University of Alberta

The Correspondence between Child and Parent Pedometer Steps in a Northern Canadian City

by

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Abstract

Purpose: This study examined whether parent physical activity (PA) is related to children's PA, as measured with pedometers.

Methods: As part of a longitudinal cohort study being conducted in Edmonton, Canada, 471 children between the ages of 6 and 10 years-old, wore SC-T2 pedometers for four consecutive days.

Results: Significant small-to-moderate correlations between parent and child steps were found on day 1(r = .24), day 2 (r = .24) day 3 (r = .19), and day 4 (r = .33). After controlling for covariates, parent steps remained a significant predictor of both girls (p < .001) and boys steps (p < .001). Parent steps also remained a significant predictor of child weekend (p < .001) and weekday steps (p < .001) after controlling for covariates.

Conclusion: The study highlights the importance of parent PA modeling in promoting children's PA and suggests that parents may be optimal targets for intervention.

Preface

I have been involved with the Environmental Determinants of Health and Growth among Children project since June 2009. I worked as one of the research assistants for the project, conducting fitness assessments with the children. This job involved measuring height, weight, waist circumference and running fitness tests for sit-ups, pushups, vertical jump, grip strength, flexibility, and aerobic fitness. We administered an assent form, a consent form, and a survey to the parents, and sent them home with a 4-day pedometer and food record log book. In January 2010, I began doing data entry for the study. Up until this point the job was done by another research assistant. As of September 2010, I have had the help of Annie Selzler.

At the end of July 2010 I took over for Mildred Masimira as the research coordinator of the project because she left on maternity leave. As the research coordinator my job entailed calling parents and setting up appointments for the fitness assessments. I was also responsible for organizing the schedule, ordering supplies, and hiring new employees.

For my Master’s thesis I was completely responsible for preparing the data set (e.g., screening variables, aggregating data) and conducting all analyses.

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Chapter 1: Introduction

Background

Over the past few decades obesity has become a key global health concern with many describing it as an "epidemic" (e.g., Anderson, 2000; James, Leach, Kalamara, & Shayeghi, 2001). The 2004 Canadian Community Health Survey found that 35% of children (i.e., 3 – 12 years-old; Gustafson & Rhodes, 2006) and adolescents (i.e., 13 - 18 years-old; Gustafson & Rhodes, 2006) aged 6- to 17-years-olds were classified as either overweight or obese (Shields & Tremblay, 2010). Further, between 1978/79 to 2004, these levels increased from 27% to 38% in boys and 19% to 31% in girls (Shields & Tremblay, 2010). Along with changes in diet, increasing daily physical activity (PA) levels is one avenue that childhood obesity can be prevented (Janssen & LeBlanc, 2010; Strong et al., 2005).

Living a physically active lifestyle is important for the health and well-being of people of all ages (Janssen & LeBlanc, 2010; Penedo & Dahn, 2005). Although most are aware of the benefits (Cameron, Craig, & Paolin, 2004), a large proportion of the Canadian population is insufficiently active. According to the Canadian Health Measures Survey (CHMS), only 15% of Canadian adults are able to accumulate the recommended 150 minutes of moderate-to-vigorous physical activity (MVPA) per week and 35% are able to accrue 10,000 steps per day (Colley et al., 2011a). Similarly, among Canadians 6- to 19-years-old approximately 9% of boys and 4% of girls are able to accumulate 60 minutes of MVPA on 6 or more days of the week (Colley et al., 2011b). Further, 10% of boys and less than 9% of girls in Canada aged 6- to 10-years-old are able to surpass the 13,500 step cut-off on 6 or more days of the week (i.e., equivalent to 60 minutes of MVPA per day).

The sedentary lifestyles evident in modern day society are a major concern, as inactivity has been linked to markers of disease (e.g., high blood pressure, metabolic syndrome; Janssen & LeBlanc, 2010) and an increased risk of obesity, coronary heart disease, diabetes, and all cause mortality in adulthood (Berlin & Colditz, 1990; Blair & Brodney, 1999; Helmrich, Ragland, Leung & Paffenbarger, 1991). Both PA and obesity have been shown to track into the adult years (Janz, Dawson, & Mahoney, 2000; Malina, 1996; Malina, 2001; Twisk, Kemper & van Mechelen, 2000). Therefore, the promotion of PA in childhood is an important public health strategy.

Theoretical Framework

Health promotion interventions and initiatives should be informed by theory and evidence-based research (Baranowski, Anderson & Carmack, 1998). Before such programs can be created, researchers need to first develop a clear understanding of the influences or determinants of children's PA (Sallis, Prochaska, & Taylor, 2000). One important area of research is parental influences. Several theories such as Welk's (1999) Youth Physical Activity Promotion (YPAP) Model and Taylor, Baranowski, and Sallis's (1994) socialization model of child behaviour (based on Social Cognitive Theory [Bandura, 1986]), highlight the vital importance that parents play in determining children's PA behaviours. According to YPAP, parental influences act as "reinforcing factors" that directly influence children's PA as well as their perceived competence and self-efficacy (i.e., "am I able?"), enjoyment, beliefs and attitudes (i.e., "is it worth it?"; Welk, 1999). Taylor and colleagues' model of child socialization describes reciprocal relationships between the parent (cognitions and behaviours), child (cognitions and behaviours) and the environment. According to this model, parent's behaviours and the environment directly influence children's behaviours, while parent cognitions influence children's behaviours indirectly through the environment and the parent's behaviours. In line with these models, this thesis will investigate whether parents own PA behaviours influence the PA behaviours of their children (i.e., parental modeling).

Ecological models provide a useful framework for understanding the complexity of human behaviour. According to these models, PA is influenced by a multitude of interdependent factors that exist within (i.e., intra-individual) and outside (i.e., extra-individual) of the individual (Spence & Lee, 2003; Wachs, 1992). These factors consist of psychological (i.e., cognitions, emotions, behaviours), biological, and environmental variables. Although the idea of an interactive system was first introduced by Bronfrenbrenner (1977) as the bioecological systems theory, it has since been adapted for childhood obesity (Davidson & Birch, 2001), sport (Garcia Bengoechea & Johnson, 2000), and PA (Spence & Lee, 2003). This thesis will draw upon Spence and Lee's (2003) ecological model of physical activity (EMPA) as a guiding framework because it was developed for research examining the determinants of PA.

According EMPA, the environment consists of multiple layers of influence with the most proximal having the most immediate effects and the more distal having more broad effects (Spence & Lee, 2003). Ranging from the most proximal to distal, the layers of extra-individual influences include the micro (i.e., settings of a child's immediate environment, either physical or social), meso (i.e., connections or interactions between microsystems), exo (i.e., multiple microsystems where the individual is a part of one but not all settings), and macro systems (i.e., the broad sociocultural environment in which the child lives), as well as physical ecology, and pressure for macrosystem change. The intra-individual factors include biological or genetic (e.g., sex) and psychological influences (e.g., attitudes).

Parental modeling is a microsystem factor that is thought to influence children through the process of vicarious learning. According to Bandura (1986) there are four ways in which vicarious learning can occur. First, an observer can acquire a new skill (cognitive or behavioural) by watching a model perform the skill. For instance, a child may learn how to throw a baseball from watching his father throw the ball during a game.

