University of Alberta

Behavioural and Environmental Factors Associated with Body Mass Index during Adolescence

by

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This thesis is dedicated to my lovely family in particular to my grandpa, Abdullah Abudawood who was loving, caring, kind, gentle, intelligent, knowledgeable and assertive. He taught me a lot of things and encouraged me to pursue my masters degree. Although he passed away while I was writing my thesis, he will be forever remembered. This thesis also dedicated to my parents who taught me that every goal could be achieved by hard work.
They are an unfailing source of love and support

Abstract

The growing prevalence of overweight and obesity in adolescents is of great concern. The objective of this research was to assess the relationship between body mass index (BMI) and individual factors such as: dietary intake, physical activity and sedentary behaviours; and to assess the relationship between BMI and interpersonal factors such as: food availability and encouragement of activity. A web-based survey of physical activity and nutrition (WebSPAN2) was completed by 4360 adolescents in grades 7 to10 in Alberta. Results from this study suggest that gender and grade level contributed significantly to BMI. Insufficient physical activity and extended periods of time spent in sedentary behaviours were the only modifiable risk factors associated with a higher BMI of adolescents. The variable, 'nutrition beliefs' was positively associated with BMI. Cohort studies are required to clarify the relative importance of individual and interpersonal factors on BMI during adolescence.

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

Acceptable Macronutrient Distribution Ranges (AMDR)

Availability of Unhealthy Food (FA)

Basal Metabolic Rate (BMR)

Eating Well with Canada's Food Guide (EWCFG)

Canadian Community Health Survey (CCHS)

Carbohydrate grams (C)

Diet Quality (DQ)

Encouragement of Activity (EA)

Energy Intake (EI)

Fat grams (F)

Frequency of unhealthy (UN)

Grade level (GL)

Gycemic Index (GI)

Institute of Medicine (IOM)

Insulin Resistance Syndrome (IRS),

International Obesity Task Force (IOTF)

Nutrition Attitude (NA)

Nutrition Knowledge (NK)

Physical Activity (PA)

Physical Activity Questionnaire for Older Children (PAQ-C)

Physical Education (PE)

Protein grams (P)

Resting Metabolic Rate (RMR)

Sedentary Behaviours (SB)

Sex (S)

Socioeconomic Status (SES)

Sugar-sweetened Beverages (SSB)

The American Heart Association (AHA)

The Body Mass Index (BMI)

The National Health and Nutrition Examination Survey (NHANES)

Thermic Effect of Food (TEF)

Variance Inflation Factor (VIF)

Web-Survey of Physical Activity and Nutrition (Web-SPAN)

Chapter One

Introduction

1.1 Introduction

In the past few decades the rates of overweight and obesity have increased dramatically among adolescents in Canada. Over a 25 year period, from 1978/79 to 2004, the prevalence of those considered to be overweight increased in boys from 13 – 18%, and in girls from 12 – 18%. Also over the same period, obesity rates increased from 4 – 9% in boys and from 3 – 7% in girls (Shields, 2005). The growing proportion of overweight and obese teens is of great concern. Many researchers report that obesity has a serious negative impact on adolescents' physical and psychological health (Davies el at., 2008).

Researchers have also demonstrated a link between obesity and an increased risk of developing numerous chronic diseases. For example, obesity is associated with many health conditions that can cause premature death, including: cardiovascular disease, cancer, asthma, osteoarthritis and kidney disease (National Institute of Environmental Health Sciences, 2005). Moreover, as a person's weight exceeds a normal range, there is an increased risk in the development of the following health problems: type 2 diabetes, stroke, hypertension, dyslipidemia, liver and gallbladder disease, sleep apnea and respiratory problems (Centers for Disease Control and Prevention, 2009). There are clusters of diseases, which at one time were strictly linked with adulthood that are now found to be occurring

among overweight and/or obese youth. Type 2 diabetes is one of these diseases - which has been diagnosed in children as young as eight years of age living in Canadian First Nation communities. In the next 15 years, it has been predicted that the occurrence of type 2 diabetes in children worldwide will increase by up to 50 per cent (Canadian Diabetes Association, 2010).

Obesity, like most chronic health conditions, is caused by complex interactions between multiple factors. These factors are genetic, environmental, and behavioural in nature. Some people are less active than others and consume more energy, yet they maintain a healthy physical condition. Others, however may be more active and eat healthier, yet they have a higher body weight. This fact emphasizes that a variation in genetic susceptibility to weight gain may greatly influence a person's physical health. Conversely, the interaction between multiple genetic and environmental factors has been found to influence the development of obesity (Bouchard and Loos, 2008). While scientists are trying to more clearly understand the genetic factors contributing to obesity, the environmental factors influencing obesity are more readily known. To have an impact on the development of obesity it is necessary to control the known environmental factors. According to Stead and Cairns 2009,"(an) obesogenic environment is characterized by increasing accessibility and affordability of energy-dense foods and declining levels of physical activity." For example, if access to energy-dense foods is limited in schools, teens will have a healthier environment leading to a potentially lower obesity rate. Furthermore, a relationship exists between environmental and behavioural factors. For example,

parents might not allow their children to walk to school or play outside because the neighbourhood is considered unsafe. This will result in a decrease in overall physical activity. Behavioural factors include: physical activity, sedentary activity (time spent watching television, playing video games, viewing the internet), food choices, and meal patterns, to name just some factors that influence adolescents.

Because of the interaction between environmental and behavioural factors, using an ecological model to address the complexity of obesity may be most appropriate. Obesity is a result of behavioural patterns which are influenced by personal, interpersonal, institutional and community factors (Lightfoot et al., 2008). Studying obesity within an ecological framework presents a more comprehensive assessment of the problem, and aids researchers in designing evidence-based interventions.

1.2 Rationale

Obesity is linked to significant health conditions among adolescents and it is a risk factor for many chronic diseases. By investigating the multiple factors associated with increasing overweight and obesity rates, we will have a better understanding of the cause of the problem. This will help in developing effective strategies and policies to decrease obesity and prevent chronic diseases (both physical and psychological) in the future. Preventing risk factors in youth today, instead of treating chronic disease during adulthood, therefore, may impart an improvement of the quality of life of individuals and reduction in costs incurred by the healthcare system.

Using an ecological framework (Figure 1) to address obesity is recommended. A person's body weight is a direct result of individual eating and activity behaviours, but these behaviours are influenced by other complex factors including: interpersonal, institutional and community factors and public policy (Lightfoot et al., 2008). Some of the interpersonal factors are the influences of family and friends who play an important role in obesity because of the direct and indirect influence on childrens' physical activity and nutrition behaviours (Welk et al., 2005). For example, mothers' nutritional knowledge can lead to healthier food choices such as vegetables and fruit snacks. Also, adolescents who consumed evening meals with their family were less likely to have low intakes of fruits, vegetables, and dairy foods; and less likely to skip breakfast (Manning &Videon, 2003). According to Hong et al.(2010), adolescents' eating behaviours are affected by family dietary practices and they found a negative association between the

availability of fruit at home and overweight of the children. Moreover, children's food preferences and dietary patterns might be influenced by interactions with friends and siblings (Davison & Birch, 2001).

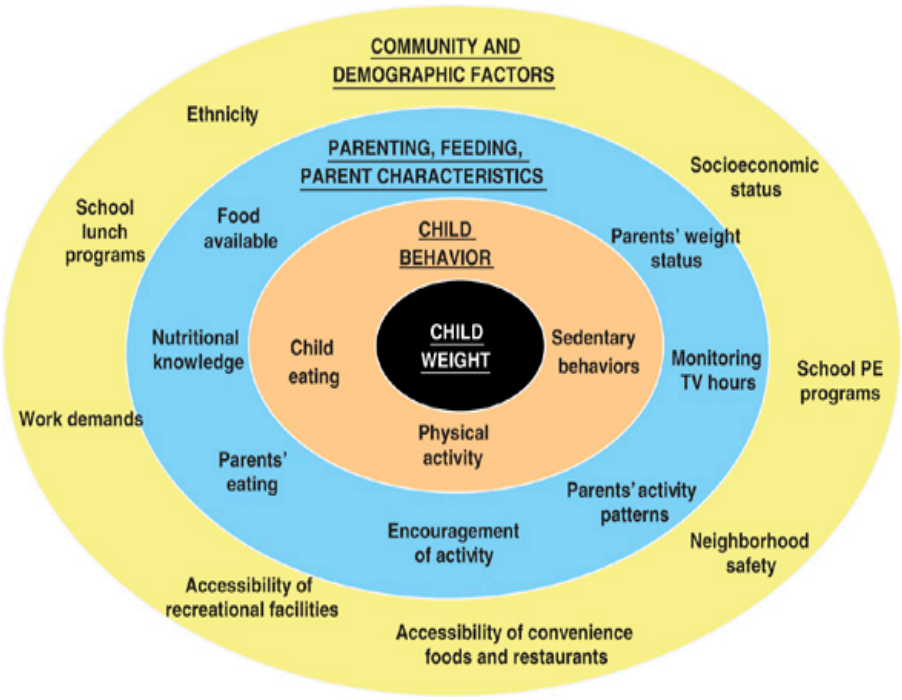

Figure 1:An ecological model for the causes of childhood obesity (Ventura and Birch, 2009) with permission from the International Journal of Obesity

The school environment is considered to be one of the institutional factors that contributes to obesity. All food and beverages served at school should be healthy and meet nutritional standards, because children spend a significant amount of time at school, in after school programs and in childcare facilities. Nevertheless, foods high in calories and low in nutritional value are being sold in school cafeterias, vending machines and school stores (Institute of Medicine, 2004). Finkelstein et al.(2006), demonstrated that school vending machine use and fast- food restaurant use were linked to sugar- sweetened beverage intake

during adolescence. In 2004, the American Academy of Pediatrics proposed the need to limit access to soft drinks in schools to decrease related health issues including overweight.

Neighbourhood and community factors may also influence the body weight of youth. Access to food is different for each community and it depends, in part, on the socioeconomic conditions. In low-income neighbourhoods where small convenience grocery stores are usually the most readily available options, access to healthy food such as lean meat and whole-grain breads is limited(Cassady&Jetter, 2006). In contrast, in high- income neighbourhoods where supermarkets are situated, a variety of healthy food is available (Cassady&Jetter, 2006). When access to healthy food is easy and affordable, obesity rates decrease. There was less BMI gain observed in children over a three-year period in neighbourhoods with easy access to low-cost fruit and vegetables compared to neighbourhoods with higher prices (Datar& Sturm, 2005). In addition, neighbourhood safety is a major determinant of outdoor activity. Youth are less likely to use walking and cycling as a method of transportation when parents are concerned about neighbourhood safety; and these youth are more vulnerable to obesity (Salmon et al., 2005).

Public policy is the last level of the ecological framework. Municipal, provincial, and national laws and policies are needed to prevent childhood obesity. Restricting vending machines that offer less healthy food is a good example of policy that may help to prevent overweight. Moreover, food price is a key factor that affects food choice and healthy eating. A study conducted in the

United States investigated vending machines that sold low fat snacks and regular snacks (French,Jeffery, Story, Hannan, & Snyder,1997). In this study, the price of the low fat snacks was decreased for 3 weeks then the price returned to the regular level. French et al. (1997) found that when the price of low fat snacks was dropped, the percentage of total sales rose from 25.7% to 45.8%;however, the percentage fell back again to 22.8% when the price returned to the regular level. This study showed how food price is an important determinant of healthy eating when the price was increased. Increasing unhealthy food prices and decreasing healthy food prices is another example of policy that has potential to help reduce the obesity rate.

In summary, the ecological approach provides a framework for prevention of childhood obesity. For the purpose of this thesis the focus was on individual factors such as eating behaviours (fast food, soft drinks, meal patterns) and exercise behaviours (physical activity and sedentary activity). Also, we investigated interpersonal factors such as family environment and peer influence on children's weight. Most studies focus on individual factors; however, in this study we investigated the problem from a somewhat broader perspective which included some interpersonal factors. Due to the limits of the survey methodology used, most community factors and public policy were not within the scope of this thesis. However, socioeconomic status (SES) (a community factor) was available and it was included in the analysis.

1.3 Overall purpose*

The overall purpose of this thesis was to increase the understanding of the behavioural and environmental factors that are associated with adolescent overweight and obesity. We assessed behavioural and environmental contexts and the influence of individual and interpersonal factors on weight status.

**Note: Data from the Web-Survey of Physical Activity and Nutrition 2 (2008) Web-SPAN2 were used to answer the research questions listed below. Web-SPAN2 included 4360 students between grades 7-10 from 109 schools throughout Alberta. The variables analyzed from the survey for this thesis are itemized at the end of this chapter.*

1.4 Research questions

1) What is the prevalence of overweight and obesity among adolescents in Alberta?

2) *Individual factors* and BMI:

   A. Is there a relationship between gender, grade level and BMI?

   B. Is there a relationship between adolescents' dietary intake and BMI?

   C. Is there a relationship between adolescents' nutrition beliefs and attitudes and BMI?

   D. Is there a relationship between adolescents' physical activity and sedentary behaviours and BMI?

3) *Interpersonal factors* and BMI:

   A. Does food availability at home have an impact on adolescents' BMI?

   B. Is this relationship (in 'A') mediated by adolescents' dietary behaviours?

   C. Does encouragement of activity from friends have an impact on adolescents' BMI?

D. Is this relationship (in ‘C’) mediated by adolescents’ physical activity?

4) *Socioeconomic status as a global factor:*

A. Is there a relationship between socioeconomic status and adolescents’ BMI?

1.5 Objectives

1) To assess the prevalence of overweight and obesity from a province-wide sample of adolescents in Alberta.

2) To assess the relationship between adolescents' eating behaviours, nutrition beliefs and attitudes, physical activity and sedentary behaviours*(individual factors)* and BMI.

3) To assess the relationship between adolescents' *interpersonal factors* and BMI; (including food available at home and friends' physical activity).

4) To assess the relationship between *socioeconomic status* and BMI.

