicator of SNP adherence was constructed by comparing the specific foods offered in the school lunch programs, vending machines, and canteens to those allowed by the SNP regulations, which includes food lists specifying food types and the frequency of consumption. "Most often" foods (allowed daily) included nutrient dense foods identified in Canada's Food Guide which were also low in fat and sugar. "Sometimes" foods (allowed 2-3 times per week) contained essential nutrients but were higher in fat and

sugar. Foods in the "least often" category (allowed 1-2 times per month) were low in nutrients and high in sugar, fat and/or sodium. An individual food/beverage was considered "allowed" if it was included in the "most often" category, or if it was included in the "sometimes" or "least often" categories, and the sum of the frequency of all foods offered in these two categories did not exceed the maximum frequency permitted on a weekly or monthly basis. For example, if a school offered two "sometimes" foods (chicken pizza once per week and chicken noodle soup twice per week), both foods would be classified as "allowed" since the total frequency that they were offered (3 times per week) did not exceed the allowed 2-3 times/week for "sometimes" foods. The proportion of "prohibited" foods for a given school was calculated by dividing the total number of "prohibited" foods by the total number of food items offered.

A two tailed t-test was used to assess district level differences in mean policy adherence scores. Chi square analysis of association was used to determine if there was an association between district (ESD or WSB) and the observed proportion of "allowed" and "prohibited" foods served at school. Normality of the data was confirmed prior to analyses using Cramer-Von Mises, and Anderson-Darling normality tests.

3.3 Results

3.3.1 Principal's Perceived Adherence to Policy Components

Of the 41 schools that participated in the study, all reported having a school milk program and nearly all schools had an emergency food cupboard for students and allowed students at least 20 minutes to eat lunch (Figure 3.1). Over half of the schools in the sample reported having a school breakfast program (Figure 3.1).

There was variation in the proportion of schools that adhered to specific nutrition policy components. Most school principals "agreed" or "strongly agreed" that the foods at their school were priced to encourage healthy eating and that staff and volunteers at school were familiar with safe food handling practices (Table 3.1). Less than half of the schools reported that the foods offered at school were "always" selected from the food policy lists, and less than a quarter of schools "always" promoted healthy food choices/advertising at school, participated in PEI Healthy Eating Alliance/ nutrition activities when offered, or offered non-food items or healthy foods for rewards (i.e. having a vegetable/fruit tray versus a pizza party for school events) (Figure 3.2). However, many schools carried out these activities "most" of the time. A low percentage of schools reported involving students in planning food choices "most of the time" or "always", but the majority of schools were following the policy components which specified using healthy foods or non-foods for fundraising and teachers serving as positive healthy eating role models.

3.3.2 Overall Perceived Policy Adherence

The mean overall raw perceived policy adherence score was 36.0 ± 4.0 (out of a possible maximum score of 45) or 78.3 ± 8.7% for all elementary schools who participated in the study. Approximately half of the schools (56.3%) had a policy adherence score of ≥75%. There were no statistically significant differences between the ESD and WSB in regards to mean policy adherence (t-test, p=0.76).

3.3.3 Objective Assessment of Adherence

Foods Offered at Lunch:

All schools reported offering a lunch program for children. A more objective assessment of foods offered as part of school lunch programs indicated that three quarters of all foods were "allowed" according to the PEI SNP. Approximately half (21/40) schools reported that ≥75% of foods offered at lunch were allowed. Twenty eight schools (68.3%) offered at least one "prohibited" food. Meat pizza (e.g. pepperoni) was the most frequently reported food served at schools that did not meet the SNP guidelines, and "regular chicken" (deep fried chicken nuggets, chicken burgers), was the second most frequently served food not meeting the nutrition policy criteria (Figure 3.3). The most frequently reported food served at schools which met the SNP guidelines was baked potatoes, followed by meat and cheese pizza (i.e. in these cases the meat pizza was served infrequently enough to meet the SNP guidelines (Figure 3.4). Although 73.7% of all foods offered at lunch were allowed by the policy, for more than half of schools (52.5%), 20% or more of the foods offered were considered prohibited by the policy (Figure 3.5).

Foods Offered in Vending Machines

Overall, 61.9% of the schools reported that they had a vending machine and 94.8% of the foods served in those vending machines were considered "allowed" by the SNP. The most commonly offered "allowed" foods in vending machines were bottled water and 100% fruit juice, whereas, the most commonly offered "prohibited" foods in vending machines were fruit drinks/fruit crystals.

Foods Offered in Canteens

Over half (60.0%) of the schools reported that they had a canteen and 85.4% of the foods served in those canteens were considered allowed according to the SNP. The most commonly offered "allowed" foods in canteens were yogurt, cheese and crackers, granola bars, and 100% fruit juice (Figure 3.6a), whereas the most commonly offered "prohibited" foods offered in canteens were ice cream, cookies and potato chips (Figure 3.6b). Although 85.4% of all foods offered in canteens were "allowed" by the SNP, for 24.0% of elementary schools, 25% or more of the foods offered were considered prohibited by the SNP (Figure 3.7).

There were some statistical differences in SNP adherence between school districts: 63% of schools in the Eastern School District reported that $\geq$75% of the foods offered were considered allowed by the SNP whereas only 23% of schools in the Western School Board reported that level of compliance (Figure 3.8). No statistically significant differences existed between lead and non-lead schools or consolidated and non-consolidated schools in regards to the proportion of "allowed" and "prohibited" foods being served in vending machines or canteens (Chi Square Test of Association, $p>0.05$).

3.4 Discussion

This is one of the first studies in Canada evaluating elementary schools' adherence to a SNP. The overall aim of this research study was to assess the extent to which PEI elementary schools are following the recently implemented nutrition policies, both with respect to perceived and objective assessments of adherence.

Overall, school principals reported that they felt they were adhering well to the recently implemented SNP. The high mean perceived policy adherence score (78.8) for all schools that took part in the study was very similar to the findings of the 2006 survey (Taylor & Brown, 2007 = 77.5%). Another similarity to the 2006 survey was the variation in the level of adherence to individual policy components. For example, all schools reported participating in the provincial school milk program (which provides white milk at a subsidized cost) but less than half of the schools reported that they were "always" selecting foods for sale at school from the "always" or "sometimes" food lists. In addition, a low percentage of schools reported involving students in planning food choices "most of the time" or "always." The fact that there have been few, if any, improvements made in this area is a concern since the importance of involving students in planning school food choices in successful implementation of SNP has been well documented (Passmore & Harris, 2005; French et al., 2004). A similar survey in BC (BC Ministry of Education & Ministry of Health, 2005) indicated that 56% of responding schools indicated that at least one of the seven SNP categories were "currently in place"; 9% reported that they were in the process of developing guidelines or policies in at least one of the categories. This suggests that PEI is further along in regards to policy

implementation than BC, with 100% of schools on the Island currently having a SNP in place.

The more objective assessment of the extent to which actual foods and beverages offered at lunch, in canteens, and vending machines were consistent with the nutrition policy generally supported the perceptions of the principals. Three fourths of all foods reported to be offered as part of lunch programs were found to be consistent with the SNP guidelines when assessed by researchers in this study. However, for more than half of schools surveyed, 20% or more foods offered at lunch were prohibited by the policy.

In contrast, nearly all schools offered foods in vending machines and canteens which were consistent with the SNP. This is consistent with a previous "Food at School" survey (Taylor et al., 2005) which indicated that schools made these changes early on in policy implementation. The small proportion of "prohibited" items still offered in school canteens consisted mainly of ice cream, cookies and chips. These findings again suggest that PEI is ahead of some other Canadian jurisdictions in terms of policy implementation, for example, BC and Manitoba (BC Ministry of Education & Ministry of Health, 2005; Government of Manitoba, 2006). Schools in BC may not have been as advanced as compared to PEI schools in regards to policy implementation and as a result may have more unhealthy food choices being offered at school. Pastries and cookies accounted for the bulk of items available in British Columbia school stores (i.e. canteens) and Manitoba reported that hot dogs, chips, pizza and candy were the most popular canteen choices (BC Ministry of Education & Ministry of Health, 2005). In PEI (this study) the most common "allowed" foods offered in school canteens were yogurt, cheese & crackers, granola bars and 100% fruit juice in contrast to the results of the BC study which had reported few

school stores offered healthy choices such as 100% fruit juice, water or milk. Eighty percent of BC school districts either have a SNP in place, under development or have one planned. It should be noted that while foods offered in BC schools were categorized as "more healthy" or "less healthy" choices by dietitians, food items were not evaluated against the SNP. This makes it difficult to make comparisons between PEI and BC with respect to how closely schools are following the SNP.

Breakfast programs are another way that schools can influence students eating habits. For example, Breakfast for Learning™, a leading non-profit organization that supports school nutrition programs (such as the breakfast program in Atlantic Canada), provides breakfast to 48,750 children and youth annually (www.breakfastforlearning.ca). Over half (51.2%) of the schools who participated in the PEI study reported having a breakfast program, representing a small (4%) increase since 2006 (Taylor & Brown, 2007). Full participation in breakfast programs was not expected, since the policies state that schools should have a "Breakfast Program" when "a need for one is identified." The responsibility for identifying the need for such a program thus lies with each individual school. Schools may also have differing views on "school's responsibility" and "parental responsibility" regarding the dietary quality of school-aged children (Nollen et al., 2007). For example, in Manitoba (Government of Manitoba, 2006) only 36% of participating schools reported offering a breakfast program in 2006.

Information from this study on policy adherence provides valuable information that will be critical to assess the impact of SNP on student food consumption. These data have been lacking in Canada, probably because most provinces are just beginning full implementation of SNP (Dietitians of Canada, 2008). In this study, subjective

assessments suggested that certain policy components were adhered to more closely than others but that, overall, school principals indicated that they are making an effort to offer healthier food choices at school. Objective assessments of foods offered at school indicated that, three fourths of all foods and beverages served at lunch were considered "allowed" by the PEI SNP indicating that principal's perceptions were in good accord with the actual pattern. Furthermore, a high proportion of foods and beverages offered in those schools with vending machines and canteens (95 and 85%, respectively) were considered "allowed" by the PEI SNP. However, many schools continued to sell foods at lunch which were prohibited by the policy. These findings may reflect a lack of understanding regarding which specific foods are permitted by the SNP. It is therefore critical to provide support to schools since the benefits to children will only be seen if SNP are understood and followed. It is also important to assess whether implementing SNP in Prince Edward Island elementary schools is reflected in the nutritional quality of children's lunch time food intakes; this will be addressed in Chapters Four and Five.

Table 3.1 Proportion of principals who disagreed, agreed or strongly agreed that their school was adhering to specific policy components.

Nutrition Policy	Disagree %N (n)	Agree %N (n)	Strongly Agree %N (n)
Proper food pricing (n=39)	2.5 (1)	62.5 (25)	32.5 (13)
Safe food handling practices (n=40)	0.0 (0)	70.0 (28)	30.0 (12)

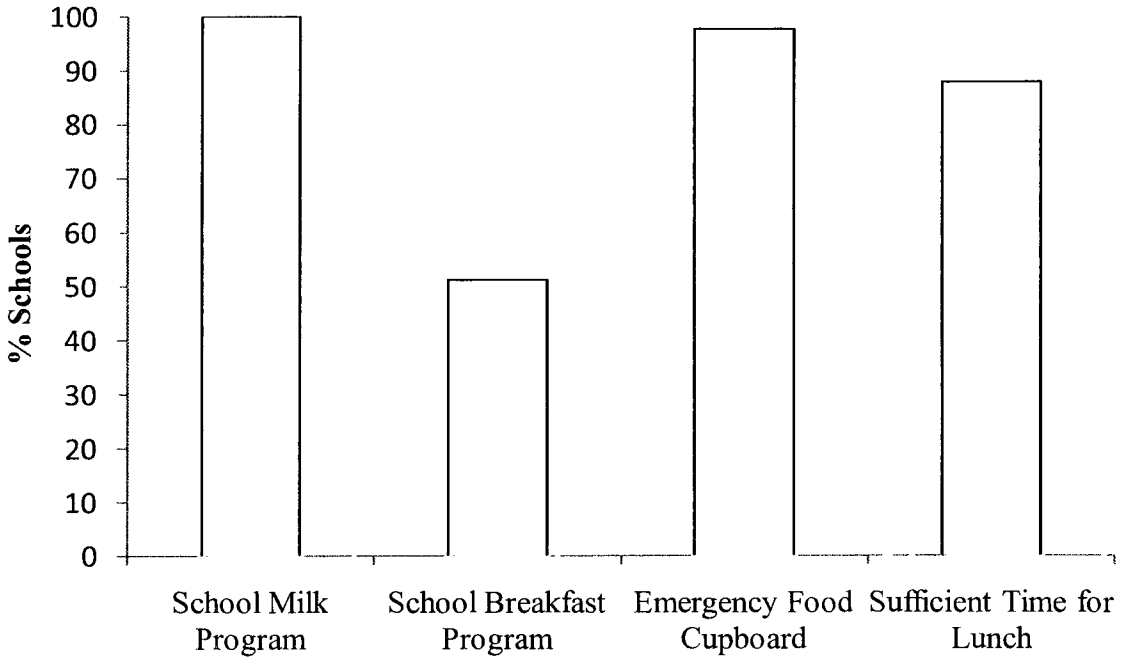


Figure 3.1 Percentage of principals reporting that their school offers selected programs.

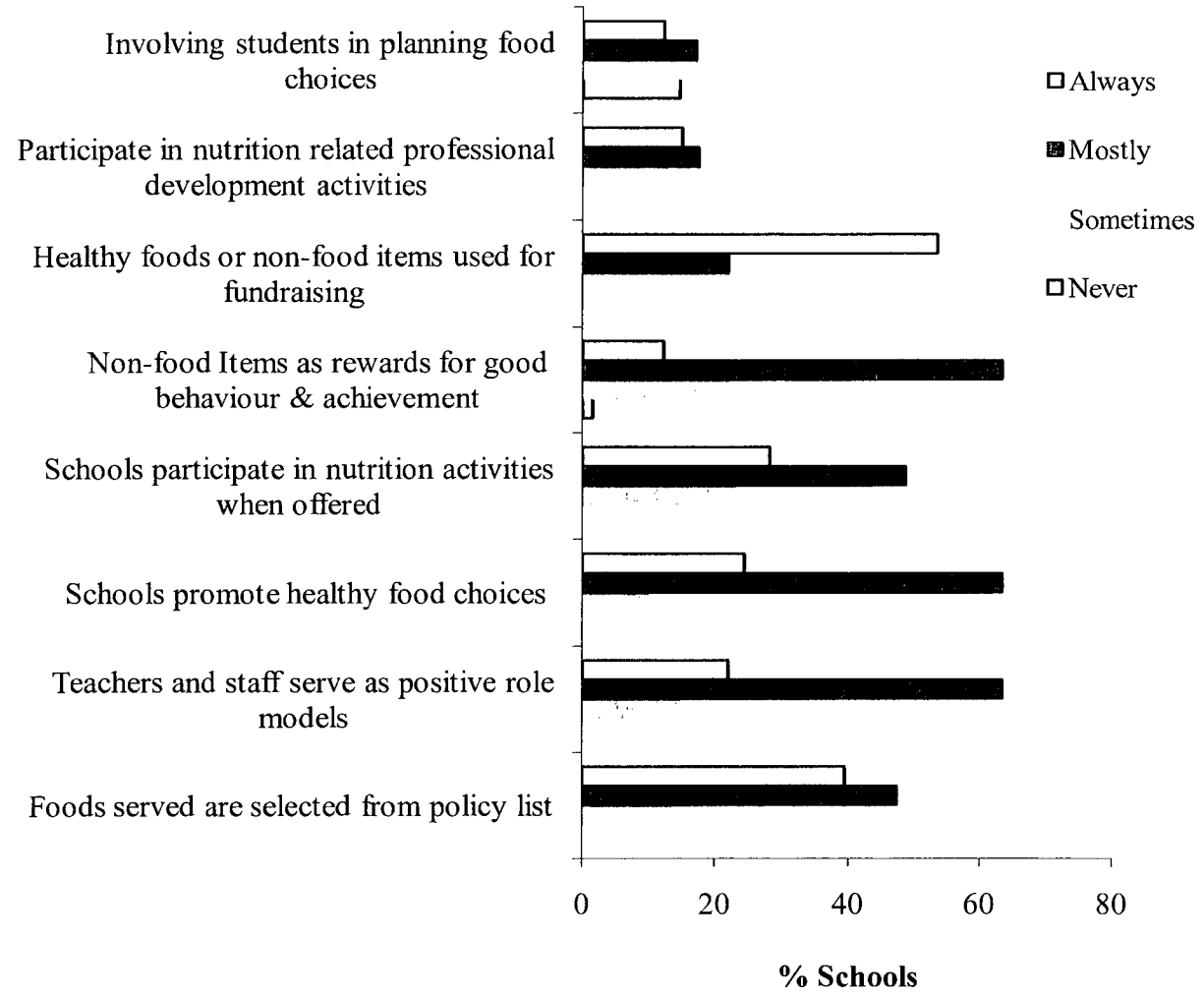


Figure 3.2 Percentage of principals reporting their perceived level of adherence to specific nutrition policy components.

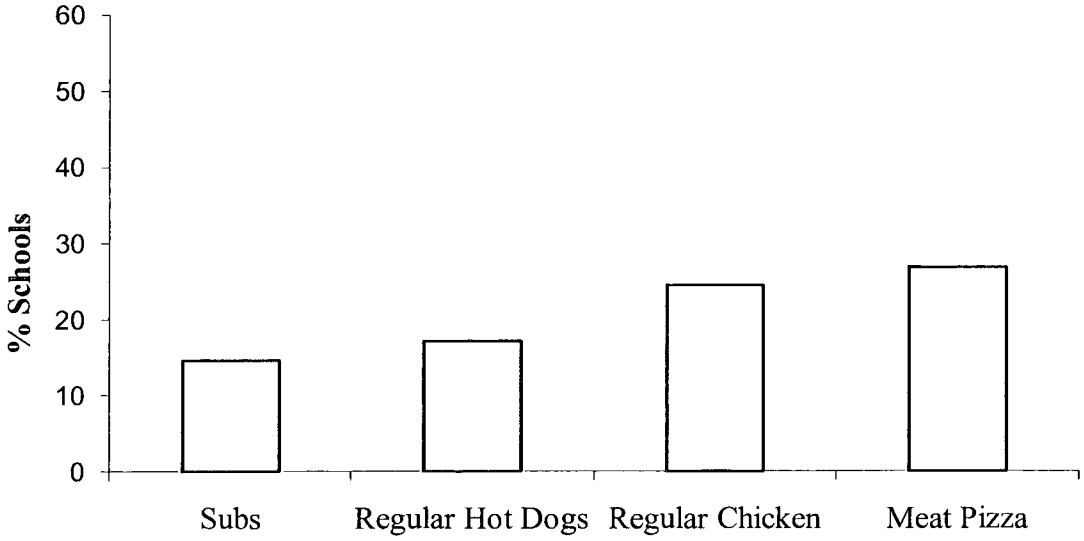


Figure 3.3 Percentage of principals reporting specific "Prohibited"[1] foods offered at lunch-time at their schools.