The second and third processes are *inhibitory* and *disinhibitory effects*, whereby a previously learned behaviour is further strengthened or weakened. For example a child may learn the importance of being active at school, but if their parents are not active on a regular basis, it may weaken the personal importance of PA for the child. On the other hand, if the child's parents are regularly active, this may strengthen the child's cognitions regarding the importance of maintaining a physically active lifestyle. The last process is *response facilitation effects* whereby others behaviours serve to prompt or cue the observer to perform a previously learned skill. For instance if a child's mother decides to go walking with a few of her girlfriends, it may prompt her young daughter to invite a friend over to play at the park.

The experience of vicarious learning or modeling will not occur or will not be as strong, unless four processes occur: the observer is attentive, they are able to retain the information, their body is able to reproduce the skill behaviourally, and they are motivated to learn or perform the skill (Bandura, 1986). Younger children may not pay attention to their parent's actions, their bodies may lack the physical and/or cognitive abilities to learn different skills, and they may lack motivation to be active. Therefore, it is important for studies to examine this phenomenon with children in different age groups (i.e., within or across studies). If parental modeling is found to have a greater influence at specific age groups, interventions can be developed accordingly.

Current Literature on Parental Modeling of Physical Activity

In the early years, children spend a large majority of their time accompanied by their parents and therefore parents act as key socializing agents in children's lives (Tinsley, 2003). Parents can influence children's physical activities (e.g., organized sport, outdoor play) by providing logistic support (e.g., transporting and paying for programs), giving verbal encouragement, modeling active behaviours, and demonstrating positive (or negative) attitudes and beliefs towards PA (Saelens & Kerr, 2006).

A common method for assessing parental modeling of PA is to examine the relationship between parent and child PA. There have been several reviews of the literature, some finding support for a positive relationship (Peugliese & Tinsley, 2007; Edwardson & Gorely, 2010; Van Der Horst, Paw, Twist, & Mechelen, 2007) and others concluding that there is a lack of evidence or no evidence (Edwardson & Gorely, 2010; Ferreira et al., 2007; Gustafson & Rhodes, 2006; Sallis et al., 2000; Van Der Horst et al., 2007).

An important limitation of many of the studies within these reviews is the overuse of self- and proxy-report measures for parent(s) and/or child's PA (Ferreira et al, 2007). The accuracy of these measures is questionable for multiple reasons. The parents and/or children may respond consciously or unconsciously in a manner that is socially desirable (e.g., overestimate the number of times they were active in the last week in an effort to present themselves in a positive light). In addition, children's behaviour is very sporadic and intermittent (Banqet, Stratton, Van Praagh, & Berthoin, 2007), therefore it is difficult for a child or parent to accurately recall every bout of activity that occurs throughout the day (Sirard & Pate, 2001). Thus, direct measures such as pedometers or accelerometers are preferred as the data are obtained solely from an electronic/mechanical device, rather than abstracted from memory (Rowlands & Eston, 2007).

It should also be noted that by examining the relationship between parent and child PA, we do not known for certain whether parental modeling of PA is occurring. The relationship could be due to shared activities, co-participation, genetic predispositions, social support, or a home environment conducive to PA (Fuemmeler, Anderson, & Masse, 2011; Gustafson & Rhodes, 2006; Moore et al., 1991). The term "parental modeling" is often used in the literature to refer to the parent-child PA relationship (Cleland et al., 2011; Ferreira et al., 2006; Pugliese & Tinsley, 2007; Sallis et al., 2000), although some studies acknowledge that it is not definitively known whether parental modeling is occurring (Fuemmeler et al., 2011; Gustafson & Rhodes, 2006; Moore et al., 1991). As children spend a large majority of their time with their parents (Tinsley, 2003), we assume that parental modeling is likely occurring but we acknowledge that this may not be the case.

The purpose of this thesis was to examine the relationship between parent and child free-living activity, as measured by pedometers, in a large sample of children aged 6- to 10-years-old and one of their parents. To date, seven studies have used a direct measure of PA in both parents and children to examine the parent-child PA relationship in children 12-years-old and younger (Freedson & Evenson, 1991; Fuemmeler et al., 2011; Jago, Fox, Page, Brockman, & Thompson, 2010; Loucaides & Jago, 2006; Moore et al., 1991; Oliver, Schofield, & Schluter, 2010; Taylor et al., 2008). Only three of these studies were conducted with children in the 6- to 10-year-old age range (Freedson & Evenson, 1991; Fuemmeler et al., 2011; Moore et al., 1991). The current study is a unique addition to the literature because it is has the largest sample size of the aforementioned studies, it is the first to be conducted in Canada and in a Northern climate and it compares both weekend and weekday PA patterns as well as differences between boys and girls.

Research Questions and Hypotheses

The present study aimed to:

(1) determine the relationship between the number of pedometer steps taken per day by parents and children on each day of measurement (i.e., day 1, 2, 3, 4 separately);

(2) determine the relationship between the average *total* number of pedometer steps taken per day by parents and children (boys and girls separately) after controlling for covariates; and

(3) determine the relationship between the average weekday and weekend day pedometer steps of parents and children after controlling for covariates.

The covariates included child age, gender (for Research Question 3 only) and BMI, area-level socioeconomic status (SES), and season.

We hypothesized that:

H1: Positive correlations will exist between parent and child steps on each day of measurement.

H2: A positive relationship will exist between the average total steps of parents and children (both boys and girls).

H3: A positive relationship will exist between parent and child pedometer steps on both weekdays and weekend days.

Chapter 2: Literature Review

This thesis focused on the role of parents in determining children's activity levels. Specifically, we investigated how parent PA or parent PA modeling influences in children's PA. To set the context, this literature review will begin by discussing the health benefits of PA and the link between PA and obesity. Then it will describe the instruments commonly used to measure children's PA along with the advantages and disadvantages of each. Next it will review the current Canadian Society for Exercise Physiology (CSEP) and World Health Organization (WHO) PA guidelines as well as the proportion of Canadians and people worldwide who are meeting these guidelines. Further it will discuss the psychological, biological, and environmental variables that consistently correlate with children's PA, followed by specific parental factors known to influence children's PA. Finally, I will lay out the current evidence for parental PA modeling and will describe how this thesis advances knowledge in this area.

Health Benefits of Daily Physical Activity

The physical and psychological benefits of regular PA in adulthood are well understood. At the physical level, habitual PA is known to reduce one's risk of developing more than 25 chronic diseases including cardiovascular disease, type 2 diabetes, hypertension, obesity, colon cancer and breast cancer (Katzmarzyk & Janssen, 2004; Warburton, Charlesworth, Ivey, Nettlefold, & Bredin, 2010; Warburton, Katzmarzyk, Rhodes & Shephard, 2007; Warburton, Nicol, & Bredin, 2006). At the psychological level, PA is associated with higher levels of self-esteem (Spence, McGannon & Poon, 2005), and lower rates of depression and anxiety (Strohle, 2009). Further, PA is an effective secondary prevention strategy for the management of obesity, cardiovascular disease (CVD), type 2 diabetes, cancer and depression (Strohle, 2009; Warburton et al., 2006).