1.6 Variables assessed

1) ***Individual factors*****:**

A. Adolescents' eating:

- Total caloric intake
- Grams from carbohydrates, protein and fat
- Diet quality
- Frequency of intake of unhealthy food

B. Nutrition beliefs and attitudes

- Questionnaire

C. Adolescents' physical activity:

- PAQ-C Score

D. Adolescents' sedentary behaviours:

- Hours of playing video games
- Hours of using computers
- Hours of watching TV

2) Interpersonal factors:

A. Food availability:

- Fruit and vegetables
- Milk
- Junk food
- Potatoes and salty snacks
- Chocolate
- Soft drinks

B. Encouragement of activity

- Questionnaire

3***) Socioeconomic status***

- Census data (median income) for school community

Chapter Two

Literature Review

Adolescence is a critical period of growth that has been defined as the time period between 13 and 17 years of age. It is also a transitional stage between childhood and adulthood. In this stage, physical, emotional, social and cognitive development is achieved (Brown & Isaacs, 2011). Adolescents experience significant changes in weight, height and body composition (Brown & Isaacs, 2011). During adolescence, up to 50% of ideal adult body weight is gained. In later puberty, girls may gain as much as 6.4 kg (Brown & Isaacs, 2011) including up to a 44% increase in lean body mass and a 120% increase in body fat. In contrast, boys experience a 12% decrease in body fat; and almost half of adult peak bone mass is accrued during puberty. By age 18, the body has developed to >90% of adult skeletal mass (Brown & Isaacs, 2011; Matkovic et al., 2004).

As discussed in chapter 1, adolescent obesity is an increasing problem that poses a serious risk to the well-being of youth. This public health problem is defined as a condition in which excessive fat accumulates to an extent that may impair health (World Health Organization, 2011). Overweight and obesity are most commonly caused by an energy imbalance between energy consumed and energy expended. Overweight and obesity can be caused by a lack of physical activity, and genetic susceptibility (Kushner &Bessesen, 2007), among other factors.

Many researchers have focused on individual-level factors such as motivation, knowledge and self-efficiency to understand dietary habits, exercise and obesity (Jelalian& Steele, 2008). This approach is somewhat limited in addressing the obesity problem because obesity is complex and is a result of interactions between behavioural and environmental factors (Figure 1).

2.1 Individual factors

2.1.1 Dietary intake

Diet plays a fundamental role in obesity. Eating a healthy diet helps people to maintain a healthy weight; whereas consuming a poor diet, which is high in fat, sugar and calories, can lead to overweight. The total number of calories that the human body needs to remain healthy is determined by many factors, such as weight, height, age, gender and activity level (Institute of Medicine 2005). The American Heart Association (AHA) (2011) recommends that, in youth, energy intake should be adequate to support growth and development and maintain a healthy body weight. The AHA also estimated the dietary energy requirement for females and males from 14 to 18 years, who have a sedentary lifestyle, to be 1800 and 2200 kcal per day respectively. In 2004, results from the Canadian Community Health Survey (CCHS) showed that Canadian adolescents have the highest caloric intake for any stage of the lifecycle, and that consumption declines after this age group. Also, the study showed that females and males (aged 12 to 19 years) consumed an average of 2,000 calories and 2,800 calories per day respectively. Similarly, results from the National Health and Nutrition

Examination Survey (NHANES) 2005-2006 demonstrated that females and males (aged 12 to 19 years) consumed 1906 calories and 2707 calories per day respectively (United States Department of Agriculture, 2008). Thus, youth in Canada and the United States consumed energy intakes, on average, higher than the AHA recommendation.

Regarding macronutrient intakes, health officials in Canada and the United States have adopted "acceptable macronutrient distribution ranges" (AMDR) (Institute of Medicine (IOM), 2005; Garriguet, 2006). The AMDR for carbohydrates is 45% to 65% of daily caloric intake. The CCHS reported that on average, Canadian adolescents consumed 55.4% of their calories from carbohydrates as their main source of energy (Garriguet, 2006). The NHANES showed that on average females and males consumed 53.6% and 52.7% of their calories from carbohydrates respectively (United States Department of Agriculture, 2008).

Moreover, the AMDR for fat is 25% to 35% of calories for youth. Canadian females and males aged between 14 and 18 consumed 28.7% and 27.1% of their calories from fat per day respectively (Garriguet, 2006). Whereas, the NHANES showed that on average females and males aged 12 to 19 consumed 33.4% and 33.1% of their calories from fat respectively (United States Department of Agriculture, 2008).

According to the IOM (2005), 10% to 30% of daily energy intake should come from protein sources. The CCHS reported that Canadian children and youth

aged 4 to 18 consumed on average 14.7% of total calories from protein. The NHANES showed that on average females and males consumed 14.6% and 13.7% of their calories from protein respectively (United States Department of Agriculture, 2008). Thus, food consumption of Canadian youth is within the acceptable ranges; however, this does not mean that all youth are eating a healthy balanced diet (Garriguet, 2006). A healthy diet can be achieved by following Canada's Food Guide.

In 1942, Canada's first food guide, which was called Canada's Official Food Rules, was introduced by the federal health department. Since then, the food guide has been transformed many times, but the original purpose of guiding food selection and promoting healthy eating is still the same. The last version of the food guide was released in 2007 and was called "Eating Well with Canada's Food Guide". This guide recommends that females and males from 14 to 18 years consume 1700-1800 and 2250-2500 kcal per day respectively. The food guide is divided into four food groups (Health Canada, 2007).

The first food group is meat and alternatives. For this food group youth are recommended to eat 2 servings (for females) and 3 servings (for males) (Health Canada, 2007). Based on the CCHS data, females consumed less meat than males (at all ages); almost no female ate more than 300 grams of meat per day. In contrast, at least 200 grams of meat per day were consumed by males aged 14 to 70 and approximately one in four males ate more than 300 grams of meat per daywhich is about approximately 4 servings(Garriguet, 2006). In 2009, a study was conducted to investigate the association between meat consumption and BMI.

This study concluded that adults who ate more meat consumed on average, an additional 700 kcal per day. The study also reported a positive relationship between meat consumption and BMI, waist circumference, obesity and central obesity (Wang &Beydoun, 2009).

The second food group is milk and alternatives. The food guide recommends that youth from 14 to 18 years of age consume 3-4 servings per day of milk and milk alternatives (Health Canada, 2007). In Canada, 61% of males and 83% of females aged 10 to 16 did not meet the minimum recommendation for this food group of three servings of milk products per day (Garriguet, 2006). In 2002, a study investigated the association between dairy consumption and insulin resistance syndrome (IRS), including obesity, glucose intolerance, hypertension, and dyslipidemia, and found a negative association between dairy consumption and IRS (Pereira et al., 2002).

The third food group is grain products. It is recommended that females and males aged 14 to 18 years eat 6 and 7 servings per day respectively (Health Canada, 2007). In addition, the food guide suggests choosing whole grain products, for at least half of the servings such as barley, brown rice, wild rice, whole-wheat pasta and whole grain bread. In 2003, a study examined the association between high-fiber whole-grain or refined-grain and weight gain over time. The study demonstrated that weight gain was positively associated with refined-grain consumption, and, inversely associated with high-fiber, whole-grain consumption (Liu et al., 2003). Moreover, the CCHS showed that Canadian girls are less likely to meet the recommendation for grain products compared to

Canadian boys. In 2004, 33% of females compared to 6% of males aged 14 to 18 ate fewer than five servings of grain products per day (Garriguet, 2006).

The fourth food group is the vegetables and fruit group. The food guide recommends that females aged 14 to 18 years eat 7 servings per day from this group; the recommendation for males from 14 to 18 years is to eat 8 servings per day. According to the 2004 CCHS, fewer than five servings of fruit and vegetables were consumed by the majority of Canadians, which is lower than the recommendation for all ages (Garriguet, 2006). He et al. (2004) suggested that long-term risk of weight gain and obesity might be reduced by increasing fruit and vegetable consumption. The mechanisms for this relationship are not clear. However, dietary fiber in fruits and vegetables may regulate satiety. Also, the low energy density of fruits and vegetables may be responsible for an overall reduction in energy intake (He et al., 2004).

Overall, Canadian adolescents are not eating the number of servings that Canada's Food Guide recommends. In 2010, a study of three communities in northern Quebec reported that 95% of adolescents aged 9 to 18 years had a lower consumption of milk and milk products, and 65% had a lower consumption of fruit and vegetables than what is recommended by Canada's Food Guide (Khalil, Johnson-Down&Egeland, 2010). According to Jennings, Welch, Sluijs, Griffin and Cassidy (2011), diet quality was inversely associated with childhood weight status; BMI was significantly lower when diet quality was high.

2.1.1.1 Snacking

In the United States, the prevalence of snacking has increased among youth (Jahns et al., 2001). Between 1977 and 1996 the frequency of snacking changed significantly among adolescents aged 12 to 18, increasing from 1.60 to 1.97 snacks/day. This trend resulted in an increase in average daily energy intake from snacks from 460 to 612 kcal/day (Moreno et al., 2010). In 2003, a study characterized whole grain consumption among 4,802 U.S. children between the ages of 2 and 18 years. The study demonstrated that snacks are an important source of essential nutrients in this age group and whole grains are commonly consumed in typical snack items such ascorn and other chips, popcorn, crackers and granola bars (Harnack, Walters & Jacobs, 2003),

A snack is food or beverage consumed between meals that can be defined as eating episodes, generally smaller and less structured than "meals" (Garriguet, 2006; Gatenby, 1997). Snacks may have low nutritional value; nevertheless, snacking does not appear to be an important factor for determining weight gain among adolescents according to some researchers. (Phillips et al., 2004; Field et al., 2004; Francis et al., 2003). Other researchers however, report that snacks can have a negative or positive effect on the diets of youth, depending on their timing and composition. Snacks that are poorly timed (e.g. consumed one hour before a meal) and low in nutrients and high in calories (junk food) can suppress the appetite for meals, so nutritious foods that the body needs for growth and development are being replaced (Cusatis& Shannon, 1996; Lifshitz, Tarim& Smith, 1993; Spear, 2002).

In some individuals, snacking might improve bodyweight control by controlling appetite and helping to prevent overeating at meals (Kirk, 2000).According to Rodriguez and Moreno (2006), the relationship between total energy intake, snacking and body fatness is not clear. A Canadian study reported that adolescents aged 14 to 18 consumed the highest proportion of snacks of any other age group, and that snacks accounted for 30% of total daily energy intake for males and 28% of total energy intake for females (Garriguet, 2006). Despite this slight difference in energy intake from snacks between males and females, the United States national nutrition data indicated that more than 85% of adolescent females consumed snacks (Jahns, Siega-Riz&Popkin, 2001).

2.1.1.2 Sugar-sweetened beverages

Sugar-sweetened beverages (SSB) are beverages that have little or no nutritional value and provide most or all of their calories from refined carbohydrate; they include non-diet sodas, fruit drinks, sports drinks and iced teas (Wiecha, Finkelstein, Troped, Fragala& Peterson, 2006). Sugar-sweetened beverages may contribute to obesity and overweight. This contribution might occur because the SSB have a low satiety value, high sugar content and extra energy (Malik, Schulze & Hu, 2006). Sugar sweetened beverages may also lead to additional energy intake because of their high glycemic index (GI) (Ludwig, 2002). Sugar-sweetened beverage consumption in the United States has increased among children and adolescents aged 2 to 18 years from 4.8% to 10.3% of total energy between 1977- 1978 and 1999-2000 (Nielsen et al., 2004; Moreno et al., 2010). Between 2001 and 2009, fourteen cohort studies investigated the

relationship between soft drink consumption and body weight among children and youth. Seven of these studies found a significant positive relationship between soft drink intake and weight status (Libuda&Kersting, 2009). The other studies, which did not find a significant relationship, investigated younger children, mean soft drink intake was low, or the studies had smaller sample sizes (Libuda&Kersting, 2009).

Another large prospective research study investigated 11,654 adolescents aged 9 to 14 years to examine the association between soft drink consumption and body weight. The study reported that each SSB consumed (12-oz serving) predicted a 3% increase in BMI for females and a 4% increase in BMI for males over 3 years (potential confounders were adjusted for). Females gained 0.07 kg/m^2 for each SSB serving added and 0.10 kg/m^2 for 2 or more servings; whereas males gained 0.10 kg/m^2 for each SSB serving and 0.14 kg/m^2 for 2 or more servings (Berkey, Rockett, Field, Gillman &Colditz, 2004).

Increases in consumption of sweetened beverages, occurred at the same time as a reduction in water and milk consumption (Neilson &Popkin, 2004). Changes in intakes of all beverages were evaluated from 1977-2001. The study found that SSB consumption increased by 135%, milk consumption decreased by 38% and total energy intake increased on average by 278 kcal per day across all age groups. Moreover, change in beverage consumption was highest in the home, followed by restaurants (Neilson &Popkin, 2004).

Another dietary factor that could explain the association between body weight and soft drink consumption is the GI. Sugar-sweetened beverages are considered to have a high GI, which has been shown to cause increased postprandial blood glucose concentrations and overstimulation of appetite, decreased satiety level and it may lead to overeating, particularly in youth. Conversely, consumption of low-GI beverages have been shown to delay hunger (Björck, Granfeldt, Liljeberg, Tovar, & Asp, 1994; Harrington, 2008).

2.1.1.3 Fast food

Fast food can be defined as "packaged foods, sold at a counter, at relatively low prices, that can be consumed in place or taken away" (Fantasia, 1995).Fast food generally has a negative impact on diet quality. This impact depends upon the frequency of visits to fast food outlets and the food choices made (Bowman, Gortmaker, Ebbeling, Pereira & Ludwig, 2004; Ebbeling et al., 2004; Kleinman& American Academy of Pediatrics, 2009). In 2004, researchers in the United States assessed the association between fast food consumption and diet quality. This study reported that 30.3% of 6212 children and adolescents were consuming fast food on a typical day. Furthermore, youth who consumed fast food had a higher total energy intake (by 187 kcal/day), than youth who did not consume fast food. These foods contributed an extra 57 kcal/day (187 kcal ×30.3%) to the average youth in the United States. This increase in energy intake theoretically could account for an extra 6 pounds (2.73 kg) of weight gain per year. Assuming that energy expenditure does not change; every additional 3500 kcal will lead to an increase of 1 pound (0.46 kg) in body weight. In addition,

children and adolescents who consumed fast food on a daily basis, also consumed more SSBs, more total carbohydrate and added sugar, more total and saturated fat, less fiber, fewer fruits and nonstarchy vegetables, and less milk compared to children and adolescents who did not eat fast food (Bowman, Gortmaker, Ebbeling, Pereira & Ludwig, 2004).

Three studies investigated the relationship between fast food consumption and obesity, and it was concluded that there is a significant effect of fast food consumption on weight gain (Niemeier et al., 2006; Taveras et al., 2005; Thompson et al., 2004). Fast food may lead to obesity as a result of several dietary factors such as high energy density, large portion sizes, high content of trans and saturated fat, low fiber and high glycaemic load (French et al., 2001). In the Eat project (Eating Among Teens), youth who reported consuming food at fast food outlets more than three times per week had higher total energy intake by almost 40% compared to youth who did not consume fast food. Fat content may explain this increase in energy intake because 50% of calories are from fat in many foods prepared in fast food outlets (French, Story, Neumark-Sztainer, Fulkerson &Hannan, 2001; Spear, 2002).