[1] Foods were categorized as "prohibited" if they were served more frequently than allowed by the SNP, so some foods can fall into more than one category.

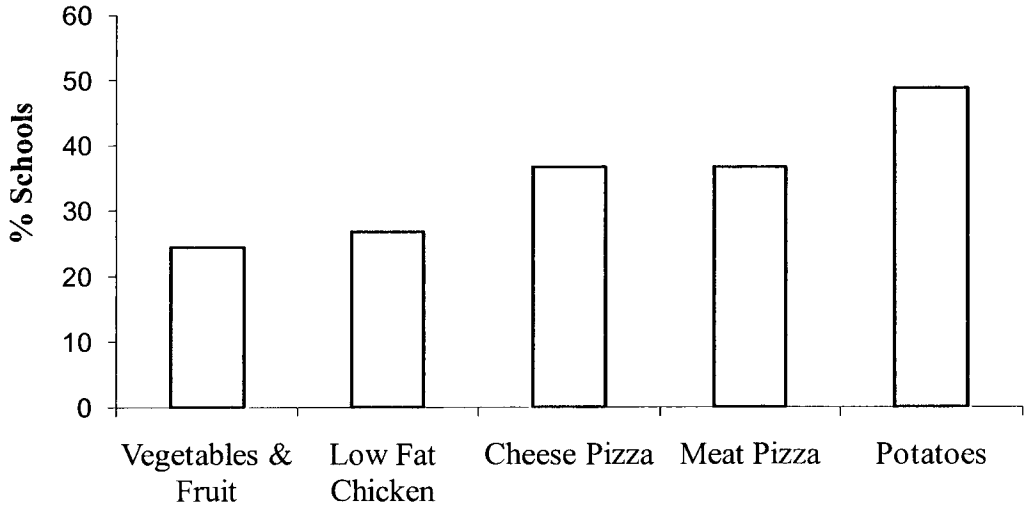


Figure 3.4 Percentage of principals reporting specific "allowed" [1] foods offered at lunch-time at their schools.

[1]Foods were categorized as "allowed" if the sum of all foods offered at lunch did not exceed the maximum frequency of allowed per week or per month.

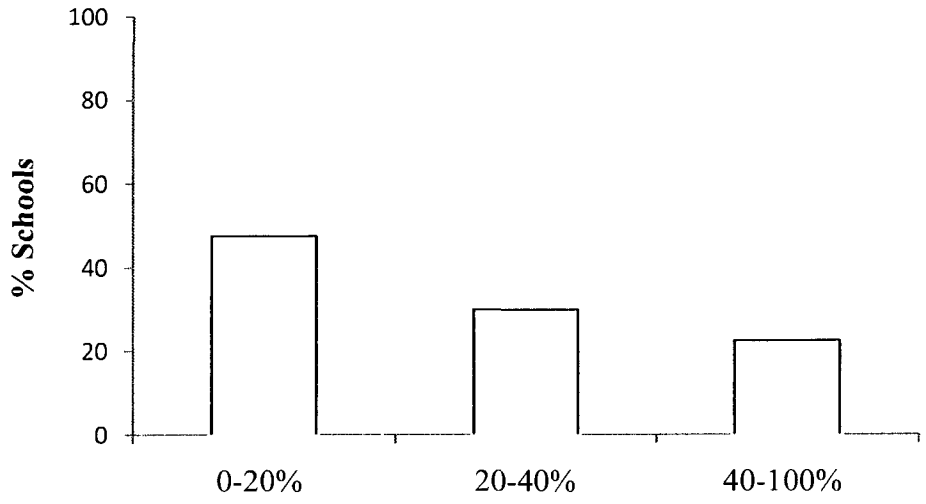
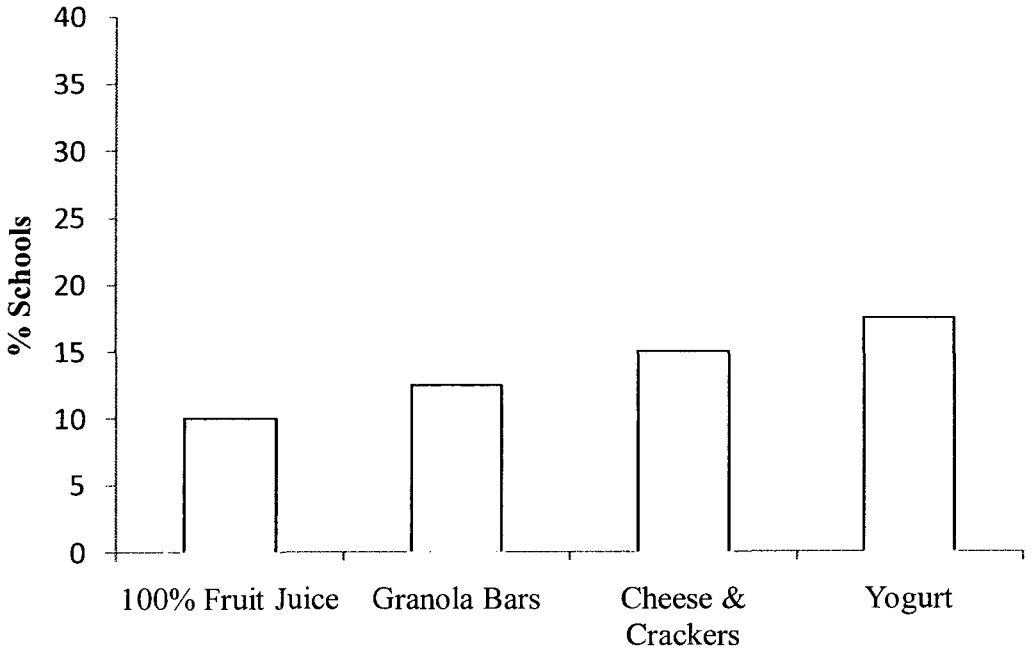
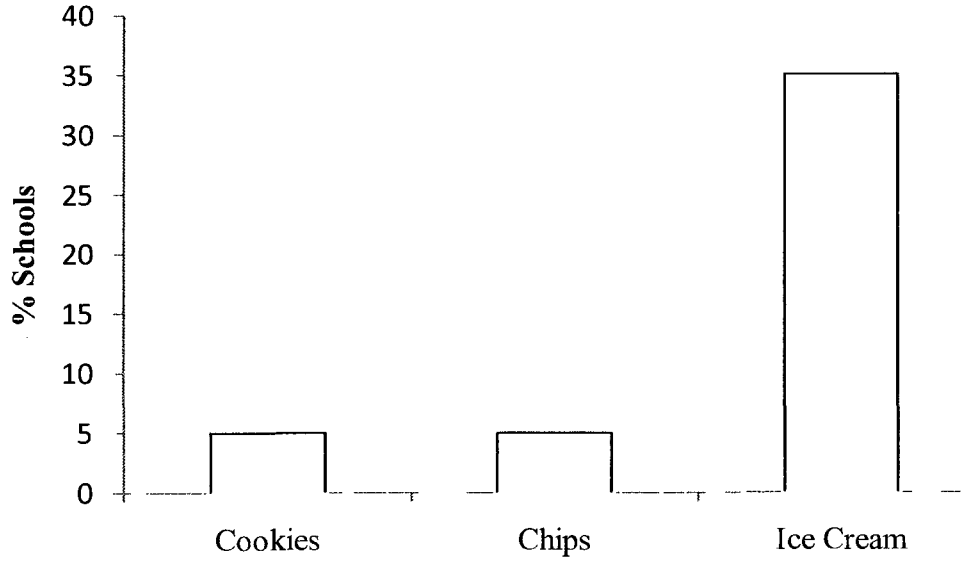


Figure 3.5 Proportion of schools selling <20%, 20-40%, or >40% of "prohibited" foods at lunch.



a) "allowed" Foods



b) "prohibited" foods

Figure 3.6 Percentage of principals reporting their school offers selected "allowed" or "prohibited" foods in canteens.

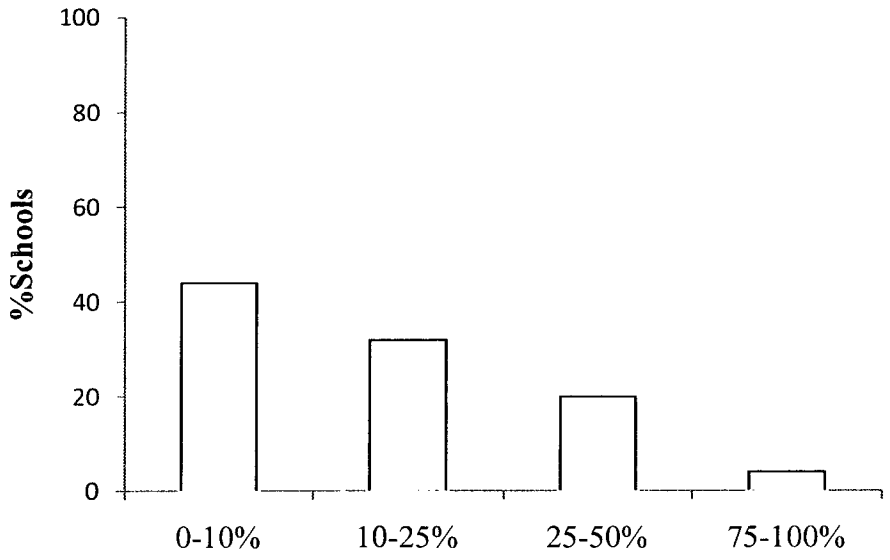


Figure 3.7 Proportion of schools selling 0-10%, 10-25%, 25-50 and 75-100% of "prohibited" foods in canteens.

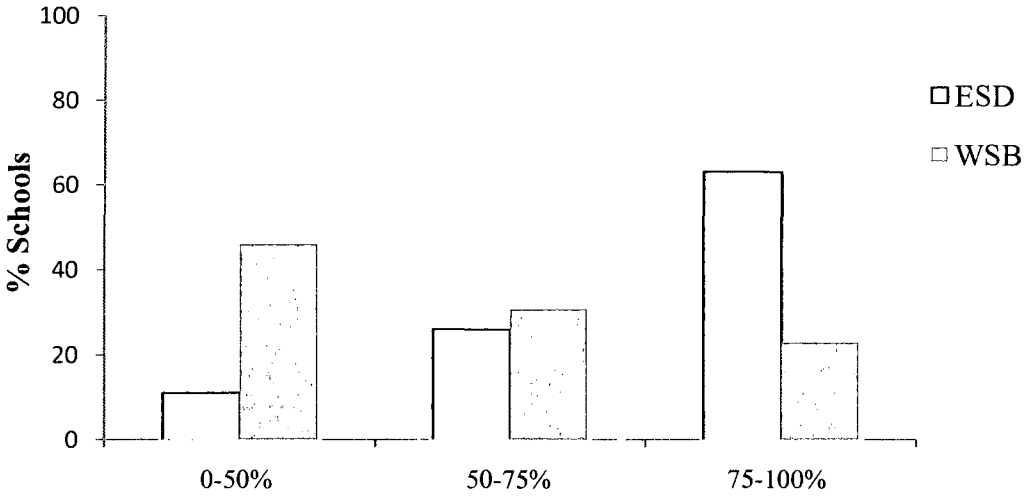


Figure 3.8 Proportion of schools selling 0-50%, 50-75%, or 75-100% of "allowed" foods at lunch by school district.

CHAPTER FOUR

4.0 Assessment of Nutrient Intakes and Overweight and Obesity Rates Among Grade Five and Six Students in English schools in Prince Edward Island

4.1. Introduction

In Canada, the rate of overweight and obesity among Canadian children aged 12-17 has more than doubled in the past 25 years (Statistics Canada, 2004a). There is considerable interest in children's dietary habits as an important contributor to this epidemic of overweight and obesity in children (Raine, 2004; Veugelers & Fitzgerald, 2005; Kubik et al., 2006; Jaime et al., 2009). School-aged children in North America are consuming too little of healthy foods such as VF and MA and too much of unhealthy foods, including soft drinks and high fat, high sugar snack foods such as potato chips and candy (Evers et al., 2001; Statistics Canada, 2004b; Hanning et al., 2007). Canadian students are also consuming diets high in fat and low in such nutrients as folate, fiber and calcium (Taylor et al., 2005; Veugelers et al., 2005; Hanning et al., 2007). The quality of dietary intakes also tends to decline with increasing grade level (Evers et al, 2001; Jahns et al., 2001; Nicklas et al., 2004).

Those interested in improving children's eating habits and reducing the risk of childhood obesity have focused on the school setting, since children spend an estimated six hours a day at school and consume at least one meal and one to two snacks while there (Budd & Volpe, 2006; Dietitians of Canada, 2008). Moreover, schools can have a potentially powerful influence on students' eating habits and weight status through healthy eating policies and programs offered (Health and Welfare Canada, 1996; Centers for Disease Control & Prevention, 1997; Veugelers et al., 2005). Unfortunately, children face a variety of challenges while trying to "eat healthy" during their time spent at school. The ready availability of high fat, high sugar foods and beverages (e.g. French fries, chips, chocolate bars, candies or soft drinks) is a major barrier to improving the eating

habits of North American school-aged children (Centers for Disease Control & Prevention, 1997; Kubik et al, 2003; Government of Manitoba 2006; Vecchiarelli et al., 2006; Wojcicki & Heyman, 2006; World Health Organization, 2008). For example, highly available low-nutrient density vending snacks are likely to be chosen over fruit, reducing children's fruit intake (French & Wechsler, 2004). Also, when children are exposed to less healthy choices at school, they do not compensate for this by choosing more healthful choices when away from school (Kubik et al., 2003).

An increasingly common strategy to combat the influence of unhealthy eating choices is to reduce or remove access to unhealthy foods at the school level (Vecchiarelli et al., 2006) through SNP. SNP provide a framework for regulating both the types and amounts of food served to school-aged children, and can improve children's dietary behaviours (Wechsler et al., 2000; McKenna, 2003; Lissau & Poulsen, 2005; Wojcicki & Heyman, 2006). In Prince Edward Island, SNP were adopted across the province in 2005 (Western School Board, 2005; Eastern School District, 2005).

Most evaluations of SNP have assessed the impact on overall children's dietary intake (Lytle et al., 2001; Veugelers et al., 2005; Hanning et al., 2007). However, very few studies have assessed children's dietary intakes at lunch time and associated them with the introduction of SNP (Cullen et al., 2006). In an American study, student consumption of saturated fat, vitamin A, calcium, sodium and milk increased and consumption of soft drinks and vegetables were significantly lower following SNP changes (Cullen et al., 2006). The policy changes at the school level have the ability to improve the dietary quality of school-aged children. However, changes must be made at all sites which offer food (i.e. school lunch, canteen, vending) to avoid compensation (i.e.

if unhealthy choices are only removed from the school lunch, children may compensate by choosing unhealthy foods from the vending machine).

The objectives of this chapter are to describe the daily nutrient intakes of grade five and grade six children, to determine the proportion of students consuming adequate intakes of nutrients according to the current standards for nutrient intakes in North America, (the Dietary Reference Intakes, DRIs) and to describe the prevalence of overweight and obesity among students.

4.2 Methods

4.2.1 Design

An in-class cross sectional survey of grade five and six students in PEI was used to assess children's lunch-time nutrient intakes and the source of foods/beverages consumed. Students' actual heights and weights were also assessed during the survey. This study was part of a five year evaluation of SNP in Prince Edward Island, SNAP (School Nutrition and Activity Project), and data for this part of the study were collected in the winter of 2007. The study protocol was approved by the University of Prince Edward Island Ethics Board (REB).

4.2.2 Sample

In Prince Edward Island, there are 52 elementary (grade one to six) and consolidated (grade one to eight) schools. Schools that had no students in grades five and six were eliminated as were the French schools which were small in number and were at a different stage of policy implementation; this left a total of 44 schools. All 3,320 grade five and six students were invited to participate in the research; 61% of these students agreed to participate. Students below grade five were not invited to participate since previous research has determined that children below grade five are less likely to provide valid dietary data (Evers et al., 2001; Taylor et al., 2005). Only those students whose parents had returned signed consent forms and had completed the parent surveys were included in the study.

4.2.3 Assessment of Lunch Food Intake

Students were asked to recall foods and beverages consumed during school lunch for one day. When data collection was in the afternoon, the present day's lunch was reported; when data collection occurred in the morning, children were asked to recall foods consumed at the previous day's lunch. Data collection was not conducted on Monday mornings, since this would require some students to report a non-school lunch on Sunday, or on Fridays to appease the schedule of the schools. The Lunch Food Record surveys (LFR; Appendix C) were administered in a classroom setting. Trained individuals provided students with instructions and a sample of a completed LFR as well as assistance with recalling and spelling food and beverage items. Students were asked to list each food and beverage item on a separate line. Students indicated how many servings they ate and the source of the food (school lunch, milk program, vending machine, home, "other 'source). Students were also asked to recall details about foods and beverages consumed (i.e. brands, flavours, condiments). Trained data collectors reviewed each student's LFR to identify missing or unclear information. Students were asked for further information when necessary. This method of data collection via food records has been shown to be valid when compared to direct observation of children's food intake by Domel et al. (1994) who showed that 117 record/observation matches were significantly correlated for eight of the nine meals items assessed (Pearson Correlation, r= 0.16 to 0.85). Results were most accurate when children recorded their intake on a daily rather than a weekly basis.