The health benefits of PA in childhood are not well understood, most likely because the diagnosis of chronic illnesses typically does not occur until adulthood (Stensel, Gorely & Biddle, 2008). As a result, the research linking PA and health in children is primarily focused on the presence of positive health indicators and disease risk factors. There is strong evidence for the positive impact of aerobic activity on cardiovascular health (i.e., aerobic fitness) and of moderate-to-high impact activities on musculoskeletal health (i.e., bone mineral density) when combined with aerobic weight bearing activities (Janssen & LeBlanc, 2010). Based upon cross-sectional designs, greater PA or fitness is linked to lower cholesterol and blood lipids, blood pressure (significant but weak relationship), metabolic syndrome, and overweight and obesity (Janssen & LeBlanc, 2010).

Aerobic exercise interventions have been shown to improve lipid and lipoprotein markers, indicators of the metabolic syndrome (e.g., fasting insulin, insulin resistance), and depressive symptoms, and to reduce blood pressure and adiposity (Janssen & LeBlanc, 2010). On the other hand, high-impact weight-bearing interventions have been shown to improve bone mineral density. PA may also positively influence self-concept and self-esteem and lead to better academic performance (Strong et al., 2005). It should be noted that the evidence for children is not as strong as with adults, due to small sample sizes, non-representative samples, and a reliance on self-report measures. Regardless, PA in children is likely to produce benefits similar to those found in adults, and therefore PA should be promoted in the younger years (Biddle, Gorely & Stensel, 2004; Riddoch, 1998).

Link between Physical Activity and Obesity

In terms of health indicators, childhood obesity has become a major concern due to substantial increases in overweight and obesity in Canada and around the world (Ball & McCargar, 2003; Deckelbaum & Williams, 2001; Wang & Lobstein, 2006). This trend is thought to be the result of a reduction of PA and the overconsumption of high-calorie foods (Andersen, 2000; Hill, Wyatt, Reed, & Peters, 2003). Currently in Canada, 35% of 6- to 17-years-olds are classified as either overweight or obese and between 1978/79 and 2004, these levels increased from 27% to 38% in boys and 19% to 31% in girls (Shields & Tremblay, 2010). For children, obesity is related to lower PA levels, self-esteem, self-efficacy, and physical competence as well as smaller peer networks and less friendship nominations (Blanchard et al., 2005; Jones, Okely, Caputi, & Cliff, 2010; Strauss, 2000; Strauss & Pollack, 2003; Wang, Wild, Kipp, Kuhle, & Veugelers, 2009). Obesity tends to track into adulthood (e.g., Clarke & Lauer, 1993; Herman, Craig, Gauvin, & Katzmarzyk, 2009) and excess adiposity is associated with an increased risk of type 2 diabetes, hypertension, and cardiovascular disease in adulthood (Goralski & Sinal, 2007). Therefore it is vital that obesity prevention initiatives are developed and implemented in the early years of life.

Measurement of Physical Activity

PA is a complex and multifaced behaviour that is difficult to directly measure. It is typically defined as "any bodily movement produced by the skeletal muscles that results in energy expenditure" (Caspersen, Powell, Christenson, 1985, p. 234). For children/adolescents aged 5- to 17-years-old, "physical activity includes [active] play, games, sports, transport, recreation, physical education, or planned exercise in the context of family, school, and community activities" (WHO, 2010, p. 7).

There are numerous methods for measuring PA or energy expenditure (EE), each with advantages and disadvantages. The most valid and reliable measures include indirect calorimetry, doubly labelled water, and direct observation, and are often referred to as primary measures (Sirard & Pate, 2001). Indirect calorimetry involves measuring a person's oxygen consumption within a laboratory setting as an estimation of EE. This method is intensive, and thus is typically only used to validate other forms of PA measurement rather than study PA patterns. Doubly labelled water requires participants to ingest two stable isotopes of water (i.e., deuterium and oxygen-18) that are eventually eliminated out of the body (Ainslie, Reilly, & Westerterp, 2003). The urine is then tested over a period of time (i.e., between 4 to 20 days) to determine the difference in excretion rates of the two isotopes. This method results in a direct measure of carbon dioxide and therefore an estimation of EE. Doubly labelled water is less intrusive than indirect calorimetry, but very costly. Both of these methods are unrealistic for use in studies with large samples, long time frames, and when there are personnel or monetary constraints (Sirard & Pate, 2001). Direct observation measures require researchers to watch children in places such as physical education class or playgrounds and to take systematic records of their activity patterns. This method requires a great deal of time and resources, and observations are limited to certain settings (Marshall & Welk, 2008). Therefore direct observation is only appropriate for certain types of research designs, and cannot be used to measure free-living activity.

Because of the limitations involved with using primary measures in field-based research, a variety of methods are used to estimate EE and/or measure PA. Patterns of PA are typically described in terms of frequency, intensity, duration, type (i.e., aerobic, anaerobic), and/or domain (i.e., context or setting; Marshall & Welk, 2008). In field studies, direct measures provide the most reliable and valid estimates of PA. Heart rate monitors, accelerometers, and pedometers are direct because the data does not rely on a subjective interpretation of the participant (Marshall & Welk, 2008). However, some subjectivity can be introduced when participants are required to record their daily steps in a pedometer log. Heart rate monitors provide an indication of physiological stress placed on the body, allowing for intensity, frequency and duration to be determined (Dale, Welk, & Matthews, 2002). There are many limitations to this method. Individual variation in age, body and muscle mass, fitness level, and emotional stress result in differential heart rate responses to body movement (Trost, 2001). Further, heart rate monitors may not capture the sporadic nature of children's movement because heart rate lags a little behind body movement. Although corrections are available to overcome some of these limitations, complications are added and therefore, this method is used less often in field-based research (Marshall & Welk, 2008).

Direct measures of PA used most frequently in field-based studies are accelerometers and pedometers. Accelerometers are small mechanical devices worn on the hip that measure the acceleration of body segments, convert them into electrical signals, and store them as movement counts (Sirard & Pate, 2001). An advantage of this method is the device stores information on duration, type and frequency of activity thereby allowing time spent in moderate and/or vigorous physical activity (MPA, VPA) to be determined, and compared to national guidelines.

Pedometers are small devices often worn on the hip or belt that measure vertical accelerations and decelerations of the hip and provide information in terms of step counts or distance travelled (Bassett & Strath, 2002). Pedometers are advantageous in their low cost (i.e., between $17 - $25; De Vries et al., 2009) and user friendliness for both researchers and participants. Although accelerometers provide more information (i.e., duration, frequency, intensity), they cost significantly more (i.e., between $300 - $4700; De Vries et al., 2009), and the output requires complex synthesis and analysis. A major limitation of both the accelerometer and pedometer is the inability to capture non-ambulatory activities such as swimming and cycling (Trost, 2001). Similarly, they do not detect upper body movement and fail to account for the increased cost of moving uphill or carrying a load.