People are consuming more fast food for a number of reasons, including reduced fast food prices, limited time for food preparation, and increased access to fast food outlets (Mehta &Chang, 2008; Moreno et al., 2010). Also, the 2004 CCHS reported that a quarter of Canadians consumed some food item that was prepared in a fast food outlet on the day before their interview. One-third of youth

aged 14 to 18 years had some food item prepared in a fast food outlet (Garriguet, 2006).

2.1.2 Nutrition knowledge, attitudes and beliefs

Increasing nutrition knowledge among youth may have an impact on preventing overweight. An increased level of nutrition knowledge among adolescents may not directly influence their dietary habits per se, but it provides them with the skills and ability to choose a nutritious diet (Frobisher, Jepson& Maxwell, 2005).

Findings related to nutrition knowledge have been inconsistent, with some studies reporting a relationship between nutrition knowledge and eating behaviours and other studies reporting no relationship. Story &Resnick (1986) reported that overall, adolescents had correct nutrition knowledge; nonetheless, they did not consume a healthy balanced diet. Frobisher et al. (2005) also found that there was no association between nutrition knowledge and eating behaviours. These findings support the idea that providing the correct nutrition knowledge does not necessarily lead to healthier food choices (Frobisher et al., 2005).

Some researchers reported contrasting results. Pirouznia (2001) found that females in the seventh and eighth grade had higher nutrition knowledge than boys in the same grades. Pirouznia also reported that there was a positive correlation between nutrition knowledge and healthy eating behaviours and food choices. Additionally, a study from England showed a significant positive association between nutrition knowledge and healthy eating (Wardle, Parmenter& Waller,

2000). The same study demonstrated that participants in the highest quintile for nutrition knowledge were almost 25 times more likely to meet the recommendations for fat intake and fruit and vegetable intake than participants in the lowest quintile (Wardle et al., 2000). In 2009, similar results were observed from another study targeting university students, which found that students with higher nutritional knowledge were 20 times more likely to consume a healthy diet that met the current recommendations, compared to students with lower nutrition knowledge (Kresić, Kendel, Pavicić, Cvijanović&Ivezić, 2009).

In 2006, Davy, Benes & Driskell reported that females had stronger nutrition beliefs compared to males. Davy, Benes & Driskell also stated that participants who wanted to lose weight consumed less sweets and believed that they should limit such food even more.Youth should be taught nutrition information and skills during childhood, because it is at that time when eating and lifestyle habits are being established (Frobisher et al., 2005).

2.1.3 Physical activity

It is well known that obesity can be caused by an imbalance between energy intake and energy expenditure. Energy expenditure can be divided into three different components: basal metabolic rate (BMR) or resting metabolic rate (RMR), thermic effect of food (TEF), and physical activity (PA) (Pařízková& Hills, 2005; Driskell&Wolinsky, 2009).

The BMR is the minimum amount of energy that a body needs under conditions of quiet sleep when lying at physiological and mental rest. It is the

energy that the body requires while sitting or lying down. Resting metabolic rate accounts for 60% to 75% of total daily energy expenditure. The body uses this energy for maintenance of general body functions such as breathing, circulation and brain activity. The RMR is mostly determined by skeletal muscle mass, which requires a substantial amount of energy for processes such as ionic regulation, heat generation and protein synthesis (Driskell&Wolinsky, 2009). The RMR can be increased by engaging in strength training activities to maximize the lean body mass. Resting metabolic rate is influenced by other factors such as growth; and it is higher for children, youth and pregnant women. Also, stress, fever and high thyroid activity increases RMR. In contrast, fasting, malnutrition and loss of lean body mass lowers RMR (Whitney &Rolfes, 2008).

The thermic effect of food is the amount of energy utilized in the digestion, absorption, transport and storage of nutrients; TEF depends generally on energy intake and on the macronutrient composition of the meal. The TEF is usually estimated as 5-10% of total daily energy expenditure, because it is difficult to measure reliably in humans. Diets which are high in protein may result in a TEF higher than 10%; while diets which are high in fat require less energy. The TEF is the lowest contributor to total daily energy expenditure, even with these slight differences (Driskell&Wolinsky, 2009).

Physical activity is the component of energy expenditure attributed to voluntary movement; it is the most modifiable component of total energy expenditure (Pařízková& Hills, 2005). On average, PA accounts for 15 to 30% of total daily energy expenditure but it can vary more in very active people

(Driskell&Wolinsky, 2009). During physical activity, extra energy is needed for muscular work, delivery of oxygen and nutrients, and for waste disposal (Whitney &Rolfes, 2008). The amount of energy the body needs to carry out any activity depends on three components: body weight, muscle mass and the activity itself. The larger the body weight and the greater the muscle mass, the more energy is expended to move. Rates of energy expenditure during activity also vary depending on duration, intensity and frequency of the activity. The longer, more frequent and more intense the activity the more calories are expended (Whitney &Rolfes, 2008)

2.1.3.1 Duration of physical activity

The duration of the activity will determine whether the fuel used will be mostly carbohydrate or fat. The longer the time spent exercising, the more fat is used as fuel. Fat can provide 60% to 70% of the energy needed to perform moderate to intense activity that can last 4 to 6 hours (Berning& Steen, 2006). Muscle glycogen is the preferable fuel for most types of exercise. However, there is a limited supply of stored glycogen. Therefore, when stored glycogen is low, fat lipolysis increases to supply most of the energy needed for exercise. This is not an immediate process and it takes approximately twenty minutes for fat to be readily available for muscle use as fuel in the form of free fatty acids (Berning& Steen, 2006). According to Jakicicet al. (2001), weight gain can be prevented by exercising at moderate intensity between 150 and 250 minutes per week, but this will provide only modest weight loss. Moreover, there is a significant association between weight loss and exercising more than 250 minutes per week.

2.1.3.2 Intensity of physical activity

The research group at the Medical College of Georgia conducted a study in 2002 to examine the effects of exercise intensity on IRS. Obese youth aged 13 to 16 years were randomly assigned to either a moderate-intensity exercise group whose heart rate average was 138 bpm during exercise, or a high-intensity exercise group whose heart rate average was 154 bpm during exercise. This study showed little evidence that high-intensity exercise was more effective in enhancing metabolic health outcomes compared to moderate-intensity exercise (Kang et al., 2002). Furthermore, another study examined the relationship between PA intensity and body fat of 780 children. The study suggested that higher levels of high-intensity exercise were associated with lower body fat; but this was not the case for moderate-intensity exercise. Also, children who engaged in high-intensity exercise more than forty minutes per day, had lower body fat compared to children who engaged in high-intensity exercise ten to eighteen minutes per day. This study concluded that high-intensity exercise has a greater benefit for treating and preventing overweight (Ruiz et al., 2006).

2.1.3.3 Frequency of physical activity

Wilmore, Costill& Kenney (2008) suggest that frequency of exercise is an important factor, but is less critical than the duration and intensity of exercise. Exercising for three to five times per week is an optimal goal and many health benefits can be achieved. However, exercising everyday is more beneficial. But inactive people, who are starting to be active, should not exceed four times per

week. They may increase physical activity to five times or more if exercise is physically tolerated and enjoyable (Wilmore, Costill& Kenney, 2008).

2.1.3.4 Obesity and physical activity

Lack of physical activity is particularly fundamental in the pathogenesis of overweight (Bray, 2011). In 2010, it was observed that increases in BMI were associated with a reduction in sports participation and time spent in physical education (Haerens, Vereecken, Maes& De, 2010). Although increasing physical activity is vital to increasing total daily energy expenditure, it has also been shown to help preserve lean body mass in situations such as dieting (Williams, Stefanick, Vranizan& Wood, 1994). Furthermore, physical activity stimulates the loss of adipose tissue by enhancing the body's ability to utilize fat (Racette, Schoeller, Kushner, Neil &Herling-Iaffaldano, 1995).Exercise can promote healthy eating behaviours by decreasing anxiety, stress, and depression, which can trigger overeating (Racette, Schoeller, Kushner & Neil, 1995). Also, Wu, Gao, Chen and Van (2009) suggest that a combination of diet and exercise will lead to greater weight loss than following a restrictive diet or exercise plan alone. According to Bagchi and Preuss (2007), a significant decrease in metabolic rate can occur as a result of an extreme calorie restricted diet; this reduction in metabolic rate can persist after the diet period ends, which can lead to rapid weight regain.

2.1.3.5 Barriers to physical activity

Girls and boys experience different barriers to exercising. There are some intrapersonal barriers that can influence physical activity. One of these obstacles is discomfort, which was listed as a barrier to physical activity by girls. Discomfort includes sweating, being tired, being out of breath and being embarrassed (Grieser, Vu, Bedimo-Rung, Neumark-Sztainer, Moody, Young & Moe, 2006). Moreover, cost, safety and accessibility to exercise facilities were other barriers to physical activity (Hohepa, Schofield &Kolt, 2006). Lack of time is a key barrier to exercising. Adolescents reported that they do not have enough time to exercise because of their homework or part-time jobs (Dwyer, Allison, Goldenberg, Fein, Yoshida &Boutilier, 2006). Furthermore, girls reported that menstrual cycles are a barrier to being active (Dwyer et al., 2006). Some interpersonal obstacles which may affect physical activity include lack of peer support, having a friend who is inactive and having family obligations (Dwyer et al., 2006;Hohepa, Schofield &Kolt, 2006). Bad weather conditions were also listed as a barrier to physical activity (Dwyer et al., 2006).

2.1.3.6 Physical activity guidelines

In 1998, Health Canada and the Canadian Society for Exercise Physiology released Canada's first physical activity guide to healthy living. This guide recommended that adults be active for at least 60 minutes per day, most days of the week (Public Health Agency of Canada & Canadian Society for Exercise Physiology, 1998). In 2002, Canada's Physical Activity Guidelines for Children

and Youth were released. The guide recommended that youth should participate in moderate to vigorous physical activity 30 minutes per day, with a gradual progression to 90 minutes per day in approximately 5 months, and to decrease non-active time. The guide also suggests that more than 90 minutes of physical activity per day can increase health benefits (Health Canada, 2002). However, recent systematic reviews did not support this recommendation (Janssen & LeBlanc, 2010); therefore, a recent guideline was released in 2011 that recommended that youth aged 12- 17 should exercise for at least 60 minutes everyday at moderate or high intensity. This should include at least 3 days per week of high intensity physical activity. The guide also recommended that youth engage in activities that strengthen muscle and bone for at least 3 days per week. Additionally, the guide suggested that the more time spent on physical activity will result in more health benefits (Canadian Society for Exercise Physiology, 2011).

2.1.4 Sedentary behaviours

A sedentary lifestyle has been associated with overweight among youth (Rennie, Johnson &Jebb, 2005). Measuring inactive behaviour can be a challenge for researchers because of the nature of these behaviours and the wide range of activities such as watching TV, playing video games, using computers, sitting in classrooms, talking on the phone and reading books (Tremblay, Esliger, Tremblay & Colley, 2007). In the United States, 26% of children aged 8 to 16 years, watched TV for 4 hours or more per day, and 67% watched TV at least 2 hours per day (Andersen, Crespo, Bartlett, Cheskin& Pratt, 1998, pp.938-942). In 2011,

a Canadian study measured the sedentary behaviours and physical activity levels of children and youth between 6 and 19 years of age. This study concluded that Canadian children and adolescents devoted, on average, 8.6 hours per day to sedentary time, which was considered to be 62% of their waking time. Also, this study reported that as age increases sedentary time increases as well. Additionally, children and youth spent another four hours per day in light-intensity activity (Colley, Garriguet, Janssen, Craig, Clarke & Tremblay, 2011).

2.1.4.1 Sedentary behaviours and obesity

A cross-sectional study showed that there was a positive association between sedentary behaviours and BMI. It also indicated that as the number of hours spent watching TV increased, overweight also increased (Hancox&Poulton, 2006).

Robinson (2001) proposed four different mechanisms to explain the relationship between TV viewing and body weight. The first explanation was that watching TV reduces resting energy expenditure. In 1993, Klesges, Shelton &Klesges (1993) studied the effect of watching TV on resting energy expenditure and concluded that TV watching lowers resting energy expenditure among obese and non-obese children. According to Grund, Krause, Siewers, Rieckert& Müller (2001), non-overweight and overweight youth experience a 13.3% reduction in the resting energy expenditure while watching TV. This reduction decreases total energy expenditure by 0.4% to 1.1%, which was considered to be less than the variation that a person can experience from day to day. Thus, it is unlikely to lead

to a significant energy imbalance. Furthermore, Dietz, Bandini&Morelli (1994) reported that there was no significant difference between resting energy expenditure for overweight and non-overweight children measured while viewing TV, sitting quietly or reading. Similarly, Buchowski& Sun (1996) measured the resting energy expenditure for obese and non-obese adults and did not detect any differences between groups for watching TV, sitting or other sedentary behaviors.

Secondly, Robinson (2001) hypothesized that watching TV might be displacing physical activity that can influence total energy expenditure. However, studies have shown inconsistent results. Some studies have reported a weak but statistically significant association (DuRant, Baranowski, Johnson & Thompson, 1994; Robinson et al., 1993) while other studies have reported no significant association (Neumark-Sztainer, Story, Hannan, Tharp & Rex, 2003) Also, an experimental study which required obese children to decrease their sedentary activity, concluded that decreasing sedentary behaviours led to an increase in physical activity level (Epstein, Saelens, Myers & Vito, 1997). Overall, these studies propose a weak association between watching TV and physical activity and that sedentary behaviour is an independent factor that influences youth weight.

Thirdly, eating while watching TV can result in a higher energy intake. An earlier study in 1989 proposed that although the majority of children consumed meals and snacks while watching TV, only snacking was associated with higher energy intake (Taras, H. L., Sallis, J. F., Patterson, T. L., Nader, P. R., & Nelson, 1989). In addition, Grund et al., (2001) observed that more fast food and sweets

were consumed by children who spent more time watching TV. In 2006, researchers demonstrated that watching TV while eating increased the consumption of high-density-food, which may lead to overweight (Blass et al., 2006). Another study investigated the association between meals consumed while watching TV and food consumed by children. The authors reported that children from families who watched TV while eating, consumed more pizza, snack food, soft drinks and red meat; they also consumed fewer fruits and vegetables (Coon, Goldberg, Rogers & Tucker, 2001).