4.2.4 Assessment of Height and Weight:

Children's heights and weights were measured to determine the prevalence of overweight and obesity, and to relate rates to the level of adherence to the SNP (See Chapter 5). Measured rather than self reported heights and weights were assessed since school-aged children are likely to underestimate their weight. All measurements were conducted in a private room at each school. Children were assured during the in-class introduction of the study so that all the height and weight measurements would be collected in a private room and so that their results would remain confidential. Standard procedures were used to collect the height and weight measurements of all grade five and six students that had permission to participate. Standing height was measured using a standard wooden stadiometer to the nearest 0.01 centimetre after students removed their shoes. Height measures were repeated at least twice and a third time if a discrepancy (>0.3 cm) between the first two measures existed. The average of the two closest measures was calculated as the final height. Students were weighed to the nearest 0.01 kg using calibrated remote display digital scales. Overweight and obesity was defined using international BMI cut off points adjusted to specific age and sex categories for children (Cole et al., 2000).

4.2.4 Data Coding/Analysis

Lunch Food Intake

All foods and beverages consumed were coded using the 2007b version of the Canadian Nutrient File (Health Canada, 2007b). Information was obtained from schools and fast food outlets, if applicable, regarding the serving sizes of foods and beverages

offered at school (i.e. size of sub sandwich offered at school; volume of carton of milk). When children were unable to provide sufficiently detailed descriptions of foods and beverages consumed, or reliable food composition information was not available from food suppliers or vendors, standard coding rules were applied using foods and/or serving sizes which are commonly consumed by Canadian children in this age group (Evers et al., 2001). For example, unspecified bread was coded as "enriched white" and unspecified milk was coded as "2% white". Assumptions were made regarding the composition of some food items. For example, students who reported consuming a ham sandwich and did not specify condiments would be also coded a standard portion of mayonnaise. Lists of codes, serving sizes and assumptions were compiled by coding assistants. Cross-referencing of coding was performed by the two research assistants to increase reliability of coding. All foods and beverages were then entered into the CANDAT nutrient analysis program (Godin, 2008) and then cross checked with those originally recorded on the LFR. Calories, mass, micronutrients (iron, calcium, magnesium, potassium, zinc, vitamin A, vitamin C, vitamin D, vitamin E, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, and folate), fiber, sugar, calories, macronutrients (protein, fat, and carbohydrates) and the proportion of calories from protein, fat, carbohydrates and sugar were then generated using CANDAT software. Nutrient data were examined for extreme values, duplicate entries and missing values using SAS (Version 9.1, SAS Institute Inc, Cary, North Carolina) and were cleaned accordingly.

Descriptive statistics (medians and percentiles) for calories and all nutrients assessed were generated for each child and according to sex (male or female) and grade (five or six). Since the distribution of intakes for all nutrients assessed differed

substantially from a normal distribution and could not be normalized by log or square root transformation, non-parametric statistical tests were used when applicable. The Wilcoxon Rank Sum Test was used to assess differences in nutrient intakes according to grade (five vs. six), sex (male vs. female) and day of recording (yesterday vs. today). Chi-square analysis tests of association were used to assess the association between the prevalence of inadequate nutrient intakes and grade/sex. A p-value of 0.05 was used to define statistical significance.

Dietary adequacy for micronutrients (vitamins and minerals) was assessed for the total sample, and according to age and sex groupings, by comparing nutrient intakes to Dietary Reference Intakes (DRI), the conventional nutrient intake standards used in North America (IOM, 2006b). The DRIs are designed to meet the needs of individuals that are considered healthy or free of any diseases that may require different nutrient requirements then those of healthy populations (IOM, 2006b). Four main groups make up the DRIs: 1) Estimated Average Requirement (EAR); 2) Recommended Dietary Allowance (RDA); 3) Adequate Intake (AI); and 4) Tolerable Upper Intake Level (UL) (Health Canada, 2004a; IOM, 2006b). The EAR is defined as the nutrient intake level estimated to meet the needs of half of the individuals in a specific life stage and gender group. The RDA is defined as the nutrient intake level that is sufficient to meet the need of almost all of the individuals in a specific life stage and gender group, and is derived from the EAR. The AI is based upon expert estimates of nutrient intakes by a defined group of healthy people and is only used when there is insufficient scientific evidence to establish an EAR. The UL is defined as the highest daily nutrient intake which is not

associated with increased health risk; intakes above this level may be associated with health concerns such as chronic disease and nutrient toxicities (IOM 2006b).

The type of DRI standard used for interpreting nutrient intake data varies depending on the nature of the study and its purpose. When one is assessing the intakes of groups rather than assessing individuals, which is the case in this study, the use of EAR standards is appropriate for assessing adequacy. Most micronutrients and protein were compared with one-third (>33.3%) of the EAR (Appendix D): one third of daily food intake is the minimum standard for set for lunches in the United States (IOM, 2006b). EAR values were used since there is no national school lunch nutrition standards in Canada. Since there are no EAR values available for calcium, vitamin D, potassium, sodium and fiber, median intakes of these nutrients are compared to the AI, which can not be used to assess adequacy (IOM, 2006b; Kaufman, 2007).

Intakes of macronutrients (carbohydrate, protein, and fat) were compared with the Acceptable Macronutrient Distribution Ranges (AMDRs) which are expressed as a percentage of total calories: 45 to 65 percent of all calories consumed from carbohydrates is recommended; 20 to 35 percent from fat; and 10 to 35 percent from protein. A maximal intake level of 25 percent or less of energy from total sugar is suggested for adults and children since there is not enough evidence to set a DRI (IOM, 2006b).

Height & Weight Data

Chi square analysis of association was used to determine whether differences in rates of overweight and obesity among PEI school children existed according to grade

and sex. International body mass index (BMI) cut off points for this age group (Cole et al., 2000; Appendix A) were used to define overweight and obesity in this population.

4.3 Results

4.3.1 Sample Description

A total of 2,036 students participated in the survey, representing a response rate of 59.2% after accounting for absent or sick children on the day of the survey. Subsequently, a total of 70 questionnaires were eliminated (3.4%): 34 (1.7%), questionnaires were eliminated due to unreliable data (children recorded multiple meals or provided insufficient detail) and 36 (1.8%) were eliminated due to missing parental consent, leaving a total of 1966 usable LFRs. The sample was distributed evenly according to grade and sex (Table 4.1). A total of 1966 student lunches were analyzed for nutrient composition.

4.3.2 Nutrient Analysis

4.3.2.1 Median Nutrient Intakes

Nutrient analysis indicated that median intakes of calcium, potassium, zinc, vitamin A, vitamin E, vitamin D, and fiber (Table 4.2) fell below the one-third DRI recommendation. Protein, iron, magnesium, vitamin C, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, folate and sodium intakes met or exceeded the one-third DRI recommendation. The median intake of calories (Table 4.2) was within the recommended range of 460-730 calories as set by the Institute of Medicine (IOM, 2006b) for children's lunches.

Micronutrients (vitamins and minerals) and protein intakes varied depending on both grade (Table 4.2) and sex (Table 4.3), but only for certain nutrients. Median intakes of calories, protein, fat, carbohydrates, iron, calcium, vitamin D, thiamin, riboflavin,

niacin, sugar and sodium were all significantly higher for boys than girls (Table 4.3; Wilcoxon Rank Sum Test, $p<0.05$). Between grades, only median intakes of iron were significantly higher for grade five students as compared to grade six students (Table 4.2; Wilcoxon Rank Sum Test, $p<0.05$).

4.3.2.2 Median Intakes of Macronutrients As a Percentage of Total Calories

The macronutrient (carbohydrate, fat and protein) content (expressed as a percentage of total calories) of the children's lunches did not differ between the two grades (Table 4.5; Chi Square Test of Association, $p>0.05$) or by sex (Table 4.6; Chi Square Test of Association, $p>0.05$).

4.3.3 Adequacy of Lunchtime Macronutrients

Assessment of the total proportion of student's lunch-time intakes of carbohydrates, fat and protein which were within, above and below the AMDRs showed that most students were within guidelines for protein and fat, but were consuming too much carbohydrates and sugar (Table 4.4). Two thirds of the students had intakes of protein that fell within the AMDR; 19% had intakes below this standard. Only 24% of children's fat and carbohydrate intakes were within the AMDR. Most (78%) had intakes below the recommended range for fat. In contrast, approximately 60% of children had carbohydrate intakes above the AMDR and sugar intakes above the recommended 25% of total calories. It should be noted that although the children had sugar intakes above the recommended level the CNF gives information regarding the amount of total sugars including natural sugars. There were no significant differences between boys and girls

(Table 4.5, Chi Square Test of Association, $p<0.05$) or between grades (Table 4.6; Chi Square Test of Association, $p<0.05$) in the proportion of students with intakes falling within the recommended ranges for carbohydrates, fat and protein.

4.3.3 Adequacy of Micronutrients and Protein

Most children reported consuming lunch foods that contained adequate intakes of micronutrients and protein (Table 4.7). The majority of students consumed adequate intakes of protein, iron, thiamin, riboflavin, niacin, vitamin B_{12}, and folate (Table 4.7). However, few students reported adequate intakes of magnesium, zinc, vitamin A, vitamin E, vitamin C, and vitamin B_6 (Table 4.7). It should be noted once again that nutrient adequacy could only be calculated for those nutrients that had an EAR. For those that had an AI adequacy was not determined due to the fact that many values below the AI can be adequate (IOM, 2006b). For nutrients that have an AI the only method available is to compare median intakes relative to the AI. Thus, intakes of fiber, potassium, sodium, calcium and vitamin D could not be assessed in terms of adequacy since many values below the AI can also be adequate (IOM, 2006b).

Some differences were seen in micronutrient intakes between sexes, but not between grades (Chi Square Test of Association). A higher proportion of girls reported adequate intakes of Vitamin A than boys (Table 4.8; $p<0.01$), whereas boys were more likely to report lunches with adequate intakes of protein ($p<0.01$), thiamin ($p<0.01$), riboflavin ($p<0.05$), niacin ($p<0.05$), and vitamin B_{12} ($p<0.01$) than girls (Table 4.8). No differences in the proportion of adequate nutrient intakes were found between the two grades (Table 4.7).

4.3.4 Median Nutrient Intakes by "Day" of Recording.

Children reported lunches with higher median intakes of most micronutrients when asked about foods and beverages consumed on the previous day compared to intakes recorded the same day as data collection (Table 4.9; all Wilcoxon Rank Sum Test, $p<0.01$ except fat, vitamin A and vitamin C, $p<0.05$). Median intakes of vitamin D and sodium were not significantly different between the two days of recording (Table 4.9; Wilcoxon Rank Sum Test, $p=0.1021$ and $p=0.9174$ respectively). There were also no significant difference in median intakes according to day of recording for protein, fat and carbohydrates expressed as a percentage of total calories; sugar also fell within the range of <25% total calories from sugar (Table 4.9).

4.3.5 Proportion of Overweight and Obese Children

One third (33.4%) of grade five and six children on PEI were considered overweight according to the international cut off points method developed by Cole et al. (2000) (Figure 4.1). Of these, 11.5% are considered obese. Significantly more boys were classified as overweight and obese than girls (Chi Square Test of Association, $p<0.05$). There were no significant differences in the proportion of obese children between boys and girls (Chi Square Test of Association, $p=0.5505$).

4.4 Discussion

The nutritional composition of children's lunches in PEI elementary and consolidated schools is quite poor, despite the implementation of the SNP. A significant proportion of children had intakes of fat and carbohydrates outside of the recommended Acceptable Macronutrient Distribution Range (AMDR). Although two-thirds of students reported lunches with protein intakes that fell within the recommended range, considerably fewer fell within the AMDR for fat (15%) and carbohydrates (23%), with most students consuming fat and carbohydrates outside the recommended range. These findings are consistent with data from the 2004 Canadian Community Health Survey (CCHS) and recent research from Veugelers et al. (2005).

Children in this study consumed a moderate protein and low fat lunch with a high number (77.5%) of children reporting lunches with fat intakes that were below the AMDR. However, almost 60% reported intakes of carbohydrates above the AMDR. The finding that lunches were high in carbohydrate and low in fat was surprising, given the concern about high fat intakes and childhood obesity (Jaime & Lock, 2009). It is difficult to know whether carbohydrates may be more important in childhood weight patterns than fat, since other studies have not looked at specific macronutrients and the AMDR. For example, Cullen et al. (2006) compared lunch composition to the national standards but did not report the number of students with intakes below the AMDR for macronutrients.

The design of this study has allowed me to assess concerns with specific nutrients which, in the long run, will provide a baseline for evaluating SNP over the next three years. Several nutrient concerns were found, including low intakes of calcium,

magnesium, potassium, zinc, vitamin A, vitamin E, and vitamin D, and fiber. These are discussed below.

Low intakes of some nutrients are of particular concern for children. Calcium is required to support bone growth during puberty (IOM, 2006b). In this study, median calcium intakes were below the one-third AI recommendation for the entire sample, although boys were more likely to consume lunches with intakes above the AI for calcium than girls. This finding likely reflects the fact that boys are consuming more milk at lunch than girls, which is consistent with the findings of other Canadian studies of nutrient intakes among school-aged children (Statistics Canada, 2004b; Veugelers et al. 2005; Hanning et al. 2007). The low intakes among girls are of particular concern, since they will be at higher risk for developing osteoporosis later in life if adequate peak bone mass is not reached (Whiting et al., 2004). Whiting et al. (2004) state that a diet inadequate in MA may also be inadequate in calcium, vitamin A, folate, riboflavin, vitamin B_6, magnesium, and potassium. There were no differences in calcium intake and age observed in the present study, suggesting that participant's age difference was not sufficient to reveal the decline in milk consumption with increasing age reported previously (Evers et al., 2001; French et al., 2003; Rampersaud et al., 2003; Mullally et.al, 2007). The decline in milk consumption is usually associated with the transition of elementary school children into junior high school (Evers et al., 2001).

Another nutrient where intakes fell well below the recommended levels (based on IOM, 2006b) was fibre. Many studies have concluded that children are not consuming enough fibre to maintain good health and prevent disease (Lytle et al., 2001; Veugelers et al., 2005; Hanning et al, 2007), so PEI children are following national trends. The

average total daily fibre intake for Canadian children aged 9-13 of 15.4g/day for boys and 13.3 g/day for girls (Statistics Canada, 2004b) is only about half of the recommended 31g/day, and 26g/day, respectively (IOM, 2006b). Fiber intakes for children in the present study were compared to one-third of the AI, so as to represent their lunch recommendation for fiber, thus the recommendation for fiber was 8.7g for girls and 10.3g for boys. The median fiber intake was well below the AI in both cases (4.3g for girls and 4.0g for boys). Similar results were reported in a study of grades 6-8 in Ontario (15 schools, n=722, Hanning et al., 2007), where 94% of children reported intakes of fiber that were below the AI. Veugelers et al. (2005), found that grade five students in Nova Scotia (n=5,200; 282 schools) also had low median intakes of fiber, at 14.6g. Consuming adequate intakes of fiber is not only important in preventing an array of chronic health issues but can be essential in helping children maintain a healthy weight, since fiber also promotes a feeling of satiety which can be essential in helping children maintain a healthy weight (Kimm, 1995).

The low intakes of vitamin E from school lunches could be a concern as vitamin E functions as an antioxidant (IOM, 2006b). Major sources of vitamin E are nuts, seeds and oils (IOM, 2006b), so apparent inadequacies may, in part, reflect the fact that many schools have "no peanut/nut policies" in place due to the potential for allergies among students. Although the prevalence of vitamin E inadequacy is common among school-aged children, the cases of deficiency are quite rare (IOM, 2006b), so they may be getting sufficient vitamin E from other sources (i.e. eggs, milk, spinach etc).

One finding that supported my hypothesis concerning the nutritional quality of children's lunches is that, despite the implementation of SNP, median intakes of sodium

in the lunches were well above the recommended level (one third of the AI level or 500 mg). The levels were so high that they exceeded one-third of the Tolerable Upper Intake Level (UL; 733.3 mg) which is the highest daily intake level identified as being associated with no increased health risk (IOM 2006b). The 2004 Canadian Community Health Survey (CCHS) had similar findings for elementary school children (Statistics Canada, 2004a) as did the study by Veugelers et al. (2005) for Nova Scotia grade five children, and a U.S study (Cullen et al., 2007) that used similar methodology to the current study in PEI. The high sodium intakes are of concern, since increased intakes of sodium have been linked to chronic diseases such as heart disease, some cancers and high blood pressure (IOM, 2006b; LaFontaine, 2008).

The higher proportion of boys with adequate intakes of protein, thiamin, riboflavin, niacin, vitamin B_{12}, and folate than girls supports findings from other studies, and has been explained by higher overall food intakes in boys as compared to girls (Lino et al., 2002; Wilkinson et al., 2002). Although girls generally have a more positive view of healthy eating, they also report consuming fewer calories which may lead to inadequacies (Levine & Guthrie, 1997; Backman et al., 2002). Since boys generally consume more food than girls, it is important to also assess the nutrient density (nutrients to energy ratio) of lunch consumption (Drewnowski, 2005). This will be investigated in the following chapter to allow for valid comparison of dietary quality among the sexes. However, the many differences in nutrient intakes between the two sexes was similar to research by Hanning et al. (2007) and CCHS (Statistics Canada, 2004b). The lack of any real differences in intakes between the two grades was expected, because of the narrow age range.

Some surprising results were seen when patterns were compared for students reporting same day versus previous day lunch-time intakes. Due to school time constraints and busy schedules it was not always possible to collect data in the afternoon. Afternoon data collection was optimal as the children had just finished consuming their lunch as opposed to collecting data in the morning where we asked children to report what they had to consume at lunchtime for the previous day. As a result, 2/3 of all students reported their lunch-time food intake the day prior to data collection while 1/3 reported their lunch the same day as data collection. The higher median intakes of all nutrients for students filling out the "yesterday" survey versus "today" survey may have been due to over-reporting. For example, students who filled out the yesterday survey may have reported components of what they had to eat for the full day (i.e. breakfast, lunch, and supper) instead of reporting lunch consumption only. Evidence for this hypothesis lies in examination of LFRs, as many that had to be omitted were dropped due to probable over reporting, and many of these were from students that filled out the "yesterday" survey. Furthermore, the omitted LFRs often included breakfast items, which provides further evidence that children were confused as to what meal they should report. To address this potential bias future research should incorporate multivariate analysis techniques which consider the effect of day of recording. These findings were unexpected, since most studies suggest that children under-report their actual consumption of food and beverages consumed, rather than over-report in this study (Rockett et al., 1997; Livingstone et al., 2004). Children's ability to remember and record what they have consumed has been identified as a key issue when assessing dietary intakes as we know that children tend to under report intakes(Rockett et al., 1997), but,

given the probable over-reporting of intakes in this study, the patterns for low intakes of many nutrients may be even more problematic than originally thought.