Finally, PA can be measured via indirect methods including diaries, interviews, and questionnaires (Sirard & Pate, 2001). These can be reported by the child, the parent, or other individuals who can make a judgement around the activity of the child (e.g., teacher reports). Contrary to direct measures, indirect assessments require participants or reporters (e.g., parent, teacher) to use cognitive and perceptual processing to think about and record the data (Marshall & Welk, 2008). Some instruments require the individual to recall activity over a period of time, while others ask for general activity habits. One advantage of indirect measures is they allow researchers to measure time spent in different activities or settings (e.g., organized sport, active play; Chinapaw, Mokkink, van Poppel, van Mechelen, & Terwee, 2010). Also, they are inexpensive and easy to administer and as a result have been the most common form of PA measurement in the past. Unfortunately, there are a lot of problems surrounding the use of indirect measures, especially with children. Errors in memory recall, inaccurately recording data, responding in a manner that is socially desirable, and other biases are key concerns (Sirad & Pate, 2001). In addition, children may lack the cognitive capacity to accurately recall the intensity or amount of time spent doing an activity, and they may misinterpret questions more readily. Further, the variable and sporadic nature of children's activity (e.g., Banqet et al., 2007) may present additional limitations on their ability to recall events, particularly with unplanned or unorganized activities. In a recent systematic review of questionnaires measuring child PA, Chinapow and colleagues (2010) concluded that none of the available questionnaires demonstrate acceptable levels of both reliability and validity. As a result, it is important that researchers employ direct measures, such as pedometers and accelerometers to measure children's PA, whenever possible.

Physical Activity Guidelines

Children. The WHO and the *Canadian Physical Activity Guidelines for Children and Youth* recommend that 5- to 17-years-olds accumulate a minimum of 60 minutes of MVPA per day (CSEP, 2011; WHO, 2010). Further, this age group should engage in VPA and bone and muscle strengthening activities at least three days per week. These guidelines are important for the public as they serve as targets for guiding daily activity, and for researchers in determining what proportion of the population is sufficiently active.

When researchers use pedometers to measure PA, the output is presented as total steps or steps accumulated per day. Because no information is obtained on intensity or duration of activity, the results cannot be directly compared to the recommended guidelines. Health-determined cut-points are useful at the individual level for guiding and evaluating PA behaviour choices and at the population level for screening, surveillance, and the development of interventions (Tudor-Locke, Hatano, Pangrazi, & Kang, 2008). While no universal guidelines have been established, different cut-points have been put forward. For instance, the step equivalent of 60 minutes of MVPA per day (i.e., WHO and Canadian PA guidelines) was determined to be 13,500 steps per day (Colley et al., 2011b). Tudor-Locke et al. (2004) calculated BMI-referenced standards (i.e., cut-point between a healthy versus unhealthy body weight) for children aged 6- to 12-years-old to be 12,000 steps for girls and 15,000 steps for boys. Tudor-Locke et al. (2008) developed *preliminary* indices based on important health related outcomes for children aged 6- to 12-years-old. The zones for girls include: copper (< 7000 steps/day), bronze (7000-9499 steps/day), silver (9500-11,999 steps/day), gold (12,000-14,499), and platinum (≥ 14,500 steps/day). For boys the zones include: copper (>10,000), bronze (10,000-12,499), silver (12,500-14,499), gold (15,000-17,499), and platinum (≥17,500). These indices were developed to equate to the adult zones of sedentary, low active, somewhat active, active, and highly active. All of the aforementioned standards are valuable for classifying children in relation to their current level of activity.

Adults. Currently, the WHO and *Canada's Physical Activity Guidelines for Adults* recommend that adults aged 18- to 64-years-old accumulate at least 150 minutes of MVPA of aerobic exercise, accrued in at least 10-minute bouts of continuous activity (CSEP, 2011; WHO, 2011). WHO also offers the following two alternatives: 75 minutes of VPA per week or an equivalent combination of both VPA and MPA. Further, muscle and bone strengthening exercises targeting the large muscle groups should be performed at least two days per week. In regards to pedometer steps, 10,000 steps per day is the threshold indicative of a level of activity for which individuals accrue health benefits (Tudor-Locke & Bassett, 2004). Tudor-Locke and Bassett (2004) developed pedometer-based indices relative to important health indicators including obesity, hypertension, cardiovascular disease, and diabetes. The indices are: sedentary (under 5,000 steps/day), low active (5,000 to 7,499 steps/day), somewhat active (7,500 to 9,999 steps/day), active (10,000 to 13499 steps/day), and highly active (over 12,500 steps/day).

Proportions of Children/Adults Who Achieve Physical Activity Guidelines

International. It is important to be aware of the activity levels of Canadians and of people in different countries around the world so that comparisons can be made between studies. Of the literature currently available on PA patterns of children, adolescents and adults, less than 50% of the world population can be classified as sufficiently active (Sisson & Katzmarzyk, 2008). Specifically Sisson and Katzmarzyk (2008) reported that 53%, 63%, 68%, and 88% of men, women, boys, and girls respectfully are considered inactive based on studies conducted in 39 countries around the world.

Although there are no internationally recognized standards for classifying children or adults as active or inactive based on pedometer steps, it is helpful to be aware of the average step counts of individuals in other countries so comparisons can be made. Vincent, Pangrazi, Raustorp, Tomson and Cuddihy (2003) conducted an international comparison between Australia, Sweeden and the United States of the average pedometers steps in children aged 4- to 12-years-old. The authors found that the Sweedish children produced a higher daily step count than did their Australian and American counterparts. The mean steps accumulated for boys ranged between 15,673 – 18,346 in Sweeden, 13,864 – 15,023 in Australia, and 12,554 – 13,872 in America. The mean steps accumulated in girls were between 12,041 – 14,825 in Sweeden, 11,221 – 12,322 in Australia, and 10,661 – 11,383 in America. Further, the step counts through ages 4 to 12 were somewhat stable. In another review, Beets, Bornstein, Beighle, Cardinal and Morgan (2010) examined studies measuring the pedometer steps of children/adolescents aged 5 – 19 in 13 countries around the world. Studies conducted in Europe (i.e., Sweden, Switzerland, Belgium, France, Greece, Czech Republic, United Kingdom) and the Western Pacific (i.e., Australia, New Zealand) had higher daily step counts than did studies conducted in Canada or the US. Across the 13 countries included in the review, the highest steps per day were found in 9- to 13-year-olds, with a significant decline in steps per day occurring in the subsequent years.

Due to similarities in culture and demographics, activity levels in the US are the most comparable to Canada. The 2005 – 2009 US National Health and Nutrition Examination Survey (NHANES) reported the average number of steps taken per day in children aged 6- to 11-years-old to be approximately 13,000 for boys and 12,000 for girls (Tudor-Locke, Johnson, & Katzmarzyk, 2010). Using the zone-based hierarchy proposed by Tudor-Locke et al. (2008) this places boys in the "somewhat active" (i.e., 12500 – 14999) category and the girls in the "active" (i.e., 12000 – 14999) category. When the authors applied a "censor" (i.e., to account for the sensitivity of the accelerometer used), eliminating steps taken below 500 counts per minute, the values were reduced by approximately 2600 steps overall (Tudor-Locke et al., 2010). Specifically, the percentage of children (i.e., 6 – 11 years) classified as "sedentary" (i.e., > 7,000 steps/day, girls; > 10,000 steps/day, boys) increased from 16.8% to 41.8% for boys and from 2.7% to 21.2% in girls. Further, the girls aged 6-, 7-, 8-, 9- and 10-years-old (the age group of the present study) took an average of 10,399, 9632, 9923, 9714, 8966 uncensored steps/day, while the boys took an average of 11715, 11096, 10603, 10720, 9759 uncensored steps/day.

Similarly to previous studies, there was a decreasing trend in average steps per day such that older boys and girls were less active than their younger peers.