Fourth, food advertising on TV may lead to increased dietary intake (Robinson, 2001). In 2008, researchers explored the association between food advertisement and children's food intake. They reported that children who were exposed to food advertisements, while watching TV, consumed higher total caloric intake. Furthermore, those children consumed more high-fat and high-sugar foods that were advertised on TV (Halford, Boyland, Hughes, Stacey, McKean &Dovey, 2008). Higher rates of obesity and overweight have been associated with children who have had greater exposure to food advertisements compared to those who had less exposure to food advertisements (Nestle, 2006).

Using a computer and playing video games are additional sedentary behaviours that may contribute to weight gain. In 2008, a randomized controlled clinical trial was conducted in the United States to investigate the influence of reducing time spent watching TV and using a computer on children's BMI. The study demonstrated that a reduction in TV watching and computer use was significantly associated with a decrease in BMI for children whose BMI was at or

greater than the 75th percentile for their age and sex (Epstein et al., 2008). Stettler, Signer and Suter (2004) also investigated the effect of video games on obesity. They also reported a relationship between playing video games and obesity during childhood. Other studies have found that the association between electronic games and obesity is weaker than the association between TV and obesity. They suggest that the absence of food advertising in these electronic games might explain the weak association (Kautiainen, Koivusilta, Lintonen, Virtanen &Rimpela, 2005; Stettler, Signer &Suter, 2004).

2.1.4.2 Sedentary behaviour guidelines

In 2011, the Canadian Society for Exercise Physiology, in partnership with Healthy Active Living and the Obesity Research Group released the first Canadian Sedentary Behaviour Guidelines for Children and Youth (Tremblay et al., 2011). This guide is based on scientific evidence from systematic reviews. The guide suggests that children and youth should limit the time spent on sedentary behaviours such as watching TV, playing videogames and using computers; and that time spent on these activities should not exceed 2 hours per day. As well, youth should limit the use of motorized transportation, and limit long periods of sitting and indoor time (Tremblay et al., 2011).

2.2 Interpersonal factors

Health related behaviours are influenced by relationships with family, friends, neighbours and colleagues (McLeroy, Bibeau, Steckler&Glanz, 1988). Adolescents' body weight is highly influenced by their parents and friends. They

may affect adolescents through promoting healthy or unhealthy eating behaviours, physical activity or inactivity and sedentary behaviours (Heinberg, Thompson & American Psychological Association, 2009). Furthermore, adolescents adopt behaviours and beliefs that are practiced by their friends so they feel acceptance (Paxton, Schutz, Wertheim & Muir, 1999). These relationships are important aspects of social identity which provide emotional support, information, access to new social contacts and assistance in fulfilling personal obligations and responsibilities (McLeroy et al., 1988). For the purpose of this thesis food availability at home and encouragement of activity were investigated.

2.2.1 Food availability

Adolescents' food environment is highly influenced by the food environment in the home (Baranowski, Cullen, Nicklas, Thompson &Baranowski, 2003). Several studies have investigated the relationship between home food environment and dietary behaviours. Parents influence their children's dietary behaviours by controlling food availability and accessibility (Golan & Crow, 2004). Furthermore, parents concerns and perceptions about healthy eating and healthy body weight affect the food availability at home. According to MacFarlane, Crawford &Worsley (2010), cakes, salty snacks, chocolate and hard candies were never available in the homes of adolescents whose parents were concerned about their weight status. In addition, children of mothers who believed that fruit and vegetable consumption could prevent disease were consuming more fruit and vegetables (Gibson, Wardle & Watts, 1998).

Adolescents' food preferences are learned through frequent exposure to foods (Birch, 1999). Therefore, youth tend to eat and prefer food that is served frequently, and is readily available and acceptable in their homes (Golan & Scott, 2004). Fruit juice and vegetable availability and accessibility accounted for 35% of the variability in the consumption of these items amongst elementary school girls (Johnson & Birch, 1994). Also, the availability of fruit and vegetables was associated with *intake* of fruit and vegetables among adolescents (Ding et al., 2011).

In 2011, researchers investigated the relationship between the home environment and soft drink consumption by youth. They found that there was a significant relationship between soft drink availability at home and soft drink consumption. Increased consumption of soft drinks can contribute to weight gain, as discussed previously. The study also reported that parental rules, regarding the limiting of soft drinks, was significantly associated with reduced soft drink consumption (Tak, et al., 2011).

Food choice is characterized by a balanced influence between parents and friends. At home, parents influence food choice, and outside the home food choice is influenced by peers (Risvas, Panagiotakos&Zampelas, 2008).

2.2.2 Encouragement of activity

Many studies have shown that peers and family have a great influence on adolescents' physical activity. Allison, Dwyer, Goldenberg, Fein, Yoshida &Boutilier (2005) demonstrated that support of friends and family was one of the

factors that encouraged physical activity. A study of girls in the sixth and eighth grade showed that different factors are associated with increased levels of physical activity, such as joining a sports team with peers, asking a friend to be active with them and exercising with a peer (Voorhees et al., 2005). As well, Smith & Biddle (2008) stated that a best friend has a great influence on youth physical activity. Friends' physical activity level was significantly associated with young people's physical activity when the friendship was emotionally supported (Vilhjalmsson&Thorlindsson, 1998). King, Tergerson& Wilson (2008) reported that adolescents exercised vigorously more days per week when their friend was engaged in physical activity, compared with adolescents who did not have a friend who exercised.

Parental encouragement of activity is another important factor that affects physical activity. King, Tergerson& Wilson (2008) showed that youth reported higher physical activity levels for both vigorous and moderate physical activity when they had parents who encouraged them to exercise, compared to those who did not have parental support. Moreover, in 2008 a longitudinal study reported that younger females had decreased screen time when their mothers encouraged them to be active. Same-sex parents have a significant effect on the physical activity of youth; therefore, paternal encouragement of activity was associated with increased level of moderate and vigorous physical activity among males, and maternal encouragement of activity was associated with females' physical activity (Bauer, Nelson, Boutelle&Neumark-Sztainer, 2008).

2.3 Socioeconomic status:

Socioeconomic status influences an individual's food choice, which may lead to obesity. People with low income consume meals in fast food restaurants more often than those with high income, because fast food outlets offer the lowest-cost option to consumers (Drewnowski& Specter, 2004). Powell, Auld, Chaloupka, O'Malley & Johnston (2007) reported that the price of a fast food meal is an important determinant of obesity; adolescents' BMI is lower when fast food is more expensive (Powell et al., 2007). Fast food outlets offer high energy density, high sugar and high fat meals that are associated with higher energy intakes (Drewnowski& Specter, 2004). In addition, fast food restaurants are located in areas with higher traffic and population density in order to attract a higher number of customers; and low SES is associated with these conditions (Reidpath, Burns, Garrard, Mahoney & Townsend, 2002). People from the lowest SES category were 2.5 times more exposed to fast food outlets than people from the highest SES category (Reidpath et al., 2002). This makes them more likely to consume their meals in fast food outlets.

Additionally, Ding et al. (2011) reported that family income is one of the strongest predictors of the availability of healthy food at home. People with higher income can afford to buy expensive food such as fruit and vegetables, compared to people with limited income who cannot afford them as often (Ding et al., 2011; Rasmussen, Krølner, Klepp, Lytle, Brug, Bere& Due, 2006).

People living with limited income struggle to fulfill their basic needs, and healthy food might not be affordable. Moreover, parents with low SES might work long hours and they may not have enough time to buy groceries and prepare meals at home (Welk, Styne, Gerstein, Crawford& Ritchie, 2005, pp. 70-79). Fast food corporations spend billions of dollars every year on advertising to make their brand well-known and most of the advertising focuses on the fact that fast food is less time-consuming and is an alternative to cooking food at home (Hemphill, Raine, Spence &Smoyer-Tomic, 2008). Furthermore, individuals with low SES are less mobile than others, because of economic constraints that can make it difficult to own a vehicle, and public transportation is often out of reach. As a result, people are reliant on food sources located near to their home (Hemphill et al., 2008). As mentioned previously, low SES neighbourhoods are 2.5 times more exposed to fast food outlets than high SES neighbourhoods (Hemphill et al., 2008). Also, large grocery stores have been moving away from poorer areas to wealthier outlying areas (Hemphill et al., 2008).

Socioeconomic status not only affects food sources and dietary intake, but differences in physical activity level may also exist as a result of socioeconomic situation. As discussed, parental encouragement of activity plays a vital role in increasing physical activity. This encouragement can take different forms. In a study by Brockman et al., people with low SES verbally encouraged their children to be active. However, people from middle or high SES encouraged their children to be active by participating in the activity, modelling activity and providing financial support for activities (Brockman, Jago, Fox, Thompson, Cartwright &

Page, 2009). Similarly, parents of children from low SES schools have lower participation in family-based activity compared to parents of children from middle and high SES schools. All SES groups listed time constraints as a barrier to participating in family-based activity; nevertheless, cost was a barrier only for the low SES group (Brockman, et al., 2009). Also, children from middle or high SES schools reported participating more in organized activities and sports clubs than children from low SES schools, who reported engaging in more unstructured activities with friends (Brockman et al., 2009).

2.4 Web-based survey methodology

Web-survey methods provide opportunities to survey large numbers of participants in different geographic locations and they can be less expensive than other methods. Also, web-surveys can improve the ability to obtain a representative sample by enhancing access to hard-to-reach areas (Eaton & Struthers, 2002). In 2002, Robinson and colleagues reported that when collecting data on health behaviours, by using a computer, 94% of 98 youth aged 12 to 18 years stated that answering a questionnaire using a computer was “easy”, and 72% found the computer-based assessment was either “somewhat cool” or “very cool”. No participants stated that using the computer was difficult (Robinson et al., 2002).

In Alberta, 429 communities throughout the province were provided with high-speed internet (SuperNet) service to thousands of facilities such as government offices, schools, health care facilities and libraries (Government of

Alberta, 2002). This implementation influenced adolescents to use computers and internet technology. In 2010, the Household Internet Use Survey demonstrated that Alberta had the second highest rate of internet usage in Canada, with 83% of households connected to the internet (Statistics Canada, 2010). In addition, 80% of Canadians used the Internet for personal reasons in 2009 (Statistics Canada, 2010). This high rate suggests that web-survey assessment offers a cost effective approach for collecting health related information (Marcus et al. 2000).

Errors and bias resulting from discrepancy of survey administration, interviewer interpretation, and data entry is reduced using web-based assessment. The participants' interactions with the survey are standardized; therefore, interviewer bias is eliminated. Moreover, errors from manual data entry (e.g. from paper-based questionnaires) are eliminated with the automatic data entry that occurs when the survey is completed (Rhodes, Bowie &Hergenrather, 2003). Additionally, web-based nutrition and physical activity interventions have been used by other researchers (Napolitano et al. 2003, McKay et al 2001, Oenema, 2001).

The prevalence of obesity in adolescents has dramatically increased in the last few decades; and as dietary intake increases and physical activity decreases the obesity rates will continue to rise. However, the obesity epidemic is not a simple problem and overweight and obesity in adolescents is caused by a set of complex factors from different contexts that interact with each other. The focus of this thesis research was to examine the potential individual and interpersonal

factors that are associated with adolescents increased risk of overweight and obesity.

Chapter Three

Experimental Design and Methodology

3.1 Ethical approval

The present study received ethical approval from the Human Research Ethics Board for the Faculty of Agricultural, Life and Environmental Sciences, and the Cooperative Activities Program Faculty of Education, at University of Alberta (Appendix A). Ethical approval was also received from some school boards that had their own ethics committees. A signed consent form was obtained from each participant's parent or legal guardian (see all ethics forms in Appendix A).

3.2 Study design

The present study was conducted at the University of Alberta, Department of Agricultural, Food and Nutritional Science. The study was a cross-sectional survey design. The Web-Survey of Physical Activity and Nutrition 2 (Web-SPAN 2) was a self-administered web-based survey of grade 7 to 10 students aged 11 to 17 years. The study was designed to assess nutrition, physical activity and related meal behaviours; and data collection occurred when school was in session throughout 2008. Of note, Web-SPAN 1 was carried out in 2005.

3.3 Participant recruitment

Schools were randomly selected to participate in the study from a list of all schools in the province after the following exclusion criteria was considered. Schools that were excluded were:

- Special education schools
- English as a second language schools
- Colony schools (no computers)
- Adult education schools
- Distance education schools, home schools, or virtual schools
- Schools in correctional facilities

The school boards of the randomized schools were then approached to obtain their approval prior to making direct contact with the schools. School boards and schools were individually contacted by mail and then a follow-up telephone call was made to request participation. School board superintendents and school principals provided verbal consent for the study. School administration selected teachers to facilitate the web-survey. Those teachers then received an information package by mail that included Parents and Students information letters outlining the study details and the consent forms. Parents of participating students provided signed consent and the teachers mailed the completed forms to research staff. Teachers were provided with logins and passwords for each student who had a consent form. Teachers randomly distributed the logins and passwords to students on the day of the survey. Students provided assent after signing on to

the survey. The anonymous survey was conducted during class time within the school day. The twenty-four page survey took most students approximately forty-five minutes to complete, depending upon the computing technology of each school. Surveys were only completed on Tuesdays to Fridays, (or Wednesdays to Fridays if Monday was a holiday) so that all 24 hour dietary recall data represented a weekday, to limit confounding factors related to weekend dietary intakes. A research coordinator was "on call" by cell phone with the teacher in case questions arose during the survey.

3.4 Methodology

Some key variables of interest were represented by multiple questions in the survey. To condense the data, results of these questions were combined into a composite score. The scores were treated as continuous variables and Cronbach's α (alpha) coefficient was calculated. According to George and Mallery (2003), a coefficient of ">.9 = Excellent, >.8 = Good, >.7 = Acceptable, >.6 = Questionable, >.5 = Poor and <.5 = Unacceptable" (p. 231). Variables managed in this manner included: intake of unhealthy foods, nutrition knowledge, nutrition attitudes, sedentary behaviours, healthy food availability, unhealthy food availability and encouragement of activity (described below).

3.4.1 Demographic information

After accessing the survey, participants were asked to state their gender, grade level and age in years.

3.4.2 Weight status

Self-reported height (either inches or centimeters) and weight (either pounds or kilograms) were obtained from participants. The body mass index (BMI) for each participant was then calculated (weight [kg] /height [m^2]). Non-overweight, overweight and obesity was defined using the International Obesity Task Force (IOTF) criteria for BMI cut-offs (Cole, Bellizzi, Flegal& Dietz, 2000). In the first cycle of Web-SPAN, a sub sample of 459 participants was studied to compare measured height and weight with self-reported values. Good agreement was observed between self-reported and measured height ($r = .88$) and weight ($r = .94$) (Spence, Clark, Plotnikoff, Blanchard, Storey &McCargar, 2010). The main difference was a slight underreporting of weight on the web survey, $t(409) = -12.18$, $P < .001$, $d = -0.23$. Test-retest reliability for self-reported height and weight on the web-based survey (completed approximately 8 days apart) indicated overall agreements of $r = .98$ for weight and $r = .90$ for height (Spence et al., 2010).