Overweight and obesity rates were found to be high in the present study: nearly 1/3 (33.4%) of grade five and six children in this study were overweight; 11.5 % of these were obese. These rates are similar to those documented in Nova Scotia children by Veugelers and Fitzgerald (2005) (33% overweight/obese and 10% obese only) but are 10% higher than the 30% previously reported for PEI children aged 2-17 (Statistics Canada, 2004a). The finding that there were higher proportions of overweight boys than girls in PEI elementary and consolidated schools was also found in other Canadian studies (Statistics Canada, 2004a; Hanning et al., 2007) but was not found by Veugelers & Fitzgerald (2005) in Nova Scotia (though Nova Scotia boys and girls varied with respect to obesity). Ongoing monitoring of weight status according to sex is therefore recommended.

The large sample used in the present research increases the ability to generalize from the findings. The response rate of almost 60% is considered acceptable for school based surveys of this type and was higher than a similar survey in Nova Scotia (Veugelers et al., 2005). However, parental consent was required for measurements with the children which may have negatively influenced the response if some parents excluded specific categories of children.

4.4.1 Conclusions

This is the first study in Canada to describe the nutritional quality of foods and beverages consumed at school time by elementary school children. The nutritional quality of PEI children's lunch time intake consumed at school is poor, with low intakes of calcium, magnesium, potassium, zinc, vitamin A, vitamin E, and vitamin D, and fiber. This is a concern, since approximately one-third of a child's total daily energy requirements are obtained from lunch eaten while at school (Koplan et al., 2005). This appears to suggest that SNP on PEI are having little effect on student eating habits. However, the dietary quality of foods from school versus home was not addressed in this chapter, and the patterns could reflect foods provided from home, rather than school.

Unhealthy dietary habits play an important role in the increasing prevalence of overweight and obesity among school-aged children (Veugelers & Fitzgerald, 2005; Jaime & Lock, 2009). However, despite implementation of a SNP in PEI nearly three years ago, rates of overweight and obesity in PEI grade 5 and 6 children continue to increase. The rates are 10% higher in this sample than reported for PEI in the Canadian Community Health Survey (Statistics Canada, 2004a). Further research should be conducted to assess whether this is a temporal trend.

Studies such as this one are an important part of assessing whether SNP are improving children's food intakes at school and for providing data to direct future preventative efforts. For example, if schools and school districts are made aware that school-aged children's lunches are of poor dietary quality, this information may provide support for continued implementation and monitoring of nutrition policies across the province. We must continue to monitor and evaluate the dietary habits of Canadian

children because we know that schools can have a powerful influence on students' eating habits through programs offered and through the implementation of healthy eating policies (CDC, 1997). A major gap in our understanding of how nutrition policies affect dietary health of school children has been the actual nutrient composition of lunch time food choices. This study has filled that gap, at least for PEI. However, even studies looking at overall intakes (e.g. Veugelers et al., 2005) have arrived at similar conclusions, stating that the overall dietary quality of school-aged children in Nova Scotia is relatively poor. More emphasis needs to be placed on both parents and children (home and school) to improve the dietary habits and reduce the prevalence of overweight and obesity. It is clear from this study as well that it is important to assess the source of foods at lunch in order to determine if the nutrition composition of the reported lunches reflects the foods purchased by children at school; this will be discussed in Chapter 5.

Table 4.1 Summary of number of students making up the study sample evaluating school lunch-time intakes in PEI schools, 2007 (n=1966)

		n	(%)
Grade	Grade 5	976	(49.6)
	Grade 6	990	(50.4)
Sex	Male	979	(49.8)
	Female	987	(50.2)

Table 4.2 Lunch-time nutrient intakes (median and inter-quartile ranges) by grade level for grade 5 and 6 children in PEI schools, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

		Total			Grade 5			Grade 6			
Nutrients	1/3 EAR/AI or AMDR	25th	Median	75th	25th	Median	75th	25th	Median	75th	p
Mass (g)		373.0	492.0	632.0	370.0	491.5	628.0	376.0	492.0	636.0	0.0613
Calories	-	387.0	520.0	695.0	389.0	520.0	698.0	387.0	519.0	690.0	0.6727
Kilojoules	-	1617.0	2174.0	2902.0	1618.0	2175.0	2920.0	1616.0	2172.0	2883.0	0.5945
Protein (g)	9.3♀, 9.0♂ (EAR)	11.0	18.3	25.0	10.9	18.1	24.6	11.1	18.6	25.2	0.6435
Fat (g)	-	10.3	16.5	23.6	10.8	16.3	23.9	9.9	16.7	24.3	0.7608
Carbohydrates (g)	-	53.3	72.8	96.6	54.6	72.5	100.0	51.6	73.0	99.1	0.3796
Sugar (g)	-	20.6	33.0	51.2	22.2	33.5	51.9	20.1	32.5	50.6	0.5119
% kcal Protein	10-30%	10.0	13.3	16.9	9.9	13.3	16.8	10.0	13.5	16.9	0.3861
% kcal Fat	25-23%	22.3	29.6	35.8	22.6	29.6	35.4	22.2	29.6	36.0	0.9818
% kcal Carbs	45-65%	48.8	56.6	65.7	49.4	56.8	65.2	48.1	56.4	66.4	0.4186
% kcal Sugar[2]	<25%	17.4	27.2	36.4	17.6	27.4	36.3	17.3	26.9	36.7	0.9771
Fiber (g)	8.7♀, 10.3♂ (AI)	2.3	3.6	5.4	2.4	3.7	5.4	2.3	3.6	5.5	0.6457
Iron (mg)	1.9♀, 2.0♂ (AI)	2.3	3.3	4.5	2.3	3.4	4.6	2.3	3.2	4.4	0.0401
Calcium (mg)	400(AI)	143.0	306.0	443.0	143.0	297.0	437.0	144.0	315.0	444.0	0.4056
Magnesium (mg)	66.7(EAR)	39.0	59.0	85.0	38.0	59.0	84.0	41.0	59.0	86.0	0.5556
Potassium (mg)	1500(AI)	446.0	652.0	899.0	446.0	657.5	901.0	448.0	648.0	891.0	0.9052
Zinc (mg)	2.3(EAR)	1.3	1.9	2.8	1.2	1.9	2.8	1.3	1.9	2.8	0.3702
Vitamin A (RAE)[1]	140♀, 148.3♂ (EAR)	16.0	119.0	170.0	16.0	102.5	167.0	16.0	140.0	174.0	0.4856
Vitamin D(μg)	1.7(AI)	0.0	1.0	2.8	0.0	0.5	2.8	0.0	0.7	2.8	0.7130
Vitamin C (mg)	13(EAR)	3.4	11.2	102.3	3.5	12.1	103.1	3.3	10.6	77.7	0.2837
Vitamin E (mg)	3(EAR)	0.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.3712
Thiamin (mg)	0.2(EAR)	0.2	0.4	0.5	0.2	0.4	0.5	0.2	0.4	0.5	0.3663

Table 4.2 Continued

Table 4.2 (Cont.) Lunch-time nutrient intakes (median and inter-quartile ranges) by grade level for grade 5 and 6 children in PEI schools, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

Nutrients	1/3 EAR/AI or AMDR	Total			Grade 5			Grade 6			p
		25th	Median	75th	25th	Median	75th	25th	Median	75th	
Riboflavin (mg)	0.3(EAR)	0.3	0.5	0.8	0.3	0.5	0.8	0.3	0.5	0.8	0.7204
Niacin (mg)	3(EAR)	4.3	6.4	8.9	4.3	6.4	8.9	4.3	6.3	9.0	0.8193
Vit B_6 (mg)	0.3(EAR)	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4	0.3252
Vit B_{12} (µg)	0.5(EAR)	0.2	1.0	1.4	0.2	0.9	1.4	0.2	1.0	1.5	0.1055
Folate (µg)	83.3(EAR)	47.0	89.0	138.0	47.0	91.0	140.0	47.0	87.0	137.0	0.3165
Sodium (mg)	500(AI)	586.0	931.0	1371.0	588.0	930.0	1363.0	583.0	935.0	1388.0	0.7659

♀ Female
♂ Male
[1]RAE (Retinol Activity Equivalents)
[2]Currently there is no DRI set for sugar, rather a maximal intake level of 25 percent or less of total Calories from added sugars is suggested for adults and children.
[3]Shaded area represents percentage of total calories from Macronutrients and Sugar.

Table 4.3 Lunch-time nutrient intakes (median and inter-quartile ranges) by sex for grade 5 and 6 children in PEI schools, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

		Total			Male			Female			
Nutrients	1/3 EAR/AI or AMDR	25th	Median	75th	25th	Median	75th	25th	Median	75th	p
Mass (g)	-	373.0	492.0	632.0	371.0	490.0	643.0	378.0	492.0	628.0	0.9956
Calories	-	387.0	520.0	695.0	397.0	532.5	711.0	375.0	510.0	678.0	0.0026
Kilojoules	-	1617.0	2174.0	2902.0	1661.0	2226.0	2972.0	1557.0	2133.0	2829.0	0.0236
Protein (g)	9.3♀, 9.0♂ (EAR)	11.0	18.3	25.0	11.5	18.9	25.9	10.6	17.7	24.3	0.0047
Fat (g)	-	10.3	16.5	23.6	11.3	17.4	24.8	9.8	16.0	23.2	0.0038
Carbohydrates (g)	-	53.3	72.8	96.6	54.3	75.4	102.7	52.2	71.6	96.0	0.0185
Sugar (g)	-	20.6	33.0	51.2	22.7	33.5	53.6	19.1	32.4	48.8	0.0217
% Calories Protein	10-30%	10.0	13.3	16.9	10.1	13.5	17.1	9.9	13.2	16.7	0.1313
% Calories Fat	25-23%	22.3	29.6	35.8	22.7	30.0	35.7	22.1	29.3	35.8	0.3457
% Calories Carbs	45-65%	48.8	56.6	65.7	48.4	56.4	64.8	49.1	56.8	66.7	0.0723
% Calories Sugar[2]	<25%	17.4	27.2	36.4	17.6	27.0	36.6	17.3	27.2	36.3	0.9080
Fiber (g)	8.7♀, 10.3♂ (AI)	2.3	3.6	5.4	2.3	3.5	5.3	2.5	3.8	5.5	0.0144
Iron (mg)	1.9♀, 2.0♂ (AI)	2.3	3.3	4.5	2.4	3.4	4.6	2.1	3.2	4.4	0.0029
Calcium (mg)	400(AI)	143.0	306.0	443.0	157.0	315.0	452.0	135.0	293.0	428.0	0.0019
Magnesium (mg)	66.7(EAR)	39.0	59.0	85.0	41.0	59.0	84.0	38.0	59.0	86.0	0.7536
Potassium (mg)	1500(AI)	446.0	652.0	899.0	446.0	654.0	898.0	448.0	650.0	903.0	0.6809
Zinc (mg)	2.3(EAR)	1.3	1.9	2.8	1.32	1.95	2.85	1.2	1.9	2.7	0.0319
Vitamin A RAE)[3]	140♀, 148.3♂ (EAR)	16.0	119.0	170.0	15.0	142.0	170.0	17.0	109.0	170.0	0.4337
Vitamin D(µg)	1.7(AI)	0.0	1.0	2.8	0.1	0.8	2.8	0.0	0.4	2.8	0.0314
Vitamin C (mg)	13(EAR)	3.4	11.2	102.3	3.2	10.5	102.4	3.6	11.8	93.7	0.4328
Vitamin E (mg)	3(EAR)	0.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.7923
Thiamin (mg)	0.2(EAR)	0.2	0.4	0.5	0.2	0.4	0.5	0.2	0.4	0.5	0.0008

Table 4.3 Continued

Table 4.3 (Cont.) Lunch-time nutrient intakes (median and inter-quartile ranges) by sex for grade 5 and 6 children in PEI schools, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

		Total			Male			Female			
Nutrients	1/3 EAR/AI or AMDR	25th	Median	75th	25th	Median	75th	25th	Median	75th	p value
Riboflavin (mg)	0.3(EAR)	0.3	0.5	0.8	0.3	0.7	0.8	0.3	0.5	0.7	0.0003
Niacin (mg)	3(EAR)	4.3	6.4	8.9	4.4	6.5	9.4	4.0	6.2	8.6	0.0084
Vit B_6 (mg)	0.3(EAR)	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4	0.4315
Vit B_{12} (µg)	0.5(EAR)	0.2	1.0	1.4	0.3	1.0	1.5	0.2	0.9	1.4	0.0016
Folate (µg)	83.3(EAR)	47.0	89.0	138.0	50.0	91.	138.0	43.0	86.0	138.0	0.3852

♀ Female
♂ Male
[1]RAE (Retinol Activity Equivalents)
[2]Shaded area represents percentage of total calories from Macronutrients and Sugar.

Table 4.4 Proportion of total student lunch-time intakes within, above and below the AMDRs[1] for grades five and six students in PEI schools, 2007 (n=1943).

Nutrients	AMDR	Within AMDR		Above AMDR		Below AMDR	
		Total	(%)	Total	(%)	Total	(%)
Protein [2]	10-30%	1293	(66.6)	284	(14.6)	366	(18.8)
Fat [2]	25-35%	302	(15.5)	135	(7.0)	1506	(77.5)
Carbohydrates [2]	45-65%	456	(23.5)	1150	(59.2)	337	(17.3)
Sugar[3]	<25%	1093	(56.3)	850	(43.8)	-	

[1]AMDR = Acceptable Macronutrient Distribution Ranges
[2]Macronutrients compared to AMDRs
[3]Currently there is no DRI set for sugar, rather a maximal intake level of 25 percent or less of total calories from added sugars is suggested for adults and children ("above AMDR" is based on intakes of total sugars).
[4]Shaded area represents macronutrient intakes that meet current DRI recommendations.

Table 4.5 Proportion of PEI student lunch-time intakes within, above and below the AMDRs[1] by grade, 2007(n=1943).

Nutrients	Within AMDR[4] Above AMDR Below AMDR	Grade 5		Grade 6	
		n	(%)	n	(%)
Protein [2]	10-30%	638	(66.1)	655	(67.0)
	>30%	142	(14.7)	142	(14.5)
	<10%	186	(19.3)	180	(18.4)
Fat [2]	25-35%	148	(15.3)	154	(15.8)
	>35%	67	(6.9)	68	(7.0)
	<25%	751	(77.7)	755	(77.3)
Carbohydrates [2]	45-65%	231	(23.9)	225	(23.0)
	>65%	578	(59.8)	572	(58.6)
	<45%	157	(16.3)	180	(18.4)
Sugar[3]	<25%	544	(56.3)	549	(56.2)
	>25%	422	(43.7)	428	(43.8)

[1]AMDR = Acceptable Macronutrient Distribution Ranges
[2]Macronutrients compared to AMDRs
[3] Currently there is no DRI set for sugar, rather a maximal intake level of 25 percent or less of total calories from added sugars is suggested for adults and children ("above AMDR" is based on intakes of total sugars).
[4]Shaded area represents macronutrient intakes that meet current DRI recommendations.

Table 4.6 Proportion of PEI student lunch-time intakes within, above and below the AMDRs[1] by sex, 2007 (n=1943).

Nutrients	Within AMDR[4] Above AMDR Below AMDR	Male		Female	
		n	(%)	N	(%)
Protein [2]	10-30%	655	(67.8)	638	(65.3)
	>30%	149	(15.4)	135	(13.8)
	<10%	162	(16.8)	204	(20.9)
Fat [2]	25-35%	160	(16.6)	142	(14.5)
	>35%	77	(8.0)	58	(5.9)
	<25%	729	(75.5)	777	(79.5)
Carbohydrates [2]	45-65%	228	(23.6)	228	(23.3)
	>65%	585	(60.6)	565	(57.8)
	<45%	153	(15.8)	184	(18.8)
Sugar[3]	<25%	540	(55.9)	553	(56.6)
	>25%	426	(44.1)	424	(43.4)

[1]AMDR = Acceptable Macronutrient Distribution Ranges
[2]Macronutrients compared to AMDRs
[3] Currently there is no DRI set for sugar, rather a maximal intake level of 25 percent or less of calories from total sugars is suggested for adults and children ("above AMDR" is based on intakes of total sugars).
[4]Shaded area represents macronutrient intakes that meet current DRI recommendations.

Table 4.7 Proportion of PEI students consuming adequate[2] micronutrient intakes at lunch by grade, 2007 (n=1943)

Nutrients	Total		Grade 5		Grade 6	
	Total	(%)	Total	(%)	Total	(%)
Protein (g)	1620	(83.4)	805	(82.9)	819	(83.8)
Iron (mg)	1547	(79.6)	782	(81.0)	765	(78.3)
Magnesium (mg)	806	(41.5)	402	(41.6)	404	(41.4)
Zinc (mg)	756	(38.9)	363	(37.6)	393	(40.2)
Vitamin A (RAE)[1]	795	(40.9)	395	(40.9)	400	(40.9)
Vitamin E (mg)	88	(4.5)	38	(3.9)	50	(5.1)
Vitamin C (mg)	915	(47.1)	465	(48.1)	450	(46.1)
Thiamin (mg)	1552	(79.9)	780	(80.8)	772	(79.0)
Riboflavin (mg)	1452	(74.7)	721	(74.6)	731	(74.8)
Niacin (mg)	1626	(83.7)	809	(83.8)	817	(83.6)
Vitamin B_6 (mg)	690	(35.5)	330	(34.2)	360	(36.9)
Vitamin B_{12} (µg)	1291	(66.4)	629	(65.1)	662	(67.8)
Folate (µg)	1026	(52.8)	552	(54.0)	504	(51.6)

[1]RAE = Retinol Activity Equivalent

[2]Adequacy is defined as one-third of the Dietary Reference Intake for each nutrient, EAR (Estimated Average Requirement), see Appendix D.