Using the NHANES, Tudor-Locke, Johnson, and Katzmarzyk (2009) published accelerometer determined steps for adults (≥ 20 years-old) in the United States. On average, the women in the study accumulated 8882 uncensored steps per day (i.e., somewhat active) or 5756 censored steps per day (i.e., low active). In comparison, the men on average took 10,578 uncensored steps per day (i.e., active) or 7431 censored steps per day (i.e., low active).

Canada. Based on the 2005 – 2007 CHMS, 14% of boys and 7% of girls in Canada aged 6- to 10-years-old accumulated 60 minutes of MVPA on six days of the week (Colley et al., 2011b). In addition, only 4% of children/adolescents aged 6- to 19-years-old accrued 20 minutes of vigorous PA (VPA; e.g., running, soccer) three days per week. Further, 10% of boys and less than 9% of girls aged 6- to 10-years-old achieved the 13,500 pedometer step cut-off on six or more days of the week. However, when *average* steps accumulated per day was examined, 40% of boys and 27% of girls obtained 13,500 steps per day. Craig, Cameron, Griffiths and Tudor-Locke (2010) published pedometer data in a large Canadian sample of 5- to 19-years-olds and compared the average step counts of girls and boys to various cut-points (i.e., BMI-referenced, 90 min MVPA equivalent). For girls, 33.8% met the 12,000 step BMI-reference cut-point, and 6.1% met the 16,500 step criteria (i.e., representing Canada's PA guidelines at the time of the study). For boys, 23.3% met the 15,000 step BMI-referenced cut-point and 13.8% met the 16,500 step criteria.

According to the 2007 - 2009 CHMS, 17% of men and 14% of women are meeting the aerobic guidelines of 150 minutes of MVPA per day accumulated in 10 minute bouts (Colley et al., 2011a). Further, only 5% are accumulating 30 minutes of MVPA on five or more days of the week. In terms of *average* daily pedometer steps, 39%

of men and 30% of women took at least 10,000 steps per day. These statistics are important as they were used as a comparison to determine how active our sample of parents and children were.

Correlates of Children's Physical Activity

Since the year 2000, three reviews have examined the biological, demographic, psychological, behavioural, social, and physical determinants of PA in childhood (see Table 1). Sallis and others (2000) reviewed studies published between 1970 and 1998 and found the consistent correlates to be sex (i.e., males are more active), parental BMI, preference for PA, intentions, perceived barriers (i.e., negative correlate), previous PA behaviours, diet, and access to facilities and programs. Van der Horst et al. (2007) updated the Sallis et al. paper by examining studies published between 1999 and January 2005. In relation to the 60 studies reviewed, gender, self-efficacy, parental modelling of PA (for boys only), and support from parents were consistent associates of children's PA. Ferreira and colleagues (2007) reviewed studies on environmental determinants of children's PA participation, published between January 1980 and December 2004. The strongest correlates were identified as: fathers PA, school policies, and time spent outdoors. Thus, there are differences and similarities across the review articles.

Within these reviews, the authors observed multiple inconsistencies between studies, and suggest various reasons for why these discrepancies exist (Ferreira et al., 2007; Sallis et al., 2000; Van der Horst et al., 2007). Differences in sample sizes and characteristics may account for some inconsistencies. When small sample sizes are used, the power to detect an association is low, thereby increasing the chance of a type II error. Therefore, a null association may be reported when in reality an association (or difference) is present. Differences in sample characteristics, such as ethnicity, SES, BMI, gender, or eagerness to participate (i.e., volunteers) may create results that are nongeneralizable to the general population. For example, children who live in privileged areas may be influenced by different factors (e.g., enjoyment of PA, self-efficacy) than those living in less privileged areas (e.g., limited availability of parks, safety, money for sporting equipment). Therefore combining the results of these studies may be misleading.

The type of measurement tool (e.g., direct, indirect) used in the reviewed studies could contribute to the inconsistent findings (Ferreira et al., 2007; Sallis et al., 2000; Van der Horst et al., 2007). Many of the studies used child- and/or parent- reported measures of PA. As mentioned previously, there are issues pertaining to the reliability and validity of these methods, and thus the accuracy of the findings are questionable. To complicate things further, many of the studies employed unvalidated questionnaires, which may have lead to systematic errors in measurement and ultimately insignificant findings.

Differences between the types of indirect measures or questionnaires used across studies could have also lead to discrepant findings. For example, in relation to parental PA modeling, some researchers had children report whether they perceive their parent(s) to be active or not, while others had parents report their own level of activity. These are two very different variables, as children may not always see their parents engage in active pursuits or they may not have an accurate perception (e.g., due to cognitive abilities) of their parents activity level. Moreover, questionnaires typically assess leisure time PA which may be limited to planned activities, and sporadic activity (characteristic of children's PA) may be missed. Direct measures on the other hand are more likely to capture both planned and sporadic activity, although non-ambulatory activities such as swimming and biking are not represented. Correlations between indirect (those with acceptable validity) and direct measures are typically moderate in size, suggesting they are not measuring the same construct, and should be considered separately (Ferreira et al., 2007). The reviews typically treat these measures of PA as interchangeable, when in fact they are not, and thus may result in very different findings. Finally, when indirect measures of PA are used along with other indirect measures such as self-efficacy or perceived barriers, shared method variance could create inflated estimates (Ferreira et al., 2007).

A final possibility for why differences exist across studies is the inconsistent use and reporting of univariate and multivariate statistics (Ferreira et al., 2007; Sallis et al., 2000; Van der Horst et al., 2007). Some studies report only univariate statistics while others report only multivariate. This is problematic as multivariate methods typically yield less significant findings than do univariate, because effects due to shared variance are eliminated.

Therefore well designed studies are needed within the literature of children's PA. Studies using large sample sizes, controlling for potential confounders and using direct measures of children's PA will hopefully lead to more consistent findings in the future.

Parental Influences on Children's Physical Activity

In most people's lives, the relationships built within the family are the most intensive, with strong emotional bonds between members (Sallis & Nader, 1988). Accordingly, these relationships are thought to affect every aspect of a child's life and may endure for a lifetime. Because children spend a great deal of time with their parents and siblings, particularly in the early years, the family is the primary social institution to which a child resides. As a result, parents are key socialization agents in the physical, psychological and emotional development of children (Welk, Wood, & Morss, 2003). Therefore it seems intuitive that parents exert a substantial influence on their children's behaviours, including PA.

Parents typically act as "gatekeepers", determining what activities children can perform (e.g., allowed to play outdoors alone, enrolment in a sports team), and providing the necessary resources to participate in activities (e.g., purchase sporting equipment, pay registration fees; Welk et al., 2003). According to many, caretakers can influence their children's PA participation by modeling interest and efforts to be active or by providing social support. That being said, the resources available to parents (e.g., income), their level of education, and the quality of the family's neighbourhood (e.g., presence of parks/playgrounds) may influence a parent's ability to be active (i.e., modeling) and provide PA related support.