3.4.3 Dietary Intake

In the web-survey, weekday dietary intake was measured by a 24-hour dietary recall using the web-based Food Behaviour Questionnaire. This

assessment tool was originally developed by Dr. Rhona Hanning at the University of Waterloo; and was expanded by our research group at the University of Alberta. This survey tool was the same tool that was used in the 2004/05 survey (We-SPAN 1). This measure required participants to remember everything that they had to eat and drink the previous day by choosing items from a list of approximately 500 foods and beverages. Items were listed in alphabetical order within food group categories. There were reminder cues, examples of portion sizes and visuals to enhance the accuracy of this information. Participants were able to add or delete items at any time throughout the 24-hour recall. This tool was validated by comparing the web-based dietary recall to a dietitian-administered recall for the same 24 hour period. Students in grade 6 to 8 were the study population. The two methods showed good agreement for total caloric intake and macronutrients (Hanning& Health Behaviour Research Group, 2004). Nutrient analysis software (ESHA version 7.9, ESHA Research, Salem, OR) was used to process the 24 hour recall results based on portion size definitions from the 2001b Canadian Nutrient File (Health Canada) database. This software was also used to estimate **total caloric intake** and **grams from carbohydrate, protein and fat.**

Diet quality was also assessed using the same procedures as Web-SPAN 1. Servings from each of the four food groups were calculated according to Canada's Food Guide to Healthy Eating (CFGHE) using data from the 24 hour dietary recall (Health Canada, 2007). Foods that were not classified as Grain Products, Vegetables and Fruit, Milk Products or Meat and Alternatives according to

CFGHE were categorized as other foods. Diet quality was determined by the number of food groups of which students met the minimum requirements. Participants were classified as having a poor diet quality if they met the recommendation for none of the food groups or one food group, average diet quality if they met the recommendation for two to three food groups and superior diet quality if they met the recommendation for all four food groups (Calengor, 2007).

Seven items on the web-based questionnaire were used to assess the frequency of **intake of unhealthy foods.** The questions included: “How often do you drink pop?”, “How often do you eat French fries?”, “How often do you eat burgers?”, “How often do you eat pizza?”, “How often do you eat hotdogs?”, “How often do you eat salty snacks?”, and “How often do you eat chocolate and candy?”. Responses were based on a 6-point Likert scale ranging from "at least twice a day", "once a day", "5-6 times a week", "2-4 times a week", "2-4 times a month", "rarely or never". These items were coded as following 1 = "at least twice a day", 2 = "once a day", 3 = "5-6 times a week", 4 = "2-4 times a week", 5 = "2-4 times a month", 6 = "rarely or never". Cronbach's Alpha was calculated with a result of 0.77 (acceptable), therefore the scores were summed to equal one variable (George and Mallery, 2003).

3.4.4 Nutrition beliefs

Five items were used to measure **nutrition beliefs** by asking adolescents “How strongly do you agree with this statement: The type of food I eat affects:

This question was followed by a list of 5 items: “My health”, “How I look”, “My weight”, “How well I do in sport”, “How well I do in school”. Answer options were on a 4-point Likert scale “strongly disagree”, “disagree”, “agree” and “strongly agree”. These items were coded as 1=“strongly disagree”, 2=“disagree”, 3=“agree” and 4=“strongly agree”.These items were adapted from Project EAT (Eating Among Teens) (University of Minnesota, 2011).Cronbach’s Alpha was calculated with a result of 0.86 (good), therefore the scores were summed to equal one variable (George &Mallery, 2003).

3.4.5 Nutrition Attitudes

Nutrition attitudes were assessed using two items on the survey. The following questions were asked, “How much do you care about eating healthy foods?” and “How much do you care about being healthy?”. The response options were based on a 4-point Likert scale “not at all”, “a little bit”, “somewhat” and “very much”.These items were adapted from Project EAT (University of Minnesota, 2011). Items were coded as the following 1=“not at all”, 2=“a little bit”, 3=“somewhat” and 4=“very much”. Cronbach’s Alpha was calculated with a result of 0.74 (acceptable), therefore the scores were summed to equal one variable (George &Mallery, 2003).

3.4.6 Physical Activity

Physical activity level was assessed over the previous 7-day period using the Physical Activity Questionnaire for Older Children (PAQ-C). It was specifically designed for Canadian school-aged youth, and it consists of 9 items to

measure physical activity in a variety of contexts such as school physical education (PE) classes, break times, after school, evenings and weekends. Responses were scored on a 5-point Likert scale where a higher score represents greater levels of PA. The average of the scores was used to reflect overall physical activity level. The PAQ-C has been shown to be a reliable and valid self-reported measure of PA in previous studies. According to Kowalski, Crocker and Faulkner (1997), the PAQ-C was a reliable measure among children aged 9 to 14 years (n = 97) when compared with other PA measurement tools including an activity rating (r = .57), a Caltrac motion sensor (r = .39), a 7-day physical activity recall interview (r = .46), the Godin Leisure Time Exercise Questionnaire (r = .41), and the Canadian Home Fitness Test (step test) (r =.28). Similarly, Crocker, Bailey, Faulkner, Kowalski & McGrath (1997) reported good test-retest reliability when the self-administered PAQ-C was completed approximately 8 days apart (r = .79).

3.4.7 Sedentary behaviours

To assess time spent in **sedentary behaviours** participants were asked to answer four items: “On average, how many hours per day would you say that you spend playing video games?”, “How many hours per day would you say that you spend in front of the computer?”, “How much television (hours and minutes) do you usually watch on school days between the time you get home and dinner?” and “How much television (hours and minutes) do you usually watch on school days between dinner and the time you go to bed?”.

These Items were coded as follows:

1= “0 hours, 0 minutes”
2= “0 hours, 15 minutes”
3= “0 hours, 30 minutes”
4= “0 hours, 45 minutes”
5= “1 hours, 0 minutes”
6 = “1 hours, 15 minutes”
7= “1 hours, 30 minutes”
8= “1 hours, 45 minutes”
9= “2 hours, 0 minutes”
10= “2 hours, 15 minutes”
11= “2 hours, 30 minutes”
12= “2 hours, 45 minutes”
13= “3 hours, 0 minutes”
14= “3 hours, 15 minutes”
15= “3 hours, 30 minutes”
16= “3 hours, 45 minutes”
17= “4 hours, 0 minutes”
18= “4 hours, 15 minutes”
19= “4 hours, 30 minutes”
20= “4 hours, 45 minutes”
21= “5 hours, 0 minutes”
22= “5 hours, 15 minutes”
23= “5 hours, 30 minutes”
24= “5 hours, 45 minutes”
25= “6 hours or more”.

Cronbach’s Alpha was calculated with a result of 0.72 (acceptable) therefore the scores were summed to equal one variable (George &Mallery, 2003).

3.4.8 Food Availability

Eight items were used to assess the **availability of “healthy” and “unhealthy” foods** in the home environment by asking adolescents, “How often are the following true?” This question was followed by a list of 8 items including: fruit and vegetables are available in my home, vegetables are served at dinner in my home, we have fruit juice in my home, milk is served with meals at my home, we have junk food in my home, potato chips or other salty snack are available in

my home, chocolate or other candy is available in my home and soft drinks are available in my home. Response options were with a 4-point response ‘‘never’’, ‘‘sometimes’’, ‘‘usually’’ or ‘‘always’’.These items were adapted from Project EAT (University of Minnesota, 2011). For data reduction, one factor, labeled “Unhealthy food availability,” described the combined scores for availability in the home of “junk” food, chips and snacks foods, chocolate and candy, and soft drinks [Cronbach’s Alpha 0.82 (good)]. The other factor, “Healthy food availability” (fruit and vegetables available, vegetables at dinner, fruit juice available, milk with meals) was not included in the analyses because Cronbach’s Alpha values were low at 0.59 (poor). Similarly, Campbell et al. (2007) found that healthy food availability at home had a low Cronbach’s Alpha value and was not included in their analysis.

3.4.9 Encouragement of Activity

Encouragement of activity was measured using three items; encouragement to be physically active, being physically active with peers, and friends’ activity level, using the following questions “How often do your best friends encourage you to be physically active?”, “How often are your best friends physically active with you?”and “How often are your best friends physically active?”. Answers were based on a 5-point Likert Scale ranging from “Never”, “Rarely”, “Sometimes”, “Often”, or “Very often”. These items were coded as 1=“Never”, 2=“Rarely”, 3=“Sometimes”, 4=“Often”, 5=“Very often”. Cronbach’s Alpha was calculated with a result of 0.78 (acceptable) therefore the scores were summed to equal one variable (George &Mallery, 2003).

3.4.10 Socioeconomic Status

Socioeconomic status was assessed based on the median income of the school community. This was determined using postal codes of the schools and Census data (2006) for average household incomes for that community. This method is similar to that used by Minaker et al (2006).

3.5 Statistical analysis

Outliers were identified using the predetermined measures from the 2005 survey(Storey et al., 2009). Stem and Leaf and histograms were used to identify outliers. Data were ranked according to energy intake in each grade level. The top 10 values were checked to determine if they were extreme and then they were added to the outliers spreadsheet. All extreme values were discussed by an expert committee on a case by case basis. Data were analyzed using IBM SPSS Inc., version 19. Descriptive data were presented in tabular and graphic forms. Mean values for each of the factors were calculated and differences between females and males were determined with student's t-tests. The proportion of non-overweight, overweight and obesity between males and females was also assessed using chi-square analysis.

Multiple linear regression was used to identify the independent predictors of BMI and the possible interaction between variables. Separate models were used for the whole sample, for females and for males. Statistical significance was set at a p-value <0.05.

A purposeful selection procedure was used to choose the variables

included in the model. According to Hosmer and Lemeshow (1999), the first step was to use Pearson correlation analysis to determine if any two variables were highly correlated, which indicates that they might have the same effect on BMI. Linear regression analysis of each variablewith BMI was the second step in the purposeful selection process. The third step was to include any variable that was significant at a p-value less than 0.2, at the univariate level in a multivariate analysis. More traditional p-values such as 0.05 can fail to identify important variables (Mickey & Greenland, 1989). Multiple regression analysis (the significant variables) to predict BMI was the third step. The fourth step was to test for the confounding effect for each variable that was not significant in the multivariate analysis. Variables were removed from the model if they were not significant and not a confounder. If a confounding variable resulted in a change greater than 15% in any other variable that was significant in the multivariate analysis, the variable was included in the final model. (Hosmer&Lemeshow, 1999).

Chapter Four

Results

4.1 Participant recruitment

Three hundred and six schools were randomly selected for the study. The school boards of these schools were contacted. Of the fifty-eight school boards who were contacted to ask for approval, 85% agreed to have their schools participate; subsequently two hundred and seventy one schools were contacted to participate in the study. Upon study completion, 109 schools (40%) representing 37 (64%) school boards participated in the survey. The main reason for not participating was lack of time on the part of school or the researchers were out of time as the school year came to close.

Participants were able to withdraw from the survey at any time and they were not required to answer every question, thus the sample size differs throughout. Participants were eliminated from the analysis if: they logged onto the survey but did not finish any part of the survey (n=26); they reported extreme values of total energy intake (n= 33) which was higher than 7098 kcal per day, (this energy intake level was determined by an expert committee which studied the individual cases); they reported extreme values for physical activity (n=19) in that they answered #5, which is highest score, in all questions in part one of the physical activity questionnaire; or they reported extreme values for BMI which was less than thirteen or higher than seventy (n= 33). BMI classification could not

be determined for 973 students because of their missing values in height and/or weight or other descriptive variables.

4.2 Demographic information

A total of 4360 students in the seventh, eighth, ninth and tenth grades were included in the final analysis. Table 1 presents a summary of the demographic and anthropometric data for the total sample, female and male participants. There was no significant difference between females and males in average age and grade level. However, males were taller, heavier and had a higher BMI than females.

Table 1: Demographic and anthropometric variables for female and male participants

Variable	Total Sample (n=4360)[a]	Females (n=2396)	Males (n=1945)	P-value [b]
Age	13.5±1.5 [c]	13.5±1.1	13.6±1.2	.451
Grade Level	8.3±1.1	8.3±1.1	8.3±1.1	.293
Height (cm)	164.0±12.7	161.1±11.2	167.2±13.5	.001
Weight (kg)	53.8±13.2	51.3±11.0	56.4±13.9	.001
BMI (kg/m^2)	20.3±4.1	20.1±3.9	20.4± 4.1	.026

[a] Numbers may vary slightly due to missing data. Some respondents did not specify gender.

[b] Comparison between females and males (t-test)

[c] Mean ± standard deviation

4.3 Weight status

Percentage of non-overweight, overweight and obesity was assessed using chi-square tests (Table 2). Overall, 17.6% of participants were overweight or obese. There was a difference in proportion of non-overweight, overweight and obesity between females and males (χ^2 $p<0.001$).

Table 2: Percentage of non-overweight, overweight and obesity

BMI classification based on IOTF cut-offs [a]	Total sample (n=3387)	Females (n=1772)	Males (n=1615)	P-value [b]
Non-overweight	82.4%	85.2%	79.4%	0.001
Overweight	13.5%	11.1%	16.1%	
Obese	4.1%	3.8%	4.5%	

[a]Cole et al., 2000

[b] **C**hi-square tests show differences in proportions of non-overweight, overweight and obesity between females and males (χ^2 $p<0.001$).

4.4 Dietary intake

Table 3 shows intake of total energy and grams from macronutrients for the total sample, females and males. Males had significantly higher total energy intake (kcal/d), and intake of carbohydrate, protein and fat (g/d) compared to females ($p<0.001$).

Table 3: Dietary intake of energy and macronutrients

Variable	Total sample[a] (n=4335)	Females (n=2387)	Males (n=1930)	P-value[b]
Total energy intake (kcal/d)	1978±1014 [c]	1711±799	2312±1148	0.001
Carbohydrate(g/d)	267±134	236±109	305±152	0.001
Protein(g/d)	79±46	67±36	94±51	0.001
Fat(g/d)	70±47	59±37	83±54	0.001

[a] Numbers may vary slightly due to missing data. Some respondents did not specify gender.