Table 4.8 Proportion of PEI students consuming adequate[2] micronutrient intakes at lunch by sex, 2007(n=1943)

Nutrients		Total		Male		Female	
	Significance	N	(%)	n	(%)	N	(%)
Protein	**	1620	(83.4)	830	(85.9)	790	(80.9)
Iron (mg)		1547	(79.6)	782	(81.0)	765	(78.3)
Magnesium (mg)		806	(41.5)	395	(40.9)	411	(42.1)
Zinc (mg)		756	(38.9)	388	(40.2)	368	(37.7)
Vitamin A (RAE)[1]	**	795	(40.9)	332	(34.4)	463	(47.4)
Vitamin E (mg)		88	(4.5)	47	(4.9)	41	(4.2)
Vitamin C (mg)		915	(47.1)	448	(46.4)	467	(47.8)
Thiamin (mg)	**	1552	(79.9)	805	(83.3)	747	(76.5)
Riboflavin (mg)	*	1452	(74.7)	745	(77.1)	707	(72.4)
Niacin (mg)	*	1626	(83.7)	828	(85.7)	798	(81.7)
Vitamin B_6 (mg)		690	(35.5)	334	(34.6)	356	(36.4)
Vitamin B_{12}(μg)	**	1291	(66.4)	669	(69.3)	622	(63.7)
Folate (μg)		1026	(52.8)	524	(54.2)	502	(51.4)

*p<0.05

**p<0.01

[1]RAE – retinol activity equivalents

[2]Adequacy is defined as one-third of the Dietary Reference Intake for each nutrient, EAR (Estimated Average Requirement).

Table 4.9 Lunch-time nutrient intakes (median and inter-quartile ranges) by day[1] of recording for grade 5 and 6 children in PEI schools, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

		Total			Yesterday			Today			
Nutrients	1/3 EAR/AI or AMDR	25th	Median	75th	25th	Median	75th	25th	Median	75th	p value
Mass (g)	-	373.0	492.0	632.0	384.0	497.0	643.0	358.0	471.0	588.0	<0.0001
Calories	-	387.0	520.0	695.0	391.0	525.0	709.0	380.0	496.0	649.0	0.0036
Kilojoules	-	1617.0	2174.0	2902.0	1625.0	2195.0	2965.0	1582.0	2076.0	2714.0	0.0028
Protein (g)	9.3♀, 9.0♂ (EAR)	11.0	18.3	25.0	11.2	18.8	25.7	10.7	16.9	23.4	0.0070
Fat (g)	-	10.3	16.5	23.6	10.2	16.8	24.3	10.2	16.0	22.9	0.1967
Carbohydrates (g)	-	53.3	72.8	96.6	54.3	75.3	100.8	49.2	67.9	92.4	0.0006
Sugar (g)	-	20.6	33.0	51.2	22.9	33.5	52.2	17.8	31.8	46.1	0.0057
% kcal Protein	10-30%	10.0	13.3	16.9	10.1	13.4	16.9	9.9	13.4	17.0	0.5608
% kcal Fat	25-23%	22.3	29.6	35.8	22.5	29.2	35.4	22.3	30.8	37.3	0.0244
% kcal Carbs	45-65%	48.8	56.6	65.7	49.3	56.7	65.9	47.8	56.2	64.9	0.0861
% kcal Sugar[2]	<25%	17.4	27.2	36.4	18.0	27.1	36.6	15.7	26.9	35.7	0.2859
Fiber (g)	8.7♀, 10.3♂ (AI)	2.3	3.6	5.4	2.5	3.8	5.6	2.1	3.4	5.0	<0.0001
Iron (mg)	1.9♀, 2.0♂ (AI)	2.3	3.3	4.5	2.3	3.3	4.6	2.3	3.2	4.3	0.0100
Calcium (mg)	400(AI)	143.0	306.0	443.0	145.0	310.0	444.0	138.0	273.0	427.0	0.0191
Magnesium (mg)	66.7(EAR)	39.0	59.0	85.0	41.0	61.0	89.0	36.0	54.0	78.0	<0.0001
Potassium (mg)	1500(AI)	446.0	652.0	899.0	470.0	670.0	925.0	395.0	609.0	837.0	<0.0001
Zinc (mg)	2.3(EAR)	1.3	1.9	2.8	1.3	2.0	2.8	1.2	1.8	2.6	0.0014
Vitamin A RAE)[3]	140♀, 148.3♂ (EAR)	16.0	119.0	170.0	18.0	142.0	173.0	13.0	88.0	163.0	0.0110
Vitamin D(μg)	1.7(AI)	0.0	1.0	2.8	0.0	0.7	2.8	0.0	0.4	2.8	0.1021
Vitamin C (mg)	13(EAR)	3.4	11.2	102.3	3.6	11.6	102.4	2.8	10.0	55.4	0.0200
Vitamin E (mg)	3(EAR)	0.0	1.0	1.0	0.0	1.0	1.0	0.0	1.0	1.0	0.0001
Thiamin (mg)	0.2(EAR)	0.2	0.4	0.5	0.2	0.4	0.5	0.2	0.3	0.5	0.0246

Table 4.9 Continued

Table 4.9 (Cont.) Lunch-time nutrient intakes (median and inter-quartile ranges) by day[1] of recording for grade 5 and 6 children in PEI schools, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

		Total					Yesterday			Today			Yesterday
Nutrients	1/3 EAR/AI or AMDR	25th	Median	25th	Median	75th	25th	Median	75th	25th	Median	75th	p value
Riboflavin (mg)	0.3(EAR)	0.3	0.5	0.8	0.5	0.8	0.3	0.5	0.8	0.3	0.5	588.0	<0.0001
Niacin (mg)	3(EAR)	4.3	6.4	8.9	6.5	9.5	4.3	6.5	9.5	4.3	6.5	649.0	0.0036
Vit B_6 (mg)	0.3(EAR)	0.2	0.2	0.4	0.2	0.4	0.2	0.2	0.4	0.2	0.2	2714.0	0.0028
Vit B_{12} (µg)	0.5(EAR)	0.2	1.0	1.4	1.0	1.4	0.2	1.0	1.4	0.2	1.0	23.4	0.0070
Folate (µg)	83.3(EAR)	47.0	89.0	138.0	90.0	141.0	49.0	90.0	141.0	49.0	90.0	22.9	0.1967
Sodium (mg)	500(AI)	586.0	931.0	1371.0	931.0	1389.0	582.0	931.0	1389.0	582.0	931.0	92.4	0.0006

♀ Female
♂ Male
[1]Day of recording refers to the time frame for recording the lunch food record: today = students were interviewed in the afternoon, and therefore reported lunch intake on the same day as data collection; yesterday=students were interviewed in the morning and therefore reported lunch consumed on the day prior to data collection.
[2]RAE (Retinol Activity Equivalents)
[3]Currently there is no DRI set for sugar, rather a maximal intake level of 25 percent or less of total Calories from added sugars is suggested for adults and children.
[4]Shaded area represents percentage of total calories from Macronutrients and Sugar.

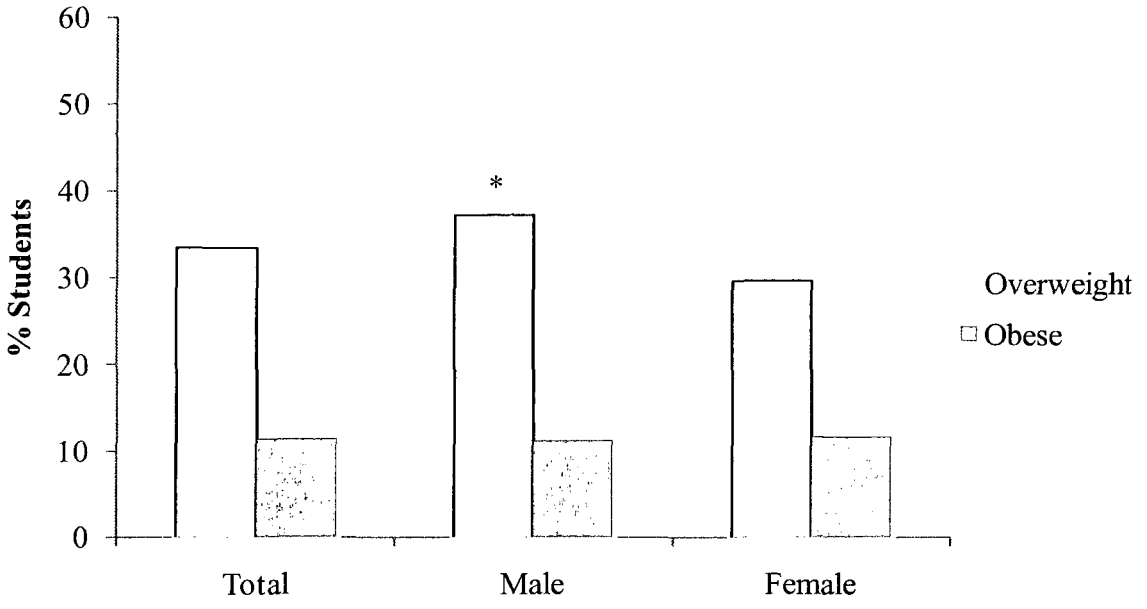


Figure 4.1 Proportion of overweight and obese[1] PEI children by sex, 2007 (n=1593)

* $p<0.05$

[1]Children were categorized as overweight and obese based on international body mass index cut-off points established for children and youth (Cole et al., 2000).

CHAPTER FIVE

5.0 Nutrient Composition of Children's Lunches:

Association between the source of food consumed (home vs. school) and nutrition policy adherence

5.1. Introduction

Experts agree that children having access to healthy foods while at school can enable healthy eating habits (Centers for Disease Control & Prevention, 1997; Wojcicki & Heyman, 2006; World Health Organization, 2008). Students spend an estimated six hours a day at school, consuming at least one meal and one to two snacks (Story, 1999; Dietitians of Canada, 2008). Unfortunately, children face a variety of challenges while trying to "eat healthy" during time spent at school due to the ready availability of high fat, high sugar treats (i.e. french fries, chips, chocolate bars, candies or soft drinks. Over-consumption of these foods is a major barrier to healthy eating which, in turn, impacts the health of North American school-aged children today (Centers for Disease Control & Prevention, 1997; Taylor et al., 2003; Kubik et al., 2003; Government of Manitoba, 2006; Vecchiarelli et al., 2006).

One common strategy to combat the influence of unhealthy eating choices is to reduce or remove access to unhealthy foods at the school level (Vecchiarelli et al., 2006) through SNP. Development of SNP is increasingly viewed as an important strategy to improve eating habits and reduce childhood obesity (Centers for Disease Control & Prevention, 1997; Raine, 2004; World Health Organization, 2008). Consequently, a multi-sectored group known as the PEI Healthy Eating Alliance formed in 2001, to work with PEI elementary (grade 1-6) and consolidated (grade 1-8) schools to develop district level SNP. In the fall of 2005, all schools in the Eastern School District and Western School Board of PEI adopted virtually identical nutrition policies. The PEI SNP addresses such issues as the quality of food available in the school environment, student

access to food, food used in school fundraising initiatives, food safety, and nutrition education.

A major gap in our understanding of how nutrition policies affect dietary health of school children is information on the actual nutrient composition of lunch time food choices, and how this is influenced by the source of the child's lunch (combination of home and school). Most evaluations of SNP have assessed impact on overall children's dietary intake (at home and at school). Few studies have examined the specific effects of improving the school nutrition environment on the nutrient composition of children's lunch time food intake. In one study of American middle school students (Cullen et al., 2006), introduction of SNP impacted children's food consumption patterns but compensation could occur if changes were not made uniformly in all school food environments (i.e. vending machines, a la carte, school lunch program etc). However, foods introduced from home can also affect children's consumption since packed lunches may be of lower quality than school lunches (Evans et al., 2008; Kim et al., 2006). In the UK, Evans et al. (2008) found that packed lunches contained many high sodium, low fiber snacks. In Korea (Kim et al., 2006), lunches from school had higher nutrient density (defined as 1000 x nutrient content (g or mg) ÷ energy content (Calories); Drewnowski, 2005) than lunches from home, so introduction of a lunch program has improved student diets there. Kim et al. (2006) is the first nutrition study to actually compare nutrient density in children's lunches based on whether they were from home or school sources.

Assessing the nutritional content of children's lunch foods based on the source of food can help us understand the role of parents and schools in improving nutritional quality of children's food intake. For example, if children's intakes of school-supplied

lunches are of better quality than of lunch intakes supplied from home, more supports may be needed for parents to encourage them to purchase and pack healthy lunch choices. Therefore, to assess the success of a SNP, it is important to compare the quality of food provided at school, which depends on the level of adherence to the policies, to the quality of food provided from home, which is determined by such factors as the nature of foods available, parental attitudes about food and diet, knowledge about nutrition and student food preferences (Birch, 1999; Wharton et al., 2008). To date, however, Canadian data are lacking. In fact, there is little known about the extent to which children participate in school lunch programs in elementary schools.

The following chapter builds on Chapter 4 which summarized the total lunch time nutrient intakes, the proportion of students consuming recommended amounts of nutrients according to the Dietary Reference Intakes (DRIs) and the rates of overweight and obesity in Grade 5 and 6 children. The objectives of this chapter are: 1) to describe the proportion of foods/beverages purchases at school versus brought from home; 2) to compare the nutrient content of foods/beverages purchased for lunch at school versus brought from home; 3) to investigate the relationship between adherence (%"prohibited" foods served at lunch) and the proportion of overweight and obese children; 4) to describe the nutrient density of foods/beverages consumed at lunch; and 5) to investigate the relationship between adherence (%"prohibited" foods offered at lunch) and nutrient density of children's lunch time food intake.

Study hypotheses were that 1) foods purchased at school will have higher nutrient density than those brought from home; 2) students attending schools with lower levels of adherence to the nutrition policies will report lunches with higher fat, sugar and sodium

compared to students attending schools with higher levels of adherence and 3) there will be a lower rate of overweight and obesity among students attending schools with higher levels of adherence to the SNP compared to those schools which are not following the nutrition policy as closely.

5.2 Methods

5.2.1 Design

An in-class cross sectional survey of grade five and six students in PEI was used to assess children's lunch-time food consumption, and the source of foods/beverages consumed as part of a 5-year evaluation of PEI SNP. Students' actual heights and weights were also assessed as part of the survey to determine the level of overweight and obesity in this age group. Data were collected in the winter of 2007. The study protocol was approved by the University of Prince Edward Island Ethics Board (REB).

5.2.2 Sample

In Prince Edward Island, there are a total of 52 elementary (grade 1-6) and consolidated (grade 1-8) schools. Schools that had no students in grades five and six were eliminated from the sample as were the French schools, leaving a total of 44 schools. All 3,320 grade five and six students were invited to participate in the research, and 61% of these students agreed to participate. Students below grade five were not invited to participate since children below grade five are less likely to provide valid dietary data (Evers et al., 2001; Taylor et al., 2005). Only those students whose parents had returned signed consent forms and had completed the parent surveys were included in the study.

5.2.3 Assessment of Lunch Food Intake

Students were asked to recall foods and beverages consumed during school lunch for one day. When data collection was the afternoon, the present day's lunch was

reported; when data collection occurred in the morning, children were asked to recall foods consumed at the previous day's lunch. Data collection was not conducted on Monday mornings to avoid children reporting on a non-school day (Sunday) or on Fridays at the request of the schools. The Lunch Food Record surveys (LFR; Appendix C) were administered in a classroom setting. Trained individuals provided students with instructions and a sample of a completed LFR as well as assistance with recalling and spelling food and beverage items. Students were asked to list each food and beverage item on a separate line. Students indicated how many servings they ate, the source of the food (school lunch, milk program, vending machine, home, "other 'source) and details about foods and beverages consumed (i.e. brands, flavours, condiments). Trained data collectors reviewed each student's LFR to identify missing or unclear information. Students were asked for further information when necessary. This method of data collection via food records has been shown to be valid when compared to direct observation of children's food intake by Domel et al. (1994), who showed that 117 record/observation matches were significantly correlated for eight of the nine meals items assessed (Pearson Correlation, r= 0.16 to 0.85). Results were most accurate when children recorded their intake on a daily rather than a weekly basis. Refer to chapter 4 (pages 56-57) for discussion on Dietary Reference Intakes (DRI) used to assess dietary adequacy in children and to Appendix D for DRI standards for comparison of children's lunch intakes.

5.2.4 Assessment of Height and Weight:

Children's heights and weights were measured in order to determine the prevalence of overweight and obesity, addressed in Chapter 4, and to relate rates to the level of adherence to the SNP (this chapter). Measured rather than self-reported heights and weights were assessed since school-aged children are likely to underestimate their weight. All measurements were conducted in a private room at each school. Children were assured during the in-class introduction of the study that all the height and weight measurements would be collected in a private room and that their results would remain confidential. Standard procedures were used to collect the height and weight measurements of all grade five and six students that had permission to participate. Standing height was measured using a standard wooden stadiometer to the nearest 0.01 centimetre after students removed their shoes. Height measures were repeated at least twice and a third time if a discrepancy (>0.3 cm) between the first two measures existed. The average of the two closest measures was calculated as the final height. Students were weighed to the nearest 0.01 kg using calibrated remote display digital scales. Overweight and obesity were defined using international BMI cut off points adjusted to specific age and sex categories for children (Cole et al., 2000; Appendix A).

5.2.5 Data Coding/Analysis

Lunch Food Intake

All foods and beverages consumed were coded using the 2007b version of the Canadian Nutrient File (Health Canada, 2007b). Information was obtained from schools and fast food outlets, if applicable, regarding the serving sizes of foods and beverages

offered at school (i.e. size of sub sandwich offered at school; volume of carton of milk). When children were unable to provide sufficiently detailed descriptions of foods and beverages consumed, standard coding rules were applied using foods and/or serving sizes which are commonly consumed by Canadian children in this age group (Evers et al, 2001). For example, unspecified bread was coded as "enriched white" and unspecified milk was coded as "2% white". Assumptions were made regarding the composition of some food items. For example, students who reported consuming a ham sandwich and did not specify condiments would be also coded a standard portion of mayonnaise. Cross-referencing of coding was performed by the two research assistants to increase reliability of coding among research assistants. All foods and beverages were then entered into the CANDAT nutrient analysis program (Godin, 2008) and then cross checked with those originally recorded on the LFR. Calories, weight, micronutrients (iron, calcium, magnesium, potassium, zinc, vitamin A, vitamin C, vitamin D, vitamin E, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, and folate), fiber, sugar, calories, macronutrients (protein, fat, and carbohydrates) and the proportion of calories from protein, fat, carbohydrates and sugar were then generated using CANDAT software. Nutrient data were examined for extreme values, duplicate entries and missing values using SAS (Version 9.1, SAS Institute Inc, Cary, North Carolina) and were cleaned accordingly.