There is evidence that parent's education, income, and occupational prestige play a role in children and adult's PA. In a large nationally representative sample of children/adolescents aged 5- to19-years-old (i.e., CANPLAY), Craig and colleagues (2010) found that approximately 1200 fewer steps per day were taken by children/ adolescents living in households with an annual income lower than $40,000 per year than households with an annual income higher than $80,000 per year. Further, approximately 1400 fewer steps per day were taken by girls whose parent had less than a secondary education in comparison to those who had a university education. Tremblay and Willms (2003) explored the role of socioeconomic factors (i.e., parent's education, income, job prestige) in determining organized and unorganized sport using a representative sample of Canadian children between 7 and 11years of age. Both organized sports and unorganized sports were associated with the socioeconomic factors although the associations were strongest for organized sport. In a 32 country comparison of 11-, 13- and 15-year-olds, the majority of countries reported that levels of self-reported MVPA decreased in proportion to social class or affluence (i.e., lower affluence children/adolescents were less active; Borraccino et al., 2009). However, the influence of socioeconomic position on children's PA is not completely supported by reviews of the literature (i.e., Ferreira et al., 2007; Sallis et al., 2000; Van der Horst et al., 2007). Further, stronger evidence exists for the impact of SES on adolescents PA (Ferreira et al., 2007). Gustafson and Rhodes (2006) concluded in their review of parental influences (3 - 18 years) that although SES appears to be positively related to children/adolescent PA, the validity of most of the studies are compromised (due to unvalidated measures) therefore no definite conclusions can be drawn. As a result, future studies should investigate the role of SES further using valid and reliable measures.

The positive influence of parental social support for PA is well documented. Beets, Bradley, and Alderman (2010) describe parental social support as involving two distinct types or mechanisms: tangible and intangible. *Tangible support* includes both instrumental support, such as transporting and paying for sporting activities, and conditional support, such as supervising, watching, or participating in activities with the child. *Intangible support* can be motivational, such as providing verbal encouragement or praise, and/or informational, such as discussing the importance of PA with the child. In a systematic review of the social support literature, Beets and others concluded that there is strong evidence for a positive association between parent social support (i.e., both tangible and intangible) and child PA. Further, boys may receive more support for PA than do girls. Therefore, parents should be informed about the benefits of providing these specific types of support to their children.

Parent-Child Physical Activity Relationship

Sallis and Nader (1988) propose that children learn PA habits and develop attitudes around PA very early in their lives by watching and imitating their caretakers' actions and speech. If this is true, then parents who are active should be more likely to have active children. However, the evidence for parental modeling is inconsistent.

Reviews. The relationship between parents and children's PA, or parental modeling, has been examined extensively in the literature. Since 2000, at least six reviews have summarized the influence of parental modeling on children's PA. Two of the reviews examined multiples correlates of children's PA (Sallis et al., 2000; Van Der Horst et al., 2007), one examined solely the environmental determinants of children's PA (Ferreira et al., 2007), and three specifically reviewed studies on parental influences of children's PA (e.g., modeling, involvement, encouragement; Edwardson & Gorely, 2010;

Gustafson & Rhodes, 2006; Pugliese & Tinsley, 2007). See Table 1 for a summary of the findings from each review.

In studies published between 1970 and 1998, Sallis and colleagues (2000) found that 38% (11/29) of the samples (i.e., boys and girls separately) reported positive effects between parental modeling and children's activity patterns. The authors coded this variable (i.e., parental modeling) as indeterminate, which indicates there are inconsistencies across studies. Van der Horst and others (2007) reviewed studies published between 1999 and January 2005 and reported that 100% of the male and 25% of the female samples indicated positive effects for parental modeling. The researchers concluded there is evidence for a positive association between parents' and boys PA only. Ferreira et al. (2007) included studies published between January 1980 and December 2004 and found that parental PA, when not separated by parental gender yielded no associations. However when fathers and mothers were separated, fathers PA became a positive correlate, with associations found in 52% of the studies. In addition, the authors found that fathers' activity appeared to influence boys and girls in a similar fashion, while mothers' activity appeared to have a greater influence on girls. For adolescents, each of these reviews concluded that there was no evidence for an adolescent-parent PA relationship (Ferreira et al., 2007; Sallis et al., 2000; Van der Horst et al., 2007).

Gustafson and Rhodes (2006) completed a systematic review of parental correlates of children/adolescents (3 – 18 years-old) PA; studies were published between 1985 and 2003. The authors found equivocal results, with six studies showing a positive relationship, seven showing a weak or no correlation, and one study showing a negative relationship. There was some evidence, although, for a positive relationship between mother-daughter and father-son PA. Pugliese and Tinsley (2007) completed a meta-analysis on studies published between 1960 and 2005 assessing the relation between parents' socialization behaviours and the activity levels of children/adolescents (aged 2 –

18 years-old). The results indicated that children/adolescents with parents who are inactive have a 10% risk difference, or 1.22 relative risk of being inactive themselves. The finding was moderated by age, with parental modeling having a larger influence in children younger than 9.75 years-old and adolescents older than 12 years-old, than children between 9.75 and 12 years-old. Because meta-analyses are purely quantitative reviews that can overcome limitations such as small sample sizes (see Ioannidis & Lau, 1999) this study provides strong support for the relationship between parent's and children's PA.

Edwardson and Gorely (2010) conducted a systematic review to examine the role of parental influences in determining child and adolescent PA as a function of activity type (i.e., overall PA, leisure-time PA, pedometer steps) and intensity (e.g., MVPA, VPA). Parental modeling was reported separately for *child/adolescent perceived* parents/mother/father PA (i.e., term used was parental/mother/father modeling) and parent/mother/father *self-reported* PA (i.e., term used was parental/mother/father PA). For 6- to 11-year-olds there were positive associations between (a) mother modeling and children's MVPA, and (b) father modeling and leisure-time PA. In 12- to 18-year-olds, there was a positive relationship between parent (i.e., mother and father PA reported together) and adolescent MVPA, and with father PA and adolescent VPA and very hard VPA. There was also a positive relationship between mother and father PA and adolescent overall PA. Therefore mothers and fathers modeling of PA may differentially affect children and adolescents and in different types of PA. That being said, there are limited studies in each category and therefore more research is needed before definitive conclusions can be drawn.

A common theme within the reviews is the lack of consistency found between studies for evidence of the parent-child PA relationship. The authors suggest various reasons for why these differences exist, most of which have been discussed earlier in the proposal. The major issue is the different types of measures used for child PA (i.e., self-report, parental-proxy, pedometer, accelerometer) and parent PA (child-reported, parental self-report, pedometer, accelerometer). Further, differences exist in the type of PA (e.g., free-living activity, MVPA) measured by each instrument, and thus the findings may not be directly comparable. In addition, many of the indirect instruments used were unvalidated (Gustafson & Rhodes, 2006). For instance, Gustafson and Rhodes (2006) found that of the six studies showing a significant relationship, three used validated measures and one used an accelerometer, while seven of the eight studies not supporting the relationship used unvalidated measures. Therefore, it is plausible the latter studies are confounded by measurement error.

Child-reported measures of PA were often used despite there being known issues related reliability and validity. For example, in the most recent review by Edwardson and Gorely (2010), 52% of the reviewed studies in children relied on child self-reported PA. Sallis (1991) reviewed the reliability and validity of self-report and other-report measures of child PA and concluded that self-report instruments should not be given to children younger than 10 years of age. Therefore, the studies using child self-reported measures of PA may be severely compromised.