[b]Comparison between females and males (t-test)

[c] Mean ± standard deviation

The proportion of students who had poor, average or superior diet quality was assessed using chi-square tests (Table 4). Overall, 51% of participants had poor diet quality. There was a difference in the proportion of poor, average and superior diet quality between females and males (χ^2 $p<0.001$).

Table 4: Percentage of poor, average and superior diet quality

Diet quality	Total sample (n=4311)	Females (n=2386)	Males (n=1925)	P-value[a]
Poor (0-1 food group met)	51%	55.9%	45%	0.001
Average(2-3 food groups met)	44.4%	41.5%	48%	
Superior (4 food groups met)	4.6%	2.6%	7%	

[a] **C**hi-square tests show differences in proportions of poor, average and superior diet quality between females and males (χ^2 $p<0.001$).

4.5 Nutrition beliefs, nutrition attitudes, physical activity and sedentary behaviour (individual factors)

Table 5 shows nutrition beliefs, nutrition attitudes, physical activity and sedentary behaviour for the total sample, females and males. Females had significantly higher nutrition beliefs and attitudes than males ($p<0.001$). Nevertheless, males had significantly higher physical activity and sedentary behaviour scores ($p<0.001$).

Table 5: Differences between females and males in nutrition beliefs, nutrition attitudes, physical activity and sedentary behaviour

Variable	Total sample[a] (n=3786)	Females (n=2113)	Males (n=1658)	P value [b]
Nutrition beliefs [c] (scores)	16.1±3.3[d]	16.5±3.21	15.6±3.4	0.001
Nutrition attitudes[c] (scores)	6.9±1.2	7.1±1.0	6.7±1.3	0.001
Physicalactivity[e] (PAQ-C)	2.9±0.7	2.8±0.7	3.0±0.7	0.001
Sedentary behaviour[f] (scores)	25.2±16.5	22.8±13.9	28.6±18.7	0.001

[a] Numbers may vary slightly due to missing data

[b] Comparison between females and males (t-test)

[d] Mean + standard deviation

[c]*Nutrition beliefs and attitudes scores: as the number increases the positive beliefs and positive attitudes increase(maximum score = 25 and 10 respectively)*

[e]*Physical activity: PAQ-C score 1 indicates low activity and 5 indicates high activity (Kowalski, Crocker & Faulkner, 1997)*

[f]*Sedentary behaviour scores: equal to 15 minutes (25.2 x 15) on average students spent 378 minutes per day being sedentary*

4.6 Food availability and encouragement of activity (interpersonal factors)

Table 6 shows unhealthy food availability and encouragement of activity for the total sample, females and males. Males had significantly higher scores for availability of unhealthy food at their homes and encouragement to be active from their friends compared to females ($p<0.001$).

Table 6: Differences between females and males in food availability and encouragement of activity

Variable	Total sample (n=3779)	Females (n=2107)	Males (n=1657)	P value [b]
Unhealthy food availability[d] (score)	10.1±2.8[c]	10.0±2.8	10.3±2.8	0.001
Encouragement of activity[d] (score)	10.6±2.8	10.4±2.8	10.9±2.8	0.001

[a] Numbers may vary slightly due to missing data.

[b] Comparison between males and females (t-test)

[c] Mean + standard deviation

[d] *As the scores increase the availability of unhealthy food and encouragement of activity increases as well (Maximum score= 16 and 15 respectively).*

Table 7 shows univariate analysis (Linear regression) for unhealthy food availability and intake of energy and macronutrients. There was a significant association between unhealthy food availability at home and total energy intake ($p<0.001$), calories from carbohydrate ($p<0.001$), calories from protein ($p<0.001$), and calories from fat ($p<0.001$). As the availability of unhealthy food increased the intake of energy and macronutrients increased as well.

Table 7: Linear regression for unhealthy food availability and energy intake and macronutrient intake.

Variable	Adjusted R Square	βCoefficients[a]	P value [b]
Energy intake (kcal/d)	0.017	50.859	0.001
Carbohydrate (kcal/d)	0.013	22.946	0.001
Protein (kcal/d)	0.003	3.619	0.001
Fat (Kcal/d)	0.022	23.912	0.001

[a]Unstandardized

[b]Variables Predicted by unhealthy food availability

Table 8 shows the association between encouragement of activity from friends and adolescents physical activity level. Encouragement of activity accounted for 20.2%of the variation in physical activity ($p < 0.001$).

Table 8:Linear regression for encouragement of activity from friends and physical activity

Variable	Adjusted R Square	βCoefficients[a]	P value [b]
Physical activity	0.202	.114	0.001

[a]Unstandardized

[b]Variable predicted by encouragement of activity

4.7 Socioeconomic status and individual and interpersonal factors

Median household income in the school communities ranged from $30,404 to $156,876 and the mean household income was $72,731 ± $21,307. Table 9 shows univariate analysis for socioeconomic status and energy intake, nutrition beliefs, nutrition attitude, physical activity, sedentary behaviours, unhealthy food availability at home and encouragement of activity from friends. There was a significant association between socioeconomic status and nutrition attitude ($p=0.031$), physical activity ($p<0.001$) and encouragement of activity ($p=0.029$). As the socioeconomic status increased the nutrition attitudes, physical activity and encouragement of activity also increased. Associations between socioeconomic status and other variables (energy intake, nutrition beliefs, sedentary behaviour, unhealthy food availability)were not significant.

Table 9: Linear regression for socioeconomic status and energy intake, nutrition beliefs, nutrition attitudes, physical activity, sedentary behaviours, food availability and encouragement of activity

Variable	Adjusted R Square	β Coefficients[a]	P value [b]
Energy intake (kcal/d)	0.000	-0.001	0.200
Nutrition beliefs	0.000	1.035E-6	0.685
Nutrition attitudes	0.001	1.941E-6	0.031
Physical activity	0.005	2.489E-6	0.001
Sedentary behaviour	0.000	-2.057E-5	0.117
Unhealthy food availability	0.000	1.089E-6	0.611
Encouragement of activity	0.001	4.794E-6	0.029

[a]Unstandardized

[b]Variable predicted by socioeconomic status

4.8 Choosing the variables for multiple regression

Correlation analysis was conducted to examine the relationships between each potential predictor of BMI with each other (see Table B1 in appendix B). Energy intake was positively and significantly ($p < 0.001$) correlated with

gramsfrom carbohydrate (r=0.927), protein (r=0.846) and fat (r=0.917). Other variables were not highly correlated.

Secondly, linear regression for each variable with BMI was completed (Table B2 in appendix B). All variables resulting in p>0.2 were excluded from the analyses. These variables were total energy intake, frequency of unhealthy food, energy from carbohydrate, energy from protein, energy from fat, nutrition attitude, unhealthy food availability. This resulted in the following variables being included in the model:

- Sex
- Gender
- Diet quality
- Nutrition beliefs
- Physical activity
- Sedentary behaviours
- Encouragement of activity
- Socioeconomic status

Next, all included variables from the univariate analysis were used in a multiple regression model (see Table B3in appendix B). Variables which were not significant (P> 0.05) were tested for confounding effects (each one separately) (see Table B4in appendix B).Since delta β's for diet quality, encouragement of activity and socioeconomic status were less than 15%; they had no confounding effect on statistically significant variables; therefore, they were excluded from the

analyses. Potential interactions between all variables were tested but no interactions were observed between any tested variables. (See table B5in appendix B for an example of some of the variables analysed).

4.9 Association between BMI and individual and interpersonal factors

Multiple regression analysis was performed to evaluate the associations between each of the selected variables and BMI. Three models were used: one for the whole sample, one for females and one for males (see Table 10). The model including both females and males accounted for 5.7% of the variation in BMI ($F [5, 2544] = 31.824$, $p < 0.001$). Results of this analysis showed that, sex and grade level contributed significantly to the model (sex: $\beta = -0.044$, $p = 0.030$; grade level: $\beta = 0.165$, $p < 0.001$). Nutrition beliefs, physical activity and sedentary behaviours were other factors significantly associated with BMI (nutrition beliefs: $\beta = 0.083$, $p < 0.00$; physical activity: $\beta = -0.076$, $p = 0.001$; sedentary behaviours: $\beta = -0.106$, $p < 0.001$).

When the analysis was separated by sex, the model for females explained 6.9% of the variation in BMI ($F [4, 1411] = 25.890$, $p < 0.001$) and the model for males accounted for 4.8% ($F [4,1132] = 14.340$, $p < 0.001$). Grade level, nutrition beliefs and sedentary behaviours continued to be significantly associated with BMI in both females and males (females: Grade level: $\beta = 0.165$, $p < 0.001$; nutrition beliefs: $\beta = 0.094$, $p < 0.001$; sedentary behaviours: $\beta = 0.98$, $p < 0.001$) (males: Grade level: $\beta = 0.163$, $p < 0.001$; nutrition beliefs: $\beta = 0.068$, $p < 0.001$; sedentary behaviours: $\beta = 0.114$, $p < 0.001$). However, physical activity was

significantly associated with BMI for females ($\beta = -0.115$, $p < 0.001$) but not for males. The Variance Inflation Factor (VIF),tolerance and condition index were used to detectmulticollinearity. The VIF and tolerance scores were in the acceptable range. Conditionindex scores were in the acceptable range (below 30)except for the last variable (nutrition beliefs) which was slightly above the range. When this variable was excluded the condition index showed minimal change so it was decided to keep nutrition beliefs in the model; especially since VIF and tolerance scores were acceptable.

Table 10: Associations between selected Variables and BMI for females and males

	Total			Females			Males		
Variable	**β**	**Partial R^2**	**P-value**	**β**	**Partial R^2**	**P-value**	**β**	**Partial R^2**	**P-value**
Sex	-0.044	-0.043	.030						
Grade level	0.165	0.164	0.001	0.165	0.163	0.001	0.163	0.161	0.001
Nutrition beliefs	0.083	0.083	0.001	0.094	0.095	0.001	0.068	0.068	0.022
Physical activity	-0.076	-0.074	0.001	-0.115	-0.112	0.001	-0.031	-0.030	0.315
Sedentary behaviours	0.106	0.104	0.001	0.98	0.098	0.001	0.114	0.112	0.001

β = Standardized Coefficient

Total: $F [5, 2544] = 31.824$, $p < 0.001$, $R^2 = 0.057$; females: $F [4, 1411] = 25.890$, $p < 0.001$, $R^2 = 0.069$; males: $F [4,1132] = 14.340$, $p < 0.001$, $R^2 = 0.048$.

Chapter Five

Discussion

5.1 Major findings

The purpose of this study was to estimate the prevalence of overweight and obesity among adolescents in Alberta and to link overweight and obesity in youth with behavioural and environmental factors. A major finding of the study was that the prevalence of overweight and obesity is slightly lower in Alberta compared to the prevalence of both overweight and obesity in Canada. Additionally, among all of the factors investigated, physical activity and sedentary behaviours were the modifiable factors that predicted BMI during adolescence. Furthermore, nutrition beliefs had a positive association with BMI. Although all thedietary intake variables were not significant predictors of BMI, unhealthy food available at home was associated with increased intake of energy and macronutrients. Encouragement of activity from friends had a positive association with physical activity level. The implications of these key findings will be discussed below; however, initially it will be useful to address each research question.

5.2 Discussion

5.2.1 Research question one: prevalence of obesity

A. What is the prevalence of overweight and obesity among adolescents in Alberta?

The prevalence of overweight in the present study was 11.1% and 16.1% for females and males respectively. The prevalence of obesity was 3.8% and 4.5% for females and males respectively. In comparison, recent results from the Canadian Health Measures Survey (CHMS) 2007-2009 for children aged 2 to 17 showed that the prevalence of overweight and obesity for females was 17.2% and 7%, and for males was 17% and 10% respectively (Alberta Health Services, 2010). Thus our results for Alberta youth showed prevalence rates slightly lower than the Canadian average. Data from the CCHS 2004 also showed that Alberta youth aged 12 to 17 had lower prevalence of both overweight and obesity than youth in other provinces in Canada: 19.8% versus 20.2% overweight and 9.4% versus 10.1% obese (Garriguet, 2006). Another possibility is that obesity and overweight rates were lower because of the missing data, as we could not determine BMI for 973 participants. Also, participants who were obese or overweight may have been less likely to report their weight, as it was optional.

5.2.2 Research question two: *Individual factors* and BMI

A. Is there a relationship between gender, grade level and BMI?

Gender and grade level were both significant predictors of BMI. Males had a higher BMI than females. This is not surprising as typically adolescent males

have a larger body size than adolescent females. As well, adolescent males are more likely to engage in sport and exercise and the use of food/supplements to build muscle and gain weight; whereas, adolescent females are more likely to engage in dieting and strategies to lose weight (McCabe &Ricciardelli, 2004). In 2000, a systematic review reported that twenty-seven of twenty-eight studies concluded that young males were more active than females; and this finding is consistent with our study (Sallis, Prochaska, & Taylor, 2000). Furthermore, as grade level increased, the BMI increased. Other studies have reported the same findings (Gray & Smith, 2003). Baum and Ruhm (2009) reported that youth BMI increases with age and is anticipated to increase approximately 0.12 kg/m^2 per year. Similarly, a slight increase in BMI occurs normally with growth; this is most likely attributable to muscle mass gain rather than fat mass gain (Berkey, Rockett, Gillman &Colditz, 2003).

B. Is there a relationship between adolescents' dietary intake and BMI?

In the present study, there was no relationship between total energy intake and BMI. The literature on the relationship between energy intake and obesity includes examples of non-associations, positive associations and inverse associations. In Switzerland, a study was conducted in 2007 which showed that there was no relationship between energy intake and BMI among children aged 6 to 14 (Aeberli, Kaspar& Zimmermann, 2007). Gray and Smith also demonstrated that energy and macronutrient intakes of children and youth were not associated with their BMI (Gray & Smith, 2003). Likewise, Calderon, Johnston, Lee and Haddad (1996) did not find any difference between dietary intakes (energy and

macronutrients) consumed by overweight and non-overweight girls.

In contrast, other studies documented a positive association. A longitudinal study reported that a larger increase in BMI was associated with a larger increase in energy intake among children aged 9 to 14 (Berkey et al., 2000). And elsewhere, Rocandio, Ansotegui and Arroyo (2001) reported that overweight children consumed a lower total energy intake than non-overweight children. The researchers did not use self-report measures,but rather a dietitian trained parents to record food intake for their children using the food weighing method. Based on these findings, Rocandio et al. (2001) suggested that overweight was caused by low energy expenditure rather than high energy intake. Moreover, Patrick et al. (2004) demonstrated that adolescents whose BMI for age was at the 85thpercentile or higher (at risk of overweight or overweight) consumed significantly lower energy intake than adolescents whose BMI for age was below the 85th percentile (normal weight); however, adolescents with normal weight were exercising for a significantly longer time than adolescents who were either overweight or at risk of being overweight.