Due to a low number of foods consumed from the "vending" and "other" categories the "source" variable was re-coded so that foods/beverages from vending machines were included with "school foods" and "other" foods (usually fast food taken to school by parents) were then included with "home foods".

Descriptive statistics (medians and percentiles) were generated for Calories and nutrients assessed. Since the distribution of intakes for all nutrients assessed differed substantially from a normal distribution and could not be normalized by log or square root transformation, non-parametric statistics were therefore used to assess patterns. Wilcoxon Rank Sum Tests were used to assess differences between the median values for nutrient densities of foods consumed at lunch from home vs. school for the two sexes and two grade levels. Wilcoxon Rank Sum Tests were also used to assess differences in nutrient intakes from foods brought from home versus purchased at school within each child. Less food was purchased from school than brought from home resulting in higher total nutrient intakes from foods brought from home than from foods purchased at school. Thus, the median nutrient densities (nutrients per 1000 calories; Drenowski, 2005) were calculated for foods consumed from school and from home to standardize the nutrients from the two sources. The association between the proportion of students with adequate nutrient intakes and SNP adherence levels (% prohibited foods offered at lunch) and the proportion of overweight and obese children according to SNP adherence levels was explored using Chi Square Analysis of Association. The SNP adherence levels represented three categories based on the percentage of "Prohibited" foods served as part of the school's lunch program: 0-20% "Prohibited" foods served, >20-40% "Prohibited" foods served, and >40-100% "Prohibited" foods served. The adherence categories were chosen based on the natural distribution of the data. Spearman's Correlation was used to investigate the relationship between adherence (% prohibited foods offered at lunch) and the nutrient density of food consumed. The relationship between adherence (% prohibited foods offered at lunch) and the mass of the food consumed from home vs. school was

investigated through ANOVA (GLM procedure in SAS). A p-value of 0.05 was used to define statistical significance.

Height & Weight Data

Differences in rates of overweight and obesity among PEI grade 5 and 6 children according to level of adherence to the policy (% prohibited foods offered) were explored using Chi Square Analysis of Association. All height and weight data were examined for extreme values, duplicate entries and missing values and were cleaned accordingly. International body mass index (BMI) cut off points (Cole et al., 2000; Appendix A) were used to define overweight and obesity in this population.

5.3 Results

5.3.1 Sample Description

A total of 2,036 students participated in the survey, representing a response rate of 59.2% after accounting for absent or sick children on the day of the survey. Subsequently, a total of 70 questionnaires were eliminated (3.4%): 34 questionnaires were eliminated due to unreliable data due to unreliable dietary data (1.7%), and 36 were eliminated due to missing parental consent (1.8%), leaving a total of 1966 usable LFRs. The sample was distributed evenly according to grade and sex (Table 5.1). A total of 1966 student lunches were analyzed for nutrient composition.

5.3.2 Nutrient Intakes

5.3.2.1 Nutrient Intakes by "Source" of food consumed at lunch

Students obtained significantly more of most micronutrients from foods from home than from school. Their median intakes of all micronutrients were significantly higher in foods from home than school, except calcium, Vitamin A and Vitamin D which were all significantly higher from school (Table 5.2; Wilcoxon Rank Sum Test, all $p<0.01$ except calcium, $p<0.05$). Median intakes of both protein and fat (expressed as a percentage of total calories) were significantly higher for foods consumed from school than foods consumed from home, whereas the median proportion of carbohydrates was higher from home (Table 5.2; Wilcoxon Rank Sum Test, all $p<0.01$). Proportion of

energy from sugar was significantly higher for foods consumed at school then foods consumed at home (Table 5.2; Wilcoxon Rank Sum Test, $p<0.01$).

5.3.2.2 Nutrient Density of Foods Consumed by Source of Lunch-time Food

Foods purchased at school (referred to as "school foods") only made up about 1/3 of lunch-time intakes, resulting in relatively low proportions of nutrients coming from school foods. Due to this unequal distribution of foods purchased from school compared to home, total nutrient intakes from foods brought from home were higher than nutrients from foods purchased at school. The nutrient density from school foods, however, which was calculated to standardize values from the two sources, was significantly higher for protein, fat, sugar, iron, calcium, magnesium, potassium, zinc, vitamin A, vitamin D, riboflavin, niacin, vitamin B_6 and vitamin B_{12} than the nutrient densities of foods from home (Table 5.5; Wilcoxon Rank Sum Test, all $p<0.01$, except vitamin B_6 $p<0.05$). The nutrient densities for carbohydrates, fiber, iron, vitamin C, vitamin E, thiamin, folate and sodium were significantly higher in home foods compared to school foods (Wilcoxon Rank Sum Test, all $p<0.01$). There were no significant differences between the nutrient density of intakes for boys and girls for food items purchased from school (Wilcoxon Rank Sum Test, all $p>0.05$; Table 5.6). However, girls reported home-packed lunches with higher nutrient densities of fiber ($p<0.01$), and vitamin B_6 ($p<0.01$) than boys did (Table 5.7; Wilcoxon Rank Sum Test).

There were weak but significant correlations (Spearman's Correlation) between school non-adherence to the policy and some nutrients. Negative correlations (Table 5.8; $r = -0.024$ to -0.182) between non-adherence (the percentage of "Prohibited" foods served

at lunch) and nutrient density for carbohydrates ($p<0.01$), iron ($p<0.05$), vitamin C ($p<0.05$), vitamin E ($p<0.01$) and sodium ($p<0.01$) indicated that intakes of these nutrients increased as the level of adherence declined (i.e. higher proportion of "Prohibited" foods offered). Positive correlations (Table 5.8; $r=0.083$ to 0.161) were seen between the percentage of "Prohibited" served at lunch and nutrient density of protein, calcium, magnesium, zinc, riboflavin, vitamin D, and vitamin B_{12} indicating that the intakes of these nutrients increased with the level of adherence to the policies ($p<0.01$ for all).

The level of adherence to the SNP also affected the total amount of food that was consumed from school sources. The lower the number of "prohibited" foods (i.e. the higher the level of adherence), the more likely students were to purchase and consume foods from school (ANOVA, $F=6.92$; $p=0.001$). Thus, schools serving a lower proportion of "prohibited" foods (better adherence to the SNP) had children eating more food from school than from home (median weights of 196.7g and 148.5g, respectively).

5.3.2.3 Comparison of micronutrient adequacy and the Proportion of Children with Macronutrients in the Recommended Range to the Proportion of "Prohibited" Foods Served at Lunch

Adherence to the SNP (% prohibited foods) did not affect the proportion of children reporting lunches with adequate intakes of micronutrients (Table 5.4). There was a positive association between fat intakes above the recommended range (AMDR) and non-adherence to the SNP: the proportion of children with fat intakes above the AMDR increased significantly as the proportion of "prohibited" foods served at lunch increased

(Table 5.4; Chi Square Test of Association, $p<0.01$). There was no association between non-adherence and the proportion of children within, below and above the range for other macronutrients (protein and carbohydrate).

5.3.2.4 Proportion of overweight and obese children by "Prohibited" foods offered at lunch

The proportion of children in grades five and six which are considered overweight and obese children according to school level adherence to the SNP is shown in Figure 5.1. No significant association (Chi Square Test of Association, $p=0.3526$ and $p=0.1277$, respectively) was found between the proportion of overweight and obese children and varying adherence level. There was a slight trend towards a higher proportion of overweight and obese children in schools which were adhering less closely to the policy as compared to those that were adhering more closely to the policy (31.9% and 9.8% vs. 36.5% and 12.8%, respectively), but it was not statistically significant.

5.4 Discussion

This is the first study in Canada, and one of the first worldwide, to evaluate the dietary quality of lunch-time foods consumed by elementary students which considers the source of the food (home versus school) and the level of adherence to a SNP. Two thirds of student intakes came from home sources, so it was not surprising that lunch time intakes of most nutrients in foods brought from home were higher than in foods purchased at school. Some important exceptions were calcium, vitamin A and vitamin D, all of which were higher in foods/beverages purchased at school, probably because all of the schools on PEI participate in the school milk program (see Chapter 3 page 41), and milk is most likely to be purchased at school rather than brought from home. Milk prices have been traditionally subsidized through the PEI School Milk Program (Government of Prince Edward Island, 2007) because milk is the primary source of calcium and vitamin D in the diets of adolescents and children (IOM, 2006b). However, even with the participation of all PEI schools in the school milk program, children's lunch-time intakes of calcium and vitamin D still fall below the current dietary recommendations. This likely reflects the relatively low child participation rate of approximately 30% (Government of Prince Edward Island, 2007). While it would be informative to identify children who participated in the school milk program the day of data collection, it as not possible to assess this in a systematic manner in the present study. Other studies evaluating lunch food sources have also noted that calcium is higher in school foods (e.g. Kim et al., 2006; Cullen et al., 2007). Children's lunches brought from home could be improved significantly by including more food and beverage items that are high in calcium such as yogurt and milk-based soups.

Comparison of nutritional quality of lunch time foods to SNP adherence (i.e. percentage categories of "Prohibited" foods served as part of the school's lunch program: 0-20% "Prohibited", >20-40% "Prohibited", and >40-100% "Prohibited") has allowed conclusions to be drawn about the effectiveness of the SNP. As has been reported in other studies (e.g. Cullen et al., 2006; Story et al., 2006), the higher proportion of "Prohibited" foods (lower adherence to the SNP) was associated with fat intakes that were above the recommended range (AMDR). Therefore, my study hypothesis that students attending schools with lower levels of adherence to the SNP will report higher fat intakes at lunch has been supported. However, the hypothesis that students attending schools with lower levels of adherence to the SNP will report higher sugar and sodium intakes was not supported. This may be due to the fact that 2/3 of lunch time intakes for these students came from home sources, and sodium, at least, was higher in home foods than school foods. Since increased intakes of fat may lead to the development of chronic diseases such as obesity, heart disease, and type II diabetes, it is important to identify sources to target to reduce fat in the diet. Furthermore, diets high in sugar may predispose children to dental decay (Centers for Disease Control & Prevention, 1997; Raine, 2004; Veugelers & Fitzgerald, 2005). Results indicated that low levels of school adherence to the policy were associated with high nutrient densities for carbohydrates, iron, and sodium but low nutrient densities of protein, calcium, magnesium, zinc, riboflavin, Vitamin B_{12} . One possible explanation for some of these findings is that more children attending schools with poor adherence participate in the school milk program.

An important finding from this study was that schools with the highest levels of adherence to SNP also had the highest level of school foods being consumed by children

at lunch. It isn't clear why this should be true, although parents may be more likely to allow children to purchase school lunches if healthy choices are available. This finding was a bit surprising, since children may not always choose healthy food, if given the choice (Wharton et al., 2008). It is therefore essential that foods available at school are consistent with those recommended in the SNP, but they must also be appealing to school-aged children. The overall cost of providing such lunches has been noted as a barrier that schools face when trying to make school lunches more appealing (McKenna, 2003; Wharton et al., 2008). Cost and time considerations have led to offering pre-packaged/pre-prepared foods at school in the United States (Gavin, 2004). However, Gavin (2004) found that pre-packaged lunches are often of low nutrient density and can be costly to the student. In PEI, meat pizza (e.g. pepperoni) was the most frequently reported food served at schools that did not meet the SNP guidelines, and "regular chicken" (deep fried chicken nuggets, chicken burgers), was the second most frequently served food not meeting the SNP criteria (See Chapter 3). The most frequently reported food served at schools which met the SNP guidelines was baked potatoes, followed by meat and cheese pizza (when offered at intervals meeting the guidelines). There is a need to examine children's nutrient intakes connected with the specific foods served at lunch with future analysis; this should also include food group analysis.

Data did not support the hypothesis that there would be a significant relationship between the proportion of "prohibited" foods served at lunch (i.e. adherence to SNP) and the proportion of overweight and obese children. This was not surprising, given the finding that a large proportion of foods consumed for lunch came from home, which may have masked any the potential benefit from the SNP. Further, the study design focused

on lunch time intakes only, and did not consider long term energy intakes which would be more likely to be correlated with weight status (Raine, 2004). The apparent trend, although not statistically significant, for lower adherence to the SNP (a higher number of "prohibited" foods served at lunch) to be associated with a higher proportion of overweight and obese children suggests that this should be investigated further, perhaps considering additional factors such as student activity levels, which is an important predictor of childhood obesity (Veugelers & Fitzgerald, 2005; Hanning et al., 2007). While it would be useful to assess the relative nutritional impacts of home versus school sources through identification of schools or groups of children that purchase most or all of their lunch foods versus those that do not, this is not feasible given the nature of the PEI school lunch system.

5.4.1 Conclusions

This study examined the nutritional composition of children's school lunches and compared the quality of foods purchased at school with those brought from home. Since approximately two thirds of the foods in children's lunches were brought from home, it was important to compare the nutrient density of foods from school versus home rather than assessing the nutritional quality of total food intake. Lunch food items purchased at school were generally higher in nutrient density than food items brought for lunch from home. Exceptions to this included carbohydrates, fiber, iron, vitamin C, vitamin E, thiamin, and folate which were higher in foods brought from home. Of particular concern in this study was the difference between the home and school lunch items in regards to calcium and vitamin D. Lunch items purchased at school were significantly higher in

both calcium and vitamin D than lunch items from home, reflecting the fact that all PEI elementary schools offer a subsidized school milk program. However, the calcium and vitamin D composition of children's school lunches remains low suggesting that children are not benefiting sufficiently from the milk program.

Children from schools that do not closely follow SNP reported lunches with low nutrient densities of most nutrients, resulting in an overall poor nutrient profile. This finding suggests that when SNP are followed, there is a strong potential to improve the quality of children's lunch intakes and that, generally, the school lunch programs in PEI elementary and consolidated schools are enabling children to consume healthier foods. However, parents also play an important role in regards to children's lunch intakes because of the high proportion of total consumption provided from home. Providing parents with nutrition education and support regarding healthy food and beverage choices to send to school is one strategy to improve the nutritional quality of children's lunch time food intake. Comparing the dietary quality of children's lunch's items purchased from school versus items brought from home can help us understand the role of schools in enabling children to consume school lunches which meet the current nutrition recommendations.

Table 5.1 Sample description (N=1966)

		n	(%)
Grade	Grade 5	976	(49.6)
	Grade 6	990	(50.4)
Sex	Male	979	(49.8)
	Female	987	(50.2)

Table 5.2 Lunch-time nutrient intakes (median and inter-quartile ranges) by source[2] of food consumed for grade 5 and 6 children in PEI schools, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

		Total			Home			School			
Nutrients	1/3 EAR/AI or AMDR	25th	Median	75th	25th	Median	75th	25th	Median	75th	p value
Mass (g)	-	373.0	492.0	632.0	131.0	323.0	654.0	0.0	128.0	264.0	<.0001
Calories	-	387.0	520.0	695.0	170.0	369.0	549.0	0.0	119.0	260.0	<.0001
Kilojoules	-	1617.0	2174.0	2902.0	701.0	1545.0	2296.0	0.0	497.0	1078.0	<.0001
Protein (g)	9.3♀, 9.0♂ (EAR)	11.0	18.3	25.0	2.8	10.5	18.7	0.0	3.0	9.7	<.0001
Fat (g)	-	10.3	16.5	23.6	3.4	10.2	18.2	0.0	2.9	7.9	<.0001
Carbohydrates (g)	-	53.3	72.8	96.6	26.7	53.5	81.8	0.0	12.1	29.5	<.0001
Sugar (g)	-	20.6	33.0	51.2	4.0	21.8	38.0	0.0	0.0	26.2	<.0001
% kcal Protein	10-30%	10.0	13.3	16.9	7.1	11.2	15.5	15.2	17.9	23.8	<.0001
% kcal Fat	25-23%	22.3	29.6	35.8	18.9	27.5	35.8	25.0	33.3	36.3	<.0001
% kcal Carbs	45-65%	48.8	56.6	65.7	50.0	60.3	71.5	38.2	49.3	57.8	<.0001
% kcal Sugar[2]	<25%	17.4	27.2	36.4	11.9	25.8	39.4	16.8	40.5	55.1	<.0001
Fiber (g)	8.7♀, 10.3♂ (AI)	2.3	3.6	5.4	1.2	2.6	4.4	0.0	0.0	1.4	<.0001
Iron (mg)	1.9♀, 2.0♂ (AI)	2.3	3.3	4.5	0.9	2.5	3.9	0.0	0.1	1.1	<.0001
Calcium (mg)	400(AI)	143.0	306.0	443.0	26.0	122.0	218.0	0.0	23.0	302.0	<.0001
Magnesium (mg)	66.7(EAR)	39.0	59.0	85.0	16.0	36.0	61.0	0.0	14.0	34.0	<.0001
Potassium (mg)	1500(AI)	446.0	652.0	899.0	156.0	361.5	605.0	0.0	152.0	446.0	<.0001
Zinc (mg)	2.3(EAR)	1.3	1.9	2.8	0.0	1.1	1.8	0.0	0.2	1.1	<.0001
Vitamin A (RAE)[3]	140♀, 148.3♂ (EAR)	16.0	119.0	170.0	1.0	14.0	74.0	0.0	0.0	145.0	<.0001
Vitamin D(μg)	1.7(AI)	0.0	1.0	2.8	0.0	0.0	0.2	0.0	0.0	2.6	<.0001
Vitamin C (mg)	13(EAR)	3.4	11.2	102.3	0.3	6.5	46.0	0.0	0.4	2.4	<.0001
Vitamin E (mg)	3(EAR)	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	<.0001
Thiamin (mg)	0.2(EAR)	0.2	0.4	0.5	0.1	0.4	0.4	0.0	0.1	0.2	<.0010

Table 5.2 Continued

Table 5.2 (Cont.) Lunch-time nutrient intakes (median and inter-quartile ranges) by source[2] of food consumed for grade 5 and 6 children in PEI schools, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

		Total			Home			School			
Nutrients	1/3 EAR/AI or AMDR	25th	Median	75th	25th	Median	75th	25th	Median	75th	p value
Riboflavin (mg)	0.3(EAR)	0.1	0.3	0.4	0.3	0.5	0.8	0.0	0.1	0.5	0.0150
Niacin (mg)	3(EAR)	1.3	4.3	6.7	4.3	6.4	8.9	0.0	0.8	2.5	0.0110
Vit B_6 (mg)	0.3(EAR)	0.1	0.2	0.3	0.2	0.2	0.4	0.0	0.1	0.1	0.0150
Vit B_{12} (µg)	0.5(EAR)	0.0	0.2	0.6	0.2	0.9	1.4	0.0	0.0	1.1	<.0001
Folate (µg)	83.3(EAR)	11.0	58.0	125.0	47.0	91.0	140.0	0.0	5.0	15.0	<.0001
Sodium (mg)	500(AI)	133.0	629.0	1169.0	588.0	930.0	1363.0	0.0	84.5	254.0	<.0001

♀ Female
♂ Male
[1]RAE (Retinol Activity Equivalents)
[2]Source of food consumed was determined by combining vending machine and school lunch into one category and combining home and other into another category.
[3]Shaded area represents percentage of total calories from Macronutrients and Sugar.