The use of child-reported parent activity may allude to similar problems. These issues were somewhat addressed in the meta-analysis by Pugliese and Tinsley (2007) whereby the moderating effects of child and parent PA measurement type was examined in relation to the parental *influence*- (i.e., modeling, encouragement, instrumental aid together) child PA relationship. A moderating effect was found for parent (i.e., child-reported vs. parent/other-reported) but not child measurement type (i.e., indirect measure vs. mechanical/electrical). Specifically, when parents self-reported their own PA or others reported parental activity, a larger effect size was detected than when the child reported the parents PA. Thus, the type of measurement used for parents' PA appears to a confounding factor. Studies examining parental influences using direct measures in both parents and children are warranted, as they will allow more definitive conclusions to be drawn.

Studies using direct measures of physical activity. To examine the relationship between parent and child PA, a comprehensive search of the literature was completed and 13 studies were identified. Seven used a direct measure of PA (four accelerometers, one pedometer) to account for both parent and child activity levels. Eight, on the other hand, used a direct measure of child PA (six used accelerometers, two used pedometers) along with a perceived parental PA measure (three studies), or a parental self-reported PA measure (five studies).

An evaluation of the seven studies reviewed revealed a general pattern of findings across studies (see Table 2). Studies involving children under 10 years of age (Freedson & Evenson, 1991; Moore et al., 1991; Oliver et al., 2010; Taylor et al., 2008) reported significant effects for parental modeling (or familial resemblance) while those with children between 10 to 12 years of age (Jago et al., 2010; Loucaides & Jago, 2006) found non-significant relations. For example, Freedson and Evanson (1991) recruited 30 triads (i.e., mother, father, child [5 – 9 years-old]) and found 67% resemblance between the fathers and children, and 73% resemblance between the mothers and children. Similarly, Oliver et al. (2010) observed a significant and positive parent-child PA (i.e., using accelerometers) relationship between children aged 2- to 5-years-old and one of their parents, after controlling for several covariates. In comparison, Jago and others (2010) had 340 children aged 10- to 11-years-old and their primary caretaker wear accelerometers for five days. Adjusting for hours of daylight, child and parent BMI, area deprivation, and for clustering within schools, no association was found between parent and child PA. Similarly, a study investigating multiple correlates in children (grades 5 and 6), found that neither maternal nor paternal steps/day were a significant predictor of children's steps/day (Loucaides & Jago, 2006). One study did not fit this pattern. With children aged 9- to 11-years-old, Fuemmeler et al. (2011) found mother and father MVPA to be related to child MVPA on weekdays, weekends, and during the critical hours period, after controlling for covariates. Regardless, as a whole, the pattern across studies appears to be that parental modeling of PA is important during the early years of childhood, with 10 years of age being the approximate age when this relationship diminishes. This pattern is not surprising considering 10 to 11 years of age is a time when children begin to gain more independence (Jago et al., 2010), and spend less time with family (Larson & Richards, 1991).

Examining studies using directly measured child PA along with parent- or child-reported parent PA allows researchers to place a moderate degree of confidence (i.e., more than when using purely indirect measures) in the findings. Unlike the studies using solely direct measures of PA (i.e., for both parents and children), there is no clear pattern of findings across studies, with some reporting positive relationship(s) and others reporting no relationship(s) (see Table 3 and 4). Not surprisingly, child perceived parental PA was only examined in children 10 years of age and older. Three studies (see Table 3) had children aged 10- to 12-years-old wear uniaxial accelerometers and report whether their father and mother were active or not (i.e., yes or no). With African American sixth grade students, Trost, Pate, Ward, Saunders, & Riner (1999a) found that *boys* classified as active (i.e., 20 min of MVPA over the seven days) were more likely to perceive their *mother* as active. Confounding factors were not controlled for. In another study executed by Trost, Pate, Ward, Saunders, & Riner (1999b), MVA and VPA were calculated separately for each day and averaged across the week to create a usual score. While boys' VPA correlated with mothers' PA and boys' MVPA with fathers' PA, these relationships were attenuated in the multivariate analysis (but were approaching significance). The third study by Trost, Kerr, Ward, & Pate (2001) compared obese and non-obese children and found that obese children had lower daily accelerometer counts, and less MVA and VPA per day. Although perceived parental activity was not examined in relation to child MVPA, obese children were less likely to perceive their fathers as being active. A major limitation of these three studies is the measure used for parental PA. Although it was not described in the studies, it appears to be a single question involving a yes/no response. Further, it was unclear whether there were specific criteria given to the children to aid determining whether their parents were active or not (e.g., more than two days per week). The yes/no scale may not have been sensitive enough to detect effects, and the non-specific criteria of active/inactive may have resulted in different judgement criteria between individuals. Therefore, due to problems of measurement and inconsistent findings, no definitive conclusions can be drawn at this time.

As previously mentioned, parental self-reported PA and child perceived PA may be different constructs. Children are at school for a large portion of the day; therefore it is possible that the child's parent(s) could be active without them knowing. Consequently, the parent's activity level as perceived by the child may not be the best predictor of child PA. For example, in a longitudinal study following girls from age 9/10 years-old until age 18/19 years-old, the girl's perception of parent PA was a stronger predictor of their PA, than was parental self-reported activity (Madsen, McCulloch & Crawford, 2009).

Five studies required children to either wear either a pedometer or accelerometer, while parent(s) self-reported their own PA (see Table 4). Two of these studies reported a lack of evidence for the parent-child PA relationship. Sallis et al. (1992) found no associations between average daily accelerometer counts of the children (i.e., aged 8 – 10 years-old) and the PA of up to three adults in the household. Sallis, Taylor, Dowda, Freedson, & Pate (2002) found nonsignificant correlations (controlling for age) between weekly minutes in VPA (i.e., children/adolescents in grades 1 to 12) and the PA (e.g., walking, chores, sports) of one parent. It is likely that the study had limited power as each category (younger, older, male, female) had between 34 and 65 participants and the correlations ranged between .24 and .32 (excluding older females where $r = -.11$) which indicates moderate effects. On the other hand, three of the five studies found associations in certain instances. McMinn, van Sluijs, Wedderkopp, Frobert, & Griffin (2008) found significant relations between grade 3 students' PA (i.e., average accelerometer counts per min) and mothers being regularly active (i.e., engage in exercise or sport two or more times per week). Further there was a significant father X child gender (grade 3) interaction effect whereby there was a relationship between father PA and girls PA, but no relationship with boys PA. No relationship existed between parent PA and grade 6 children's PA. Cleland and colleagues (2011) found maternal role modeling to be related to young and older boys (i.e., 5 - 6 year-olds, 10 - 12 year-olds) PA during the "critical hours" period (i.e., after school until 6pm), but found no relationships on weekends or with girls PA. Griffith et al. (2007) showed pedometer step counts in 10- to 14-year-olds to be related to parent's participation in sport, but not leisure activities. Finally, approximately 1700 fewer steps were taken by parents who rated themselves as less active than other adults, in comparison to those who rated themselves as substantially more active than other adults, in the CANPLAY study (Craig et al., 2010).