These contradictory results demonstrate how difficult it is to assess the true relationship between energy intake and overweight during adolescence because of the dynamic nature of body weight and body composition during this transition stage (Fulton et al., 2009). Moreover, if youth in our study were trying to lose weight during the dietary reporting period, lack of positive associations can be attributed to "reverse causation" (Moreno, Pigeot& Ahrens, 2011) .

Many researchers who have examined the relationship between energy intake and obesity have suggested that macronutrient composition (carbohydrate, fat, protein) has an impact on childhood obesity (Atkin& Davies, 2000; Gazzaniga& Burns, 1993; Gillis, Kennedy, Gillis, Bar-Or & Correspondence, 2002). According to Hassapidou, Fotiadou, Maglara, and Papadopoulou (2006) and Ortega, Requejo, Andres and Lopez-Sobaler (1995), youth who were overweight and obese consumed less carbohydrate than youth who were non-overweight. Results from the present study were not consistent with these findings, and we did not find a significant association between carbohydrate intake and BMI. Additionally, we did not find a significant association between fat and protein intake and BMI. These results were consistent with a recent Australian study which reported that of 2460 girls and boys aged 5-17 there was no significant association between macronutrient composition and BMI (Elliott et al., 2011).

C. Is there a relationship between adolescents' nutrition beliefs andattitudesand BMI?

There was a statistically significant positive relationship between nutrition beliefs and BMI but not between nutrition attitudes and BMI. This was a somewhat unexpected finding. It may be that adolescents with high BMI were interested in changing their body weight; hence they may have read more about nutrition; or their parents may have encouraged them to lose weight and possibly provided them with nutrition information. In contrast, adolescents with normal body weight may not have been interested in knowing about nutrition because

they did not think it was important. As well, students in higher grades had a higher BMI. This can help to explain the positive association between nutrition beliefs and BMI, as youth in higher grades are more likely to learn more information about nutrition. Other studies were not consistent with our finding; Frobisher et al. (2005) reported that there was no relationship between nutrition knowledge and eating behaviours. Kresić et al. (2009) documented that students with higher nutritional knowledge were more likely to eat a healthy diet compared to students with lower nutrition knowledge. In contrast, our results were somewhat consistent with a study conducted in British Columbia in 2007, which aimed to increase nutrition knowledge among children. The authors reported that their students' BMI was significantly increased during the 10-month school-based intervention program in both intervention and control schools. Healthy-living knowledge, behaviours and attitudes also increased (Stock et al., 2007).Moreover, the comparison of nutrition beliefs and attitudes between females and males showed that females had significantly higher (more positive) nutrition beliefs and attitudes. However, the raw scores were quite similar; thus the practical significance of these differences is unclear.

D. Is there a relationship between adolescents' physical activity and sedentary behaviours and BMI?

The association between physical activity and weight status has been studied by many researchers, but the results have been inconsistent. Using BMI as a measure of adiposity does not distinguish between fat and lean tissues;and thismay partly account for this inconsistency, especially considering the positive

influence of physical activity on lean body mass (Klein-Platat et al., 2005). In the present study there was a significant negative relationship between physical activity and BMI. This inverse association between physical activity levels and BMI is consistent with previous findings (Belcher et al, 2010). It is possible that youth with high BMI participated in less physical activity because they feared being teased by their peers or they were less athletic (Haerens, Vereecken, Maes, & De, 2010).

When females and males in this study were analyzed separately, the inverse association remained for females, but not for males. Similarly, Klein-Platat et al. (2005) reported that there was a negative association between structured physical activity and BMI in females only. Moreover, the effect of physical activity on BMI was different between overweight and lean boys. Boys who were overweight and increased their walking, aerobics and dancing, experienced a reduction in BMI; however, increased strength training did not lead to an increase in BMI. Boys who were lean and who increased their total physical activity or strength training had an increase in BMI. Overweight girls who increased total physical activity or strength training experienced a reduction in BMI, and overweight girls who increased their aerobics and dancing experienced a larger reduction in BMI (Berkey et al., 2003). A review conducted in 2005 reported that 22 of 24 studies demonstrated that girls are less active than boys and two studies showed no differences. Since males are more active than females, they are more likely to develop or maintain lean mass (Klein-Platat et al., 2005). This variation in physical activity level may explain, in part, the gender

differences in BMI.

Sedentary behaviours were a significant predictor of BMI. As the number of hours spent in sedentary activities increased, BMI also increased. This finding was supported by other studies. Epstein et al. (2008) conducted a randomized controlled clinical trial aimed to investigate the influence of decreased television viewing and computer use time on body weight. This study demonstrated that decreasing these sedentary behaviours were associated with a reduction in BMI. Additionally, a prospective study conducted by Gordon-Larsen, Adair and Popkin (2002) reported that increased sedentary behaviours were positively associated with overweight. Results from prospective and intervention studies were consistent with the present cross-sectional study as they reported an association between sedentary behaviour and adiposity among adolescents. Suggested mechanisms are: 1) that watching TV reduces resting energy expenditure; 2) that sedentary behaviours are displacing physical activity time; 3) that adolescents are eating more while watching TV; and 4) that advertisements on TV influence children and encourage them to eat unhealthy food (Robinson, 2001). All these mechanisms were discussed previously.

5.2.3 Research question three: Interpersonal factors and BMI

A. Does food availability at home have an impact on adolescents' BMI?

B. Is this relationship mediated by adolescents' dietary behaviours?

Food available at home was associated with adolescents' dietary intake but not with BMI. Specifically, unhealthy food available at home increased the intake

of energy and macronutrients. This is broadly supported by Tak, et al. (2011), who found that sugar-sweetened beverage consumption was positively associated with sugar-sweetened beverage availability at home. Bauer, Larson, Nelson, Story and Neumark-Sztainer (2009) reported that fast food consumption among adolescents was associated with the availability of fast food at home. Similarly, unhealthy food availability at home was positively associated with the consumption of fast food and snack food and negatively associated with vegetable, fruit and starchy food consumption (Cutler, Flood, Hannan&Neumark-Sztainer, 2011). Fast food and snack consumption was also associated with increased energy intake (Moreno et al., 2010; Pereira & Ludwig, 2004). Since energy and macronutrient intake were not significant predictors of BMI, it is expected that food availability may not have a direct impact on BMI.

C. Does encouragement of activity from friends have an impact on adolescents' BMI?

D. Is this relationship mediated by adolescents' physical activity?

Encouragement of activity from friends had a positive statistically significant impact on adolescents' physical activity but no significant association with BMI. In 2005, a similar result was reported, whereby friends' support was positively associated with physical activity (Duncan, Duncan &Strycker, 2005). In addition, a more recent study documented that physical activity encouragement from friends was related to youth physical activity (Martin-Matillas et al., 2010). Heitzler et al. (2010) demonstrated that friends' support for physical activity was

the strongest factor compared to parents' support, parents' physical activity, and individual perceptions about physical activity that predicted adolescents' physical activity. Because this relationship is not direct and is mediated by physical activity, we could not detect this association between encouragement of physical activity and BMI when other factors were considered.

5.2.4 Research question four: Socioeconomic status as a global factor

A. Is there a relationship between socioeconomic status and BMI?

Although several studies have confirmed the association between socioeconomic status and overweight and obesity, this study did not find a significant relationship between socioeconomic status and BMI.One explanation is that the majority of our participants were from middle to upper- middle income and we did not have a large variation within the sample. A study conducted by Baum and Ruhm (2009) showed that excess body weight was negatively associated with children's and adolescents' socioeconomic status. However, a 2006 study investigating the association between socioeconomic status and overweight reported inconsistent relationships between socioeconomic status and overweight across race, sex, and age (Wang and Zhang, 2006).

Moreover, our study confirmed the associations between socioeconomic status and nutrition attitude, physical activity and encouragement of activity. It may be that participants with low socioeconomic status had parents who did not have the time or skills to focus on healthy eating. Additionally, in 2006, Humbert et al. documented that youth with low socioeconomic status have lower physical

activity level than youth with high socioeconomic status. Also, the low socioeconomic status group reported family obligation, cost, access to facilities, and neighbourhood safety as barriers, whereas the high socioeconomic status group did not. All of these barriers can explain the difference in physical activity level between different socioeconomic groups. Furthermore, encouragement of activity from friends was higher in the high socioeconomic status group. One explanation is that youth with low socioeconomic status may have had more family responsibilities and had to work a part-time job; therefore, they would have less time to spend with their friends. However, those who had high socioeconomic status may have had less family obligations and had more free time to spend with friends.

The results of this study provide evidence that, gender, age, nutrition knowledge, physical activity and sedentary behaviours were significant predictors of BMI, but dietary intake, nutrition attitudes, food availability at home, encouragement of activity from friends, and socioeconomic status were not significant predictors. Moreover, we found that unhealthy food available at home is associated with increased energy and macronutrients intake. Also, encouragement of activity and socioeconomic status affected physical activity level.

We found that the ecological framework was very useful in studying multiple factors. Some of the interpersonal factors influenced the individual factors but did not influence body weight, which implies an indirect relationship. This is one of the advantages of using such a framework; it allows for the analysis of

interactions between all factors within the model even if they do not have a direct influence on BMI. However, the ecological framework is not an explanatory framework but a conceptual framework and it has some limitations. To study multiple factors results in costly and labour-intensive investigations. Also, indirect relationships limit the application of the overall model. Nevertheless, obesity is a very complex problem; and to address the problem as many factors as possible should be targeted. Targeting multiple factorsis considered an important step in better understanding the most potent intervention approaches. Using a conceptual model that is ecological in nature and suggesting a causal pathway is an important advancement in the field.

5.2 Strengths and Limitations

5.3.1 Strengths

This study used a validated web-based survey that allowed for assessment of multiple factors in a large population, which covered a wide geographic area. Also, because the survey was anonymous, it is possible that the adolescents aweremore truthful in reporting sensitive information (e.g. body weight, intake of unhealthy food).

The data were collected using self-report measures. Although many researchers would argue that self-report may result in underreporting or an underestimate of food intake, two previous studies addressed this concern. One study using the web-based 24 hour recall tool showed good agreement between self-reported dietary intake and dietary intake assessed by a dietitian (Vance et al.

2008). In addition, another study also showed good agreement between measured and self-reported height and weight (Calengor 2007).

5.3.2 Limitations

Participants' usual intake is not represented because we used a 24-hour recall for one day only. Using repeated 24-hour recalls for three or more days would provide an improved estimation of usual intake. Nevertheless, repeated 24-hour recalls would have required more class time which may have lead to lower participation rates. Also, studies have shown that a 24-hour recall is useful to compare group intakes and it is an acceptable method for children older than eight years (Gray & Smith, 2003).

Another limitation of this study is the cross-sectional design, which cannot infer a cause-and-effect relationship from the data. For example, it is not possible to know if low physical activity level caused high BMI or high BMI caused the low physical activity.

5.4 Implications, Recommendations and Future Research Directions

In conclusion, results from this cross-sectional study suggest that insufficient physical activity and extended periods of time spent in sedentary behaviours were the only modifiable risk factors associated with a higher BMI of adolescents. Cohort studies are required to clarify the relative importance of individual and interpersonal factors on overweight and obesity during adolescence. Community interventions aiming to improve physical activity levels among adolescents might be more successful if family and friends are involved.

Public health efforts should be focused on reversing the current trend of sedentary behaviours. Furthermore, educational interventions with parents, aiming to reduce the hours spent on sedentary behaviours within the family unit and increasing physical activity, seem to be one of the most suitable methods to help to reduce obesity in youth.

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Appendix A

UNIVERSITY OF ALBERTA
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Faculty of Agricultural, Life & Environmental Sciences and Physical Education and Recreation Research Ethics Board

Certificate of Ethics Approval

Applicant(s):	Linda McCargar
Co-Investigator(s):	
Faculty:	Agricultural, Life & Environmental Sciences
Project Title:	***Web-Survey of Physical Activity and Nutrition 2 (Web-SPAN 2)***
Grant/Contract Agency:	
Research Ethics Application #:	ALES 07-49 – R1
Research Ethics Approval Expiry Date:	September 26, 2009

Certification of Faculty of Agricultural, Life & Environmental Sciences and Physical Education and Recreation Research Ethics Approval

I have received your application for research ethics review and conclude that your proposed research meets the University of Alberta standards for research involving human participants (GFC Policy Section 66). On behalf of the Faculty of Agricultural, Life & Environmental Sciences and Physical Education and Recreation's Research Ethics Board (ALES/PER REB), I am providing **research ethics approval** for your proposed project.

This research ethics approval is valid for one year. To request a renewal after the approval expiry date, contact me and explain the circumstances, making reference to the research ethics review number assigned to this project (see above). Also, if there are significant changes to the project that need to be reviewed, or if any adverse effects to human participants are encountered in your research, please contact me immediately.

Chair, Research Ethics Board
Faculty of Physical Education and Recreation

Print Name: Wendy Rodgers **Signature:**

Faculty of Agriculture, Forestry, and Home Economics
Human Research Ethics Board
Approval

is hereby granted to:

Linda McCargar, Principal Investigator for

07-49 Web-Survey of Physical Activity and Nutrition 2 (Web-SPAN 2)

for a term of one year, provided there is no change in experimental procedures. Any changes in experimental procedures must be submitted in writing to the AFHE REB.

Granted on September 26th, 2007

for Walter Dixon, Chair, AFHE REB

INFORMATION LETTER for School Recruitment

[Date]

Dear [Name]:

The University of Alberta has the approval of your school board to invite [school name] to participate in a continuing study examining food, activity, and general health behaviours in Alberta youth. The research will investigate the nutrition, activity, and behavioural choices of students in grades nine and ten [or grades seven and eight] using a web-based survey. This web-based survey complements the Comprehensive School Health Model and new curriculum. Feedback from the survey will be available to the individual students, and teachers will receive group feedback with suggestions for incorporating the results into the curriculum, including relevant learning resources.

As you know, teenagers experience many physiological and psychological milestones, including the adolescent growth spurt with rapid bone development, and increasing autonomy in food and activity choices. There is little information on the diet and physical activity behaviours of Alberta youth, however dietary surveys elsewhere indicate that teens consume insufficient amounts of energy, calcium, iron, and may have low levels of physical activity. These have the potential to exert a strong deleterious impact on future health and increase the risk of chronic disease in later life. Through better understanding of the lifestyle patterns of Alberta youth, and variables that influence this pattern, targeted healthy eating and active living programs and strategies can be designed.