Table 5.3 Association between micronutrient adequacy[2] of PEI students lunch-time intakes and adherence[3] to the school nutrition policy, 2007 (n=1636)

Nutrients	Total		0-20% "Prohibited"		20-40% "Prohibited"		40-100% "Prohibited"	
			% Foods Offered at School Lunch Not Permitted by School Nutrition Policy					
	Total	(%)	Total	(%)	Total	(%)	Total	(%)
Iron (mg)	1295	(79.2)	661	(79.2)	323	(78.8)	311	(79.5)
Magnesium (mg)	682	(41.7)	351	(42.0)	162	(39.5)	169	(43.2)
Zinc (mg)	638	(39.0)	313	(37.5)	174	(42.4)	151	(38.6)
Vitamin A (RAE)[1]	678	(41.4)	355	(42.5)	162	(39.5)	161	(41.2)
Vitamin E (mg)	83	(5.1)	39	(4.7)	21	(5.1)	23	(5.9)
Vitamin C (mg)	778	(47.6)	413	(49.5)	187	(45.6)	178	(45.5)
Thiamin (mg)	1291	(78.9)	665	(79.6)	318	(77.6)	308	(78.8)
Riboflavin (mg)	1214	(74.2)	607	(72.7)	318	(77.6)	289	(73.9)
Niacin (mg)	1362	(83.3)	693	(83.0)	339	(82.7)	330	(84.4)
Vitamin B_6 (mg)	591	(36.1)	303	(36.3)	144	(35.1)	144	(36.8)
Vitamin B_{12} (μg)	1081	(66.1)	542	(64.9)	281	(68.5)	258	(66.0)
Folate (μg)	860	(52.6)	442	(52.9)	210	(51.2)	208	(53.2)

[1] RAE = Retinol Activity Equivalents

[2] Adequacy is defined as one-third of the Dietary Reference Intake for each nutrient, EAR (Estimated Average Requirement).

[3] Adherence to the SNP was determined by counting the number of "Prohibited" foods served at lunch according to the policy divided by the total number of food items offered.

Table 5.4 Association between macronutrient adequacy[2] (within, above and below the AMDRs) of PEI student lunch-time intakes and adherence[4] the school nutrition policy, 2007 (n=1636)

Nutrients	Within AMDR[4] Above AMDR Below AMDR	Total		0-20% "Prohibited"		20-40% "Prohibited"		40-100% "Prohibited"	
		n	(%)	n	(%)	N	(%)	N	(%)
Protein[2]	10-30%	1069	(65.3)	545	(65.3)	279	(68.1)	245	(62.7)
	>30%	247	(15.1)	127	(15.2)	56	(13.7)	64	(16.4)
	<10%	320	(19.6)	163	(19.5)	75	(18.3)	82	(21.0)
Fat [2]	25-35%	255	(15.6)	108	(12.9)	67	(16.3)	80	(20.5)
	>35%	118	(7.2)	48	(5.8)	34	(8.3)	36	(9.2)**
	<25%	1263	(77.2)	679	(81.3)	309	(75.4)	275	(70.3)
Carbohydrates [2]	45-65%	379	(23.2)	202	(24.2)	91	(22.2)	86	(22.0)
	>65%	967	(59.1)	493	(59.0)	243	(59.3)	231	(59.1)
	<45%	290	(17.7)	140	(16.8)	76	(18.5)	74	(18.9)
Sugar[3]	<25%	924	(56.5)	483	(57.8)	241	(58.8)	200	(51.2)
	>25%	712	(43.5)	352	(42.2)	169	(41.2)	191	(48.9)

**p<0.01

[1]AMDR = Acceptable Macronutrient Distribution Ranges

[2]Macronutrients compared to AMDRs

[3]Currently there is no DRI set for sugar, rather a maximal intake level of 25 percent or less of total calories from added sugars is suggested for adults and children.

[3] Adherence to the SNP was determined by counting the number of "Prohibited" foods served at each school (according to the policy) divided by the total number of food items offered.

[4]Shaded area represents macronutrient intakes that meet current DRI recommendations.

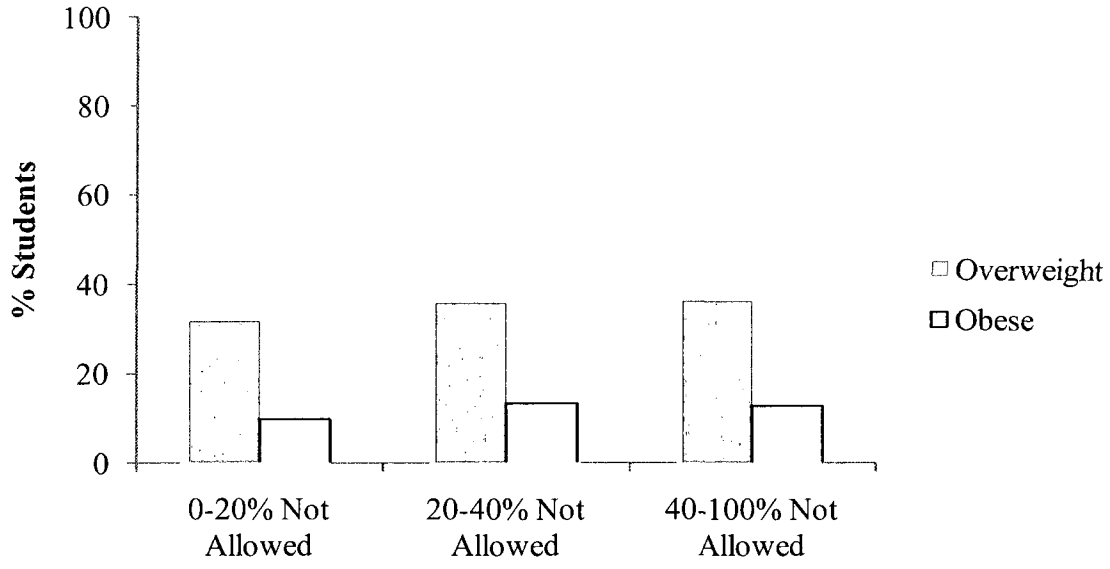


Figure 5.1 Association between the proportion of overweight and obese[1] PEI students and adherence[2] the school nutrition policy, 2007 (n=1593)

[1]Children are categorized as overweight and obese based on international body mass index cut-off points established for children and youth (Cole et al., 2000).
[2] Adherence to the SNP was determined by counting the number of "Prohibited" foods served at each school (according to the policy) divided by the total number of food items offered.

Table 5.5 Comparison of nutrient quality[2] of food consumed at lunch-time by source, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

	School			Home			
Nutrients	25th	Median	75th	25th	Median	75th	p value
Protein (g)	38.7	44.6	66.0	14.0	22.3	38.7	<0.0001
Fat (g)	27.8	38.3	39.4	19.3	31.6	42.4	<0.0001
Carbohydrates (g)	93.6	121.5	144.6	120.3	147.5	183.3	<0.0001
Sugar (g)	49.5	101.2	137.6	19.8	54.3	102.8	<0.0001
Fiber (g)	0.0	6.3	6.8	4.9	7.6	11.7	<0.0001
Iron (mg)	0.6	3.3	6.2	4.5	6.8	8.6	<0.0001
Calcium (mg)	667.9	1584.2	2113.7	139.8	303.9	510.1	<0.0001
Magnesium (mg)	121.8	178.9	217.1	76.2	102.6	148.3	<0.0001
Potassium (mg)	1350.4	2347.4	3000.0	589.7	984.5	1522.1	<0.0001
Zinc (mg)	4.8	5.7	8.6	1.7	3.1	4.5	<0.0001
Vitamin A RAE)[3]	283.6	763.2	1100.8	8.9	43.1	166.5	<0.0001
Vitamin D(μg)	3.4	13.9	18.7	0.0	0.0	0.3	<0.0001
Vitamin C (mg)	3.9	7.4	12.6	2.6	16.7	88.9	<0.0001
Vitamin E (mg)	0.5	0.7	0.8	0.4	0.7	0.9	<0.0010
Thiamin (mg)	1.1	2.3	3.7	0.5	0.7	1.0	<0.0001
Riboflavin (mg)	12.2	14.0	15.2	6.5	11.6	15.4	<0.0110
Niacin (mg)	0.4	0.6	0.8	0.3	0.5	0.8	<0.0150
Vitamin B_6 (mg)	2.2	4.7	8.0	0.0	0.4	1.5	<0.0001
Vitamin B_{12} (μg)	68.4	100.8	136.8	68.7	186.0	291.1	<0.0001
Folate (μg)	821.7	831.6	1579.1	687.7	1610.9	2739.0	<0.0001
Sodium (mg)	38.7	44.6	66.0	14.0	22.3	38.7	<0.0001

[1]RAE (Retinol Activity Equivalents)

[2]Nutrient density is defined as the nutrient content (in grams) divided by the total energy content (expressed in Calories) multiplied by 1000 (Drewnowski, 2005)

Table 5.6 Comparison of nutrient quality of food consumed at lunch-time from school sources by sex, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

	Male			Female			
Nutrients	25th	Median	75th	25th	Median	75th	p value
Protein (g)	37.9	44.6	66.0	38.9	44.6	66.0	0.7896
Fat (g)	27.8	38.5	39.4	27.8	37.6	39.5	0.4410
Carbohydrates (g)	93.6	144.6	165.4	93.6	121.8	144.6	0.4371
Sugar (g)	47.7	101.2	137.6	54.3	101.2	137.6	0.3077
Fiber (g)	0.0	6.3	6.8	0.0	6.3	6.8	0.4131
Iron (mg)	0.6	3.3	6.2	1.1	3.3	6.3	0.7493
Calcium (mg)	667.9	1584.2	2341.1	667.9	1584.2	1769.2	0.3215
Magnesium (mg)	121.8	178.9	217.1	121.8	178.9	217.1	0.8349
Potassium (mg)	1350.4	2347.4	3000.0	1357.7	2347.4	3000.0	0.6078
Zinc (mg)	4.9	5.7	8.6	4.5	5.7	8.1	0.3261
Vitamin A RAE)[3]	277.9	763.2	1100.8	284.3	763.2	1100.8	0.7079
Vitamin D(μg)	4.0	14.0	21.5	3.2	13.1	13.9	0.2798
Vitamin C (mg)	3.9	6.5	12.6	3.9	8.7	12.6	0.2531
Vitamin E (mg)	0.0	0.0	0.0	0.0	0.0	0.0	0.5304
Thiamin (mg)	0.5	0.7	0.8	0.5	0.6	0.8	0.0724
Riboflavin (mg)	1.2	2.3	3.7	1.0	2.3	2.7	0.1875
Niacin (mg)	12.2	15.2	15.2	12.2	13.4	15.2	0.0231
Vitamin B_6 (mg)	0.4	0.6	0.8	0.4	0.6	0.8	0.7591
Vitamin B_{12} (μg)	2.3	4.7	9.2	2.0	4.7	6.5	0.2268
Folate (μg)	68.4	100.8	152.7	68.4	100.8	136.8	0.8811
Sodium (mg)	821.7	831.6	1579.1	821.7	831.6	1579.1	0.7901

[1]RAE (Retinol Activity Equivalents)

[2]Nutrient density is defined as the nutrient content (in grams) divided by the total energy content (expressed in Calories) multiplied by 1000 (Drewnowski, 2005).

Table 5.7 Comparison of nutrient quality of food consumed at lunch-time from home sources by sex, fall, 2007. Differences were assessed using a Wilcoxon Rank Sum Test (n=1943)

	Male			Female			
Nutrients	25th	Median	75th	25th	Median	75th	p value
Protein (g)	14.0	28.4	40.3	14.2	25.4	37.4	0.1010
Fat (g)	19.6	31.8	42.5	18.2	30.8	41.7	0.4039
Carbohydrates (g)	117.7	144.2	177.8	123.5	152.0	192.3	0.0788
Sugar (g)	17.0	52.7	101.6	21.9	55.9	104.4	0.3804
Fiber (g)	4.5	7.2	10.5	5.3	8.2	13.7	<0.0001
Iron (mg)	4.4	6.7	8.6	4.7	6.8	8.6	0.6639
Calcium (mg)	151.3	305.9	504.5	121.0	303.8	510.8	0.8157
Magnesium (mg)	73.1	98.3	146.4	78.3	106.0	149.2	0.7280
Potassium (mg)	574.2	927.5	1478.0	605.4	1047.9	1611.1	0.1500
Zinc (mg)	1.7	3.2	4.5	1.6	3.1	4.4	0.3096
Vitamin A RAE)[3]	7.7	46.1	163.7	9.9	41.6	171.9	0.4368
Vitamin D(μg)	0.0	0.0	0.4	0.0	0.0	0.3	0.1852
Vitamin C (mg)	1.7	14.9	58.0	3.3	19.9	108.0	0.3288
Vitamin E (mg)	0.0	0.0	0.0	0.0	0.0	0.0	0.9847
Thiamin (mg)	0.4	0.7	1.0	0.4	0.7	0.9	0.1243
Riboflavin (mg)	0.5	0.7	1.0	0.5	0.7	0.9	0.2766
Niacin (mg)	7.0	11.7	15.7	6.3	11.3	15.3	0.0870
Vitamin B_6 (mg)	0.3	0.4	0.7	0.3	0.5	0.8	<0.0001
Vitamin B_{12} (μg)	0.0	0.5	1.8	0.0	0.3	1.3	0.0043
Folate (μg)	77.0	181.7	289.6	66.8	195.0	294.8	0.7990
Sodium (mg)	724.8	1600.5	2739.0	684.7	1648.0	2739.7	0.0678

[1]RAE (Retinol Activity Equivalents)

[2]Nutrient density is defined as the nutrient content (in grams) divided by the total energy content (expressed in Calories) multiplied by 1000 (Drewnowski, 2005).

Table 5.8 Relationships (Spearman's Correlation) between adherence[2] (% "prohibited" foods served at lunch) and nutrient density[3] (n = 689).

	Adherence	
Nutrient Density	Spearman r	p
Protein	0.083	0.014
Fat	0.036	0.284
Carbohydrates	-0.094	0.006
Sugar	0.054	0.112
Fiber	-0.040	0.243
Iron	-0.072	0.035
Calcium	0.149	0.000
Magnesium	0.161	0.000
Potassium	-0.024	0.368
Zinc	0.163	0.000
Vitamin A (RAE)[1]	0.044	0.199
Vitamin D	0.134	0.001
Vitamin C	-0.069	0.041
Vitamin E	-0.182	0.001
Thiamin	0.008	0.804
Riboflavin	0.133	0.001
Niacin	0.027	0.424
Vitamin B_6	0.049	0.144
Vitamin B_{12}	0.127	0.001
Folate	0.033	0.336
Sodium	-0.117	0.001

*$p<0.05$

**$p<0.01$

[1] RAE = Retinol Activity Equivalents

[2] Adherence to the SNP was determined by counting the number of "Prohibited" foods served at each school (according to the policy) divided by the total number of food items offered.

[3]Nutrient density is defined as the nutrient content (in grams) divided by the total energy content (expressed in kilocalories) multiplied by 1000 (Drewnowski, 2005).

CHAPTER SIX

Limitations

6.1 Limitations

As with all studies involving dietary assessment in children, results must be interpreted with caution. A one day lunch time food record was used to assess food intake at school; this may not represent a child's usual intake due to documented day to day variability in food intake (Rockett & Colditz, 1997). Further, since not all schools offer lunch programs on a daily basis, and the date of data collection was decided in cooperation with participating schools, foods reported to be purchased by children at school may vary significantly if the lunch food record was collected on a day that school lunch was offered than on one when it was not. However, the large sample size of children helps to reduce this potential bias.

Another limitation was the lack of control over the source of the food. Student's lunches consisted of foods and beverages purchased from school, foods and beverages brought from home, or a combination of both sources, with two-thirds of the food and beverage items coming from home and only one-third being purchased at school. This imbalance in foods and beverages consumed was addressed by calculating the nutrient density which standardized nutrient intake levels from each source.

Self-reported dietary intakes of children are often associated with recall errors, inaccurate estimation of portion sizes, social desirability biases, as well as literacy and concentration issues, among others (Smith et al., 1991; Hanning et al., 2007). In an attempt to obtain the most valid dietary data possible, research assistants received extensive training and provided students with instructions and assistance when recalling foods and spelling food items during data collection. However, following data collection, incorrect spelling of food items was still identified as an issue that made it difficult to

accurately identify food items. The grade five students often had more difficulty with accurate spelling and recalling food items than grade six students, creating another potential source of bias. However, future waves of data collection may benefit from having a higher number of trained research assistants in the classroom to increase the level of detail obtained from the children. Schools in PEI and elsewhere are increasingly being invited to participate in research and non-academic related projects and there are concerns regarding the associated classroom time required for children's participation. Therefore, there are constraints on the amount of time such studies can take. As a result, the one-day LFR method used in this study was selected because it had been identified as a valid means of assessing children's lunch-time food intake while minimizing the burden placed on the schools (Cullen et al., 2007).

The quality of student lunches was assessed by comparing intakes to one third of the Estimated Average Requirement. This was necessary due to the absence of a national school lunch program and accompanying school lunch standards in Canada. This method is useful to compare student lunches according to sex and grade, but cannot be used to assess dietary adequacy, which is appropriate for usual daily rather than a single lunch time food intake.

In total, 1966 students completed the lunch food record representing a response rate of 59%. Although this is a good response rate for a survey of this kind where parental consent was required for conducting anthropometric measurements with the children, there is a possibility of sampling bias. For example, if parents of overweight children were less likely to give consent, the survey could be skewed towards children with body

weights in a healthy range. The response rate was similar to that of a Nova Scotia study which had a response rate of 50% (Veugelers & Fitzgerald, 2005).

CHAPTER SEVEN

General Conclusions and Future Directions

7.1 General Conclusions and Future Directions

This chapter will review the research aims addressed at the beginning of the thesis, followed by a discussion of the main conclusions found in this study. Lastly, future directions for research and data collection are discussed.

This study examined, for the first time, the nutritional quality of children's lunch-time food intakes at school, and whether there is an association between following a SNP and the nutrient composition of children's lunch-time food intake. This study accomplished the following five research aims: 1) to assess the extent to which PEI elementary schools are following the recently implemented nutrition policies; 2) to describe the nutritional quality of children's lunch-time intakes; 3) to determine if there is an association between SNP adherence and adequacy of lunch-time food intake in PEI grade five and six children; 4) to assess differences in nutritional quality between foods purchased at school versus brought from home; and 5) to determine if there is an association between SNP adherence and the prevalence of overweight and obesity among PEI grade five and six children. The findings of the present research, according to each of these aims, are discussed below.

The first research aim was to assess the extent to which PEI elementary schools are following the recently implemented nutrition policies. According to subjective assessments, school principals report felt they were adhering well to the recently implemented SNP, with a perceived policy adherence score of 78%. However, there was variation in the level of adherence to individual policy components. More than 75% of schools indicated that they were following the policy components that specified using healthy foods or non-foods for fundraising, teachers serving as positive healthy-eating

role models and staff and volunteers at school that were familiar with safe food handling practices. In contrast, only 39% of the principals reported that they were "always" selecting foods for sale at school which were consistent with the SNP food lists, with an additional 46% of principals reporting that they selected foods from the food lists "most of the time, for a total of 85%. This finding, that approximately one-third of principals reported that they followed the food lists "all the time", may reflect the fact that the survey was conducted only one year into SNP implementation. As a result, principals may have felt less pressured to be fully implementing the policy. Based on this subjective assessment of SNP implementation, elementary schools appear to be making progress in adhering to the policy, with some components being easier to implement than others. Most principals reported that they were using healthy foods or non-food items for fundraising purposes and that teachers and staff were seen as positive healthy eating role models, but fewer indicated that they were serving foods from the policy lists or involving students in planning foods offered at school on a regular basis.

Objective assessments of foods offered at school also indicated that approximately three fourths of all foods and beverages served at lunch-time were considered "allowed" by the PEI SNP. Similarly, the vast majority of foods and beverages offered in vending machines and canteens were also considered "allowed" by the policy. However, more than 50% of schools still offered at least one lunch food or beverage that was prohibited by the SNP. Results indicated that lower level of adherence to the SNP (high proportions of "prohibited" foods being offered at schools) was associated with principal's low levels of perceived adherence to the policy component "choosing food from the policy list". Principal's perceived policy adherence

ratings to other SNP components were not associated with the proportion of prohibited foods. This suggests that principal's perceptions were generally related to the more objective assessment of adherence. One research study in the Texas area obtained principals' perspectives regarding the recent implementation of SNP (Deek, 2006). Over one-half of the principals reported they had not encountered any problems regarding SNP implementation, while over 20% reported that the main problem with healthy eating at school involved children bringing unhealthy food items from home. Children bringing unhealthy food and beverage items from home was a common theme that arose throughout the principal interviews, so future improvements to the SNP should target parental education regarding healthy food choices (Deek, 2006).

The second research aim was to describe the nutritional quality of children's lunch-time intakes. The overall nutritional quality of children's lunch-time intakes are poor with low intakes of calcium, magnesium, potassium, zinc, vitamin A, vitamin E, and vitamin D, and fiber. These low intakes are of concern because one-third of a child's total daily energy requirements are obtained at school. The majority of student's reported intakes of protein fell within the recommended range (Acceptable Macronutrient Distribution Range). In contrast, less than a quarter of students reported intakes of fat and carbohydrates that were within the recommended range. The majority of students (78%) reported intakes of fat that were below the recommendation, whereas 60% of students reported intakes of carbohydrates that were above the recommendation. This suggests that children are consuming lunches that are low in fat, high in carbohydrate and adequate in protein. There is limited research currently available regarding the composition of children's lunch intakes. However, results are consistent with Kim and

colleagues (2006) who concluded that Korean children's lunch-time intakes were also low in fat, high in carbohydrate and adequate in protein. This contradicted my hypothesis that school lunches would be high in fat, but confirmed my hypothesis that many nutrients would fall outside the healthy range for childhood intakes.

The third research aim was to determine if there was an association between school policy adherence and the adequacy of lunch-time food intakes among PEI grade five and six children. Children from schools with low adherence to SNP (i.e. a high proportion of "prohibited" foods offered at lunch) reported low nutrient intakes of protein, calcium, magnesium, zinc, riboflavin, and vitamin B_{12}. These nutrients could represent low consumption of foods high in calcium, vitamin D, riboflavin, and vitamin B_{12}, such as fluid milk or cheese on pizza. Findings suggest that children from schools that do not closely follow SNP report lower densities of the above listed nutrients, resulting in an overall poorer nutrient profile. This study's findings are thus consistent with a growing number of studies which have demonstrated a positive association between healthy school food environments and the nutritional quality of children's food intakes (Veugelers & Fitzgerald, 2005; Foster et al., 2008; Jaime & Lock, 2009). While the findings of this research suggest that closer adherence to SNP is associated with higher dietary quality, it is important to remember that the overall adequacy of children's lunches was poor, regardless of the level of adherence to the SNP.

The fourth research aim was to assess differences in nutritional quality between food and beverages purchased at school versus food and beverages brought from home. Findings from this study provided some support for the hypothesis that foods purchased at school will have higher nutrient densities than those brought from home. Foods

purchased at school were higher in 10 important micronutrients (calcium, magnesium, potassium, zinc, vitamin A, vitamin D, riboflavin, niacin, vitamin B_6 and vitamin B_{12}) compared to packed lunch foods from home, which were higher in five micronutrients (iron, vitamin C, vitamin E, thiamin, folate). School lunches provided sufficient protein but were also higher in sugar and fat than home lunches, although approximately 60% of the children had intakes within the recommended range, and most children had fat intakes which fell below recommendations. Foods brought from home were higher in carbohydrates and sodium than school foods. Sodium patterns are of concern as parents are sending food items from home that are higher in sodium than school lunch items. Also of concern were the low nutrient densities of calcium and vitamin D from home foods. This suggests that children are purchasing milk at school but are not bringing foods high in calcium and vitamin D from home to meet the recommended one third of daily recommendations. This finding suggests that one strategy to increase children's low calcium intakes could involve increasing the promotion of school milk programs in an attempt to increase participation rates. The school milk program offers a reliable source of calcium for school-aged children. This research finding has also identified the need for additional education for both parents and schools: while the PEI Healthy Eating Alliance has indicated that they provide schools and parents with support materials such as user friendly information letters for parents, monthly healthy eating tips, an annual newsletter and a website (www.healthyeatingpei.ca), these efforts do not appear to be sufficient to inform and engage parents in sending healthy lunches to school. It is important to disseminate these research findings to schools (school food volunteers, school nutrition councils or groups) and parents through newsletters and presentations. Since this research

indicates that schools are at differing stages of SNP implementation (which impacts the quality of lunch-time foods and beverages offered), it is not possible to make a "blanket" recommendation to increase student participation in all school lunch programs. Rather, enabling schools to follow the SNP and to offer nutritious lunch-time foods is recommended to improve the nutritional adequacy of school-aged children lunches. School foods were not uniformly higher in nutritional quality than home foods, contrary to expectations, however, it can be said that lunch items purchased at school generally had a higher nutrient density for most important nutrients, especially in schools with high adherence to the SNP. Findings of the present research suggest that improving the dietary habits of school-aged children will require a collaborative effort from multiple stakeholders (i.e. schools, families, food vendors, food service staff etc).

Finally, the fifth research aim was to determine if there is an association between school policy adherence and the prevalence of overweight and obesity in PEI grade five and six children. It was found that over one-third of children in grade five and six (aged 10-14 years; mostly 11 or 12 years) on Prince Edward Island are either overweight or obese. This is higher than the 26-29% reported for PEI children by the CCHS three years earlier (Statistics Canada, 2004a) and suggests that there have been no improvements in the overweight/obesity rates since SNP were introduced in 2005/2006.

However, there were some encouraging preliminary observations with schools which adhere more closely to the SNP having lower rates of overweight and obese children. Possible confounders which may influence the relationship between obesity and SNP adherence could include school region (ESD versus WSB), SES, and school resources (fundraising, space for storing and preparing healthy food options). These

results are in no way conclusive, given the cross sectional design, but suggest the potential for SNP to have a positive impact on reducing overweight and obesity through the restriction of "prohibited" foods and the promotion of healthier food choices. This is especially important as students in this study were more likely to buy food at school when healthy choices were available.

It is important to note that research providing evidence of SNP effectiveness in reducing overweight and improving children's eating habits has examined *comprehensive* policies which include not only changes to foods at school, but increased physical education, healthy lunches, nutrition education, training of staff and parental involvement (Veugelers & Fitzgerald, 2005; Brescoll, 2008; Foster et al., 2008). School based nutrition interventions should consider these factors in their design. Nutrition education is relatively inexpensive to provide in schools and has been shown to be more congruent with traditional values which focus on an individual's personal responsibility to make healthy food choices rather than focusing specifically on changing the school food environment alone (Brescoll, 2008). Physical activity should also be considered since it is a major determinant of overweight but was beyond the scope of this study (Raine, 2004; Jaime and Lock, 2009). Further, it is also essential to expand the scope of SNP to include the broader environment (i.e. access to corner stores, food brought from home) (Veugelers et al., 2005; Foster et al., 2008) in order to make a significant impact on children's eating habits and overweight rates.

In addressing these research aims, this study has contributed to the knowledge base regarding the association between the school food environment on eating habits of school-aged children. Specifically, it has examined the relationship between the level of

SNP implementation and the nutritional quality of school lunch-time food intakes. This study has also contributed novel information on nutritional quality of foods consumed at school according to the source of the food consumed (lunch brought from home versus lunch purchased at school) in Canadian schools. Since the present study examined nutrient intakes only, future analysis should examine the association between the consumption of specific foods and food groups and the dietary quality of children's lunch-time intakes and foods offered at school.

The high rates of overweight and obesity suggest a need for action to prevent further increases; one means of doing this could be to capitalize on the positive changes that have occurred in school lunches while addressing the potentially negative implications of lunches from home.

Future waves of data collection (occurring in 2010 and 2012) will be conducted as part of the SNAP research project in order to examine changes in weight and food consumption associated with implementing SNP over a five year period. The association between school adherence and daily/weekly food intakes will also be addressed. Other determinants of children's dietary quality should also be considered, including parental education and income levels, and physical activity (Florence et al., 2008). Finally, the relative importance of these factors as predictors of the dietary quality and weight status of grade five and six elementary school children should be investigated using a multivariate design.

Overall, the results of this study have contributed to the growing knowledge base regarding the relationship between the school environment and children's dietary intakes. Given that both school change and changes to children's eating habits and body weights

is a process that may take some time (McKenna, 2003; Jaime and Lock, 2009), it is important to continue to monitor SNP implementation and examine its potential benefits in Prince Edward Island and across the country.

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APPENDIX A

Age (Years)	BMI=25 (Overweight)		BMI=30 (Obese)	
	Males	Females	Males	Females
2	18.41	18.02	20.09	19.81
3	17.89	17.56	19.57	19.36
4	17.55	17.28	19.29	19.15
5	17.42	17.15	19.30	19.17
6	17.55	17.34	19.78	19.65
7	17.92	17.75	20.63	20.51
8	18.44	18.35	21.60	21.57
9	19.10	19.07	22.77	22.81
10	19.84	19.86	24.00	24.11
11	20.55	20.74	25.10	25.42
12	21.22	21.68	26.02	26.67
13	21.91	22.58	26.84	27.76
14	22.62	23.34	27.63	28.57
15	23.29	23.94	28.30	29.11
16	23.90	24.37	28.88	29.43
17	24.46	24.70	29.41	29.69
18	25	25	30	30

APPENDIX B

School Nutrition and Activity Project Policy Checklist

Please tell us about the extent to which you have implemented the following aspects of the Nutrition Policy at your school. Check the box which best represents your opinion.

At my school...

1. We allow a minimum of 20 minutes to eat lunch	Yes - No -
2. We stock an emergency food cupboard with healthy choices for students in need	Yes - No -
3. We participate in the PEI School Milk Program	Yes - No -
4. We offer a breakfast or snack program available to all children	Yes - No -
5. We price foods in a way to encourage healthy food consumption	Disagree - Agree - Strongly agree -
6. Staff and volunteers are familiar with safe food handling practices	Disagree - Agree - Strongly agree -
7. The food and beverages sold in vending machines, which are accessible to students, are selected from the "Healthy Vending Machine and Canteen Foods" list.	Never - Sometimes - Most of the time - Always - NA -
8. We promote only healthy food choices and advertising at school	Never - Sometimes - Most of the time - Always -
9. We participate in Healthy Eating Alliance, or other nutrition activities when offered	Never - Sometimes - Most of the time - Always -
10. We involve students in planning school food choices	Never - Sometimes - Most of the time - Always -
11. Foods sold or provided at school are selected from "Foods to Serve Most Often" or "Foods to Serve Sometimes" lists	Never - Sometimes - Most of the time - Always -
12. School fundraising activities emphasize non-food or healthy food products	Never - Sometimes - Most of the time - Always -
13. Our staff participate in professional development which addresses nutrition and food issues when available	Never - Sometimes - Most of the time - Always -
14. Teachers and school staff act as positive role models with regards to healthy eating	Never - Sometimes - Most of the time - Always -
15. We only offer non-food items as rewards for good behaviour, achievement or participation in fundraising activities.	Never - Sometimes - Most of the time - Always -

16. A) Does your school currently offer a LUNCH PROGRAM on any day during the week? ~YES ~NO = Go to Question #17

B) If your school does offer a LUNCH PROGRAM, please fill in the following information regarding the foods offered:

Food Offered	How Often? # Days/Week	What Brand? (i.e., brand name, restaurant provider, producer)	What Type? (e.g., flavour, variety, toppings)
Example: pizza	2	Pizza Delight	pepperoni
hot dogs	1	Maple Leaf	original, all beef
Pizza			
Hot Dogs			
Chicken Nuggets			
Chicken Burgers			
Sandwiches			
Subs			
Wraps			
Baked Potatoes			
Soup			
Chili			
Spaghetti			
Other:			

17. **Does your school have a VENDING MACHINE(s)?** ☐ Yes ☐ No ☐Go to Question 18.
If YES, please check (☐) all items currently offered:

Food	Offered	Food	Offered
baked potato chips		milk (white)	
bottled water		milk (chocolate)	
cheese & crackers		muffins	
chips/tortilla chips/cheesies (reg)		raisins	
chocolate bars/candy/gum		pretzels	
cookies/cakes/pies/pastries		rice cakes (e.g. *Mini Crisps*)	
fruit (fresh or canned)		sandwiches/subs/wraps	
fruit juices (100% juice)		soft drinks/pop/sports drinks (e.g. *Gatorade*)	
fruit drinks/fruit crystals		trail mix/cereal snack mix	
granola/cereal bars		yogurt/frozen yogurt	
ice cream products/milkshakes/popsicles		Other (specify)_____	
Other (specify)_____		Other (specify)_____	

18. Other than meal programs, canteens, vending machines and the cafeteria, does your school sell any other items for fundraising?

~ Yes ~ No ☐ Go to Question 19.

If answered YES please check items sold:

~ Chocolate bars/candy ~ Cookies/cakes ~ Cheese
~ Fresh Fruit/juice ~ Magazines ~ Bulbs
~ T-Shirts, Hats, etc. ~ Cards/Wrapping Paper
~ Other (Specify:)_____

APPENDIX C

Lunch Food Record

We are interested in what you had for lunch **today**. Please write each food or drink you had on the lines below.

Food/Drink Item (1 per box)	**# of servings eaten**	**Where did you get the food?**				
		School Lunch	**Milk Program**	**Vending Machine**	**Home**	**Other**
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐

APPENDIX D

DRI Standards for Comparison of Children's Lunch Intakes (IOM, 2006b)

Nutrient	**1/3rd EAR[1] (9-13y)**	**1/3rd AI[2] (9-13y)**	**AMDR[3](9-13)**
Carbohydrates (g)	33.3		45-65%
Protein (g)	♀ 9.3, ♂ 9		10-30%
Fat (g)			25-35%
Fibre (g)		♀ 8.7 , ♂ 10.3	
Iron (mg)	♀ 1.9, ♂ 2.0		
Zinc (mg)	2.3		
Potassium (mg)		1500	
Sodium (mg)		500	
Folate (µg)	83.3		
Calcium (mg)		400	
Magnesium (mg)	66.7		
Thiamin (mg)	0.2		
Riboflavin (mg)	0.3		
Niacin (mg)	3		
Vitamin A (RAE)[4](µg)	♀ 140, ♂ 148.3		
Vitamin B_6 (mg)	0.3		
Vitamin B_{12} (µg)	0.5		
Vitamin C (mg)	13		
Vitamin D (µg)		1.7	
Vitamin E (mg)	3		
Sugar[5]			<25% Calories

[1]EAR = Estimated Average Requirement; [2]AI = Adequate Intake; [3]AMDR = Acceptable Macronutrient Distribution Range

[4] RAE = Retinol Activity Equivalents

[5] Currently there is no DRI set for sugar, rather a maximal intake level of 25% or less of energy from added sugars is suggested for adults and children