The web-based tool was developed by Dr. Rhona Hanning at the University of Waterloo, and has previously been used to survey over 5000 Alberta students. We are planning to survey another 5000 Alberta students, creating the most comprehensive assessment of Alberta youth's nutrition and physical activity. Your school has been randomly selected to participate in this survey. Please find attached copies of the following: 1) a summary of the project with details on the design, objectives and measures to be used for this study, 2) the survey questions, 3) the information letter and consent form that will be sent to parents, 4) the information letter for the students, and 5) our ethics approval letter. Upon your approval of this research study, we would ask you to randomly select four classrooms (if possible) to participate in the nutrition and physical activity survey.

The research has been reviewed by and received ethics clearance from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta.

This research is funded by the Alberta Centre for Child, Family and Community Research and the Canadian Institutes of Health Research.

We would like an opportunity to speak with you to discuss this project and the possibility of your school's participation. We appreciate the strain on schools at this time and do not wish to create more pressure. If there is anything we can do to make it easy for your school to participate, please let us know. One of our staff will call you to determine your interest. In the meantime, if you have any questions, please contact Shauna Downs at (780) 492-3700, or downs@ualberta.ca. We look forward to further collaboration with you on this project.

Sincerely,

Shauna Downs, MSc
Research Coordinator,
Dept of Agricultural, Food & Nutritional Science
University of Alberta
Phone: 780-492-4182
780-903-9453

Linda McCargar, PhD, RD
Professor,
Dept of Agricultural, Food & Nutritional Science
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Phone: 780-492-9287

In the case of any concerns or complaints, please contact:

Ruth Butler,
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Parent Information Letter

Title of Research Project: Web-Survey of Physical Activity and Nutrition 2 (Web-SPAN 2)

This letter describes research being conducted by the University of Alberta (Department of Agricultural, Food & Nutritional Science) at your son or daughter's school. Dr. Linda McCargar is the researcher leading the study, and Shauna Downs is the coordinator of the study. We would like to give you some information about the study to help you to decide if your son or daughter should be a part of it.

Your school board and principal have given us permission to conduct this research. This study has received ethics clearance from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta.

Why is the study being done?

Teenagers are going through a time of physical and emotional changes. They are experiencing the final stages of the adolescent growth spurt with rapid bone development and increasing independence in food and activity behaviours. Previous surveys have shown that children and teens do not get enough food energy, calcium, iron, and are becoming less active. However, there is very little information on the diet and activity levels of Alberta youth.

Who are we looking for?

Teachers of eligible classrooms in your son or daughter's school are being invited to participate in this research. The study will involve 5000 grade seven through ten students throughout Alberta. If you are the parent/guardian of a student invited to take part in this research study, we hope you will agree to his or her participation in the research.

What does my son/daughter have to do?

A student will not be included in the study if a parent or guardian indicates that he or she does not want the student to participate, or if the student does not agree to take part. In order to participate in this survey, your son/daughter **must return a signed and completed consent form** to their teacher.

All of the students in participating classes will be invited to complete a nutrition and physical activity survey on the Internet during class time. This survey is designed to examine food and physical activity habits. We want to know what types of food your son/daughter eats and how they feel about certain foods. Upon completing the survey, your son or daughter will receive immediate feedback on their diet based on 'Eating Well with Canada's Food Guide'. If your son or daughter wishes to revisit the web site on another day, the same set of questions about his/her food behaviour will be available. Revisiting the survey is optional, and may be done on a computer at school, at home, or in the community.

It will take approximately one class period (~45 minutes) to learn about the web site and complete the on-line survey.

Why is the survey web-based?

In the past, other nutrition surveys have included only a small number of participants due to practical issues such as cost. The proposed research will use a web-based tool to deliver a nutrition and physical activity survey to a large number of Alberta children and adolescents. This will result in the most complete assessment of the diet and physical activity of Alberta youth to date.

What will the data be used for*?*

The information collected from the web-based survey will be used to increase our understanding of the nutrition and physical activity habits of adolescents in Alberta. It will also be used to make recommendations about the types of programs needed to improve the health of Alberta youth. All responses will be anonymous and research journal articles and reports will be written based on the group results obtained from this study; individual results will not be referred to in any publication, report, or presentation. We will compare our results to those of a similar study done in Alberta and Ontario. As well, if we re-administer this survey in the future, we will use the results from this study as a comparison for other data. Your son or daughter's involvement in this project does not obligate them in any way to participate in future surveys.

What if I change my mind about participation?

Being in the study is completely voluntary. Your son or daughter is free to refuse to answer any question(s). Being in the study does not pose any risks for your son or daughter. If you and your son or daughter agree now to participate, but either of you change your mind later, either you or your son or daughter can withdraw at any time, up until the point when your son or daughter submits their survey on the Internet.

The final decision to participate in this study must be made by the individual student and his/her parent(s) or guardian(s). Your co-operation in permitting your son or daughter to take part in this research is greatly appreciated. However, there is no penalty of any kind if he/she does not participate. If you have any questions or concerns, please contact Shauna Downs at (780) 492-4182.

Will information about the student go back to the school?

Student names will not be included on the survey; the survey is anonymous. Individual student responses will be kept completely confidential and no individual results will be made available to school or other personnel. Each student will have a unique identification and password. The web site will be password protected so that unauthorized users will be unable to gain access.

Only the researchers at the University of Alberta will have access to the locked computer files on which we will keep your information. These computers are located in locked offices. The data will be permanently stored in electronic form on CD or memory stick, which will be held in locked offices at the University of Alberta. Funders and the Advisory Committee will not have access to this information.

Identification codes, not participant names, will be used in the data analysis. All data are published in group form so that it will not be possible to determine the responses from any

individual student. The teacher will have access to the group results and we will provide feedback to their class. This ensures that the study can support and enhance the curriculum.

Who is funding this project?

This research is funded by the Alberta Centre for Child, Family and Community Research and the Canadian Institutes of Health Research.

How do I include my son/daughter in the project?

If you would like to include your son or daughter in this research project, please complete and sign the attached consent form and have your son/daughter return it to their teacher as soon as possible.

If we do not receive a signed and completed consent form from you, your son/daughter will not be able to participate in the survey.

Sincerely,

Shauna Downs, MSc
Research Coordinator,
Dept of Agricultural, Food & Nutritional Science
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Phone: 780-492-4182
780-903-9453

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UNIVERSITY OF ALBERTA

Student Information Letter

This letter is a request for your help in a study we are doing at the University of Alberta. We would like to give you some information about the study and what you need to do to take part.

Why is the study being done?
We want to collect information on what pre-teens and teenagers in Alberta are eating, how active they are and other factors that influence nutrition and physical activity.

What do I have to do?
If you wish to participate, your parents and/or guardians have to sign and complete the study consent form. After the signed consent form is given to your teacher, he/she will give you a login and password. This login and password will let you sign in to our web survey. We will first ask you to complete the survey on the Internet at school.

What if I want to quit being in the study?
Being in the study is completely up to you. You are free to say you don't want to answer any question. You can also decide to stop all together at any time before you submit your survey on the Internet. If you have any questions about the study, please contact Shauna Downs at (780) 492-3700 or downs@ualberta.ca.

Will information about me go back to my school?
Your name will not be on the survey. All the information that you give to the research group will be kept private. No one at your school will know your answers. Your classroom's average group results will be provided to your teacher.

The final decision to be in this study must be made by you and your parents. We hope you enjoy this survey – and learn from the information you get from the survey. However, there are no consequences any kind if you do not participate.

Sincerely,

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Phone: 780-492-4182
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In the case of any concerns or complaints, please contact:

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CONSENT FORM

Please COMPLETE, sign, date and <u>return this form</u> to your son/daughter's teacher

UNIVERSITY OF ALBERTA

Consent Form

(Please COMPLETE, sign, date and <u>return this form</u> to your son/daughter's teacher)

Title of Research Project: Web-Survey of Physical Activity and Nutrition- 2 (Web-SPAN 2)

Investigators:

Shauna Downs, MSc
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Dept of Agricultural, Food
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Phone: 780-492-4182
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Linda McCargar, PhD, RD
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Phone: 780-492-9287

Consent: Please circle your answers:

Do you understand that you have been asked to include your son or daughter in a nutrition and physical activity research study that will require approximately 45 minutes of class time?

Yes **No**

Have you read and received a copy of the attached Information Letter?

Yes **No**

Do you understand that there are no anticipated risks involved in including your son or daughter in this research study?

Yes **No**

Do you understand that your son or daughter can quit taking part in this study at any time up until the point he or she submits their survey on the Internet? Neither you nor your child has to say why and it will not affect the benefits your son or daughter will receive.

Yes **No**

Was confidentiality adequately explained to you in the information sheet?

Yes **No**

Do you understand who will be able to access the nutrition information collected from this study?

Yes **No**

Do you understand that the information obtained from this project (group results) may be compared to results obtained from a similar survey conducted in Alberta and Ontario and that the information may also be compared to results from future surveys?

Yes **No**

WILL YOU CONSENT TO HAVING YOUR SON OR DAUGHTER TAKE PART IN THIS RESEARCH STUDY?

Yes **No**

Please sign and date below:

Date: _____

Signature of parent/guardian:_____ Name of parent/guardian:_____

As per research guidelines, the anonymous data will be stored for seven years following time of collection. There will be no paper copies of the data. All data will be stored electronically (on CD) and kept in locked offices on password-protected computers.

Appendix B

Table B1: Correlations between all the variables with each other

Variables	S	EI	C	P	F	DQ	UN	NB	NA	PA	SB	FA	EA	SES
Sex (S)	**1**	.289	.248	.294	.259	.130	.199	.139	.167	.132	.174	.063	.086	.015
Energy intake (EI)	.289	**1**[a]	**.927**	**.846**	**.917**	.615	.266	.073	.082	.106	.114	.133	.052	.020
Carbohydrate in grams (C)	.248	**.927**	**1**	.688	.725	.575	.224	.066	.053	.125	.090	.114	.054	.012
Protein in grams (P)	.294	**.846**	.688	**1**	.770	.627	.183	.041	.031	.113	.073	.054	.062	.002
Fat in grams(F)	259	**.917**	.725	.770	**1**	.514	.272	.074	.113	.052	.126	.150	.031	.033
Diet quality (DQ)	.130	.615	.575	.627	.514	**1**	.072	.008	.054	.159	.007	.008	.083	.010
Frequency of unhealthy (UN)	.199	.266	.224	.183	.272	.072	**1**	.199	.318	.024	.379	.438	.010	.049
Nutrition beliefs (NB)	.139	.073	.066	.041	.074	.008	.199	**1**	.364	.122	.209	.095	.123	.007
Nutrition Attitude (NA)	.167	.082	.053	.031	.113	.054	.318	.364	**1**	.241	.303	.207	.199	.034
Physical Activity (PA)	.132	.106	.125	.113	.052	.159	.024	.122	.241	**1**	.197	.087	.449	.075
Sedentary Behaviours (SB)	.174	.114	.090	.073	.126	.007	.379	.209	.303	.197	**1**	.230	.172	.027
Availability of Unhealthy food(FA)	.063	.133	.114	.054	.150	.008	.438	.095	.207	.087	.230	**1**	.033	.008
Encouragement of Activity (EA)	.086	.052	.054	.062	.031	.083	.010	.123	.199	.449	.172	.033	**1**	.037
Socioeconomic status (SES)	.015	.020	.012	.002	.033	.010	.049	.007	.034	.075	.027	.008	.037	**1**

[a] Pearson Correlation **R values**

Bolding means that there is a high correlation (>0.80)

B2: Univariate analysis (linear regression) for all potential variables with BMI

Level	Factor	Variables	P value	Decision at P≤ 0.2
***Individual* level**	Demographic	Sex	0.030[a]	Inclusion
		Grade level	0.000	Inclusion
	Adolescents' Eating	Total energy intake	0.977	Exclusion
		Diet quality	0.138	Inclusion
		Frequency of unhealthy food	0.907	Exclusion
		carbohydrate (g)	0.484	Exclusion
		fat (g)	0.755	Exclusion
		protein (g)	0.302	Exclusion
	Nutrition beliefs	Nutrition beliefs	0.020	Inclusion
	Nutrition attitude	Nutrition attitude	0.580	Exclusion
	Physical Activity	PAQ- C Score	0.001	Inclusion
	Sedentary Behaviours	Sedentary behaviours	0.001	Inclusion
Interpersonal level	Food availability	Unhealthy food availability	0.492	Exclusion
	Encouragement of activity	Encouragement of activity	0.001	Inclusion
Global factor	Socioeconomic Status	Socioeconomic Status	0.080	Inclusion

Table B3: Multiple regression analysis to select variables

Variables	P value[a]	Decision at P≤ 0.05
Sex of student (S)	0.036	**Inclusion**
Grade level (GL)	0.000	**Inclusion**
Diet quality (DQ)	0.100	Exclusion
Nutritional beliefs (NB)	0.000	**Inclusion**
PAQ- C Score (PA)	0.004	**Inclusion**
Sedentary behaviours (SB)	0.000	**Inclusion**
Encouragement of activity (EA)	0.446	Exclusion
Median income of school community (SES)	0.603	Exclusion

[a] Multiple regression to predict BMI

Table B4: Test for potential confounders each one separately

Variables	β Coefficients[a]	β SES	β EA	β DQ	Δβ SES	Δβ EA	Δβ DQ
S	-.424	-.441	-.404	-.436	-3.85%	-4.95%	2.75%
GL	.614	.611	.633	.625	0.49%	3%	1.76%
NB	.096	.097	.096	.097	-1.03%	0%	1.03%
PA	-.395	-.376	-.384	-.400	5.05%	2.86%	1.25%
SB	.027	.029	.026	.027	-6.90%	3.85%	0%
DQ				.207			
EA			-.020				
SES		-1.300					

β = beta Coefficient

Δβ= Delta Beta

[a] Multiple regression that include all significant factor

Table B5: Test for potential interactions (each one separately) which might influence the relationship with BMI

Interaction	P value [a]	Decision at P≤ 0.05
PA + SB	.105	No interaction
PA + EA	.649	No interaction
EA + SB	.962	No interaction
Kcal + FA	.707	No interaction
Kcal + NB	.338	No interaction
Kcal + DQ	.329	No interaction
Kcal + PA	.860	No interaction
Kcal+ SB	.860	No interaction
Kcal+ S	.325	No interaction
Kcal+ GL	.420	No interaction

[a]Multiple regression that include all significant factors and each potential interaction separately

[b] sub-set of variables presented