A possible reason for the differences in findings across studies is the different types of PA assessed in both the parents (e.g., leisure, work, and/or sport activities, active/inactive categorization) and children (e.g., mean steps/day, total daily counts, minutes in VPA). It is possible that the parent-child PA relationship only exists with certain types of PA (e.g., parent leisure activity influences child activity while parent work activity does not). Further, the parent PA measure was not always proportional to the child PA measure used. For example, Sallis et al. (2002) measured accelerometer-determined VPA in children/adolescents, but measured self-reported PA including all intensities (i.e., light, moderate, vigorous) in parents. When PA measures are not consistent between children and parents (e.g., free-living activity vs. leisure-time PA), it is not surprising that different findings are reported across studies.

Clearly, more research is needed examining the parent-child PA relationship using direct measures of PA for both the children and parents in all age categories. Particularly in studies using indirect measures (or a combination of direct and indirect), there are many inconsistencies in regards to whether parent and child gender play a role in this relationship (e.g., stronger relationships between same sex genders, positive relations with maternal PA only). Thus, it is important for future studies to explore the role of gender (parent and child) within the child-parent PA relationship. As such, this thesis will examine gender specific relations within the parent-child PA context.

Two studies in the literature have looked at parental modeling in different time segments of the week (e.g., critical hours, weekends; Cleland et al., 2011; Fuemmeler et al., 2011). In Cleland et al. (2011), 190 children aged 5- to 6-years-old and 350 children aged 10- to 12-years-old wore accelerometers in 2001, 2004, and 2006. Based on child gender, age, and the measurement time period (i.e., critical hours, weekends), different variables within the family environment (e.g., parent *self-reported* PA, family co-participation, social support, reinforcement) were associated with average change in child MVPA. In regards to parental role modeling, the “critical hours” period appeared to be the time frame when mother’s PA had the most influential effect on boys activity (no other relationships were significant). Fuemmeler et al. (2011) found that mother and father MVPA predicted child MVPA on weekends from 6 am to 12 am, and weekdays from 6 am to 12 am and 3 pm to 7 pm (i.e., critical hours period). Because the literature suggests that children are more active on the weekdays than on weekend days (Beets, Vogel, Chapman, Pitetti, & Cardinal, 2007; Rowlands, Pilgrim, & Eston, 2008), further examination of parental modeling on different days of the week and time frames is appropriate.

This thesis will add to what is known about the relationship between parent and child PA by using a direct measure of PA (i.e., pedometers) in both the parents and children, and comparing boys and girls as well as weekdays and weekend days.

Chapter 3: Methods

Participants

The participants were a part of a larger longitudinal project called the Determinants of Health and Growth among Children. The purpose of this project was to examine the association between the built environment and PA, diet and bodyweight status of young children. The project took place in Edmonton, a North Western city in Canada and the capitol of Alberta and the surrounding areas (i.e., Capital Health region). The population of the region was 1,036,813 in 2006, with 59,590 preschool children aged 0- to 4-years-old and 60,285 children aged 5- to 9-years-old (Statistics Canada, 2007). During the baseline phase of the study (November 2005 to August 2007), parents were recruited from the Capital Health region when they brought their children (approximately 4 – 5 years-old) into health centers for preschool immunizations. Because a majority of preschool children in the region are taken to the centres for their immunizations (i.e., approximately 74%; Edwards, Evans, & Brown, 2008), the initial sampling frame consisted of a large majority of the children in the Edmonton region. In total, 1715 parent-children dyads participated and completed the questionnaire correctly at baseline. Within the questionnaire, parents were asked if they would be willing to participate in a future follow up study. Parents of 1,377 children (79.5%) agreed to the follow up and were recontacted between April 2009 and March 2011.

The current study was conducted with the participants in the follow up phase of the project. The families were asked to bring their child to the University of Alberta for a fitness assessment. In total, 664 children completed the assessment (32% retention rate from original sample). Then the children and parents were asked to complete a 4-day pedometer log; 471 parent-child dyads (girls, n = 251; boys, n = 220; mother's n = 356; fathers's n = 83; missing n = 32) completed the log and returned it to the researchers (71% retention rate from completion of the first portion of the study). One grandmother and one grandfather participated, but were coded as “mother” and “father” based on gender.

Procedures

Participants were sent an information letter (Appendix C), consent form (Appendix D), and a brief questionnaire (i.e., approximately 10 minutes to complete; Appendix A). They were then contacted by the research coordinator by telephone. Those who agreed and were able to continue on with the study were scheduled for a fitness assessment. The testing sessions took place at an off-campus University of Alberta athletic fitness facility that is centrally located and has free parking. Appointments were offered during the weekdays from 4:00 PM until 8:00 PM and on Saturdays between 11:00 AM and 3:30 PM. Parents were asked to bring the consent form and questionnaire to the appointment. If they arrived without the materials, new paperwork was provided.

Once at the testing facility, the procedures were explained and informed assent (Appendix E) and consent (Appendix D) was obtained from the child and parent, respectively. An assessment of physical fitness (including anthropometric measures) was then completed with the child. While waiting for their child, the parent was asked to complete a second questionnaire (Appendix B).

At the end of their visit, the child and one parent were provided with pedometers and given instructions on how to use and wear the device. As recommended by StepsCount, all participants were instructed to wear the pedometer on their belt or waistband in the right mid-line of the thigh. This location has been shown to be the most accurate position for the Yamax SW200 pedometer (Horvath, Taylor, Marsh, & Kriellaars, 2007). Parents were then provided a log book and instructed to record both their steps and their child’s steps daily and to reset the counter before going to bed each night. Further, the parents were asked to record what the child ate on these same days.

Once the pedometer recording period was over, the parent was instructed to mail his/her pedometer and the log book back to the researchers using a preaddressed envelope provided by the research team.

At the outset of the study, all research assistants were familiarized with the procedures and training to ensure standard methods of measurement. Equipment for measuring weight and height was also tested on a regular basis to ensure they met appropriate standards.

To encourage participation in the study, the parents and children were offered modest incentives. Specifically, parents were offered a $15 Safeway gift certificate for either gas or groceries, while children were given a gift bag including pens, pencils, addition cards, stickers, and pencil crayons. In addition, the children were allowed to keep their pedometer. Careful consideration was given to the use of incentives related to children’s involvement in research due to their vulnerability in relationships with adults in power positions and compromised ability to weigh risks and benefits (Rice & Broome, 2004).

Ethical considerations. This study was approved by the University of Alberta Health Research Ethics Board (HREB) before the data collection began. At all stages of the study, investigators made every effort to ensure free and informed consent, as well as privacy and confidentiality. Because this is a longitudinal study that involves tracking of individuals over time, personal identifying information was kept confidential but not anonymous.

Each participant was randomly assigned a four-digit numeric identification number, at the baseline phase of the study. To ensure confidentiality, the data collection forms (i.e., questionnaires, fitness assessments) were identified solely by this number. Private information such as participant’s names, addresses, and phone numbers were stored on a desktop computer within the research coordinators office and were protected by a system password as well as passwords for each file. The questionnaires and record sheets were stored in a locked cabinet within the same office. Only the research coordinator and one research assistant (i.e., who enters the data) had a key to this cabinet.

Measures

Parents completed two questionnaires. The first (Appendix A) is similar to the questionnaire completed at baseline (see Carson, Spence, Cutumisu, & Cargill, 2010) and included questions about the child's food and beverage consumption (over the past couple of weeks), eating behaviour, PA and sedentary habits (during a typical week), as well as the typical time they go to bed and wake up (both weekend and weekday). A second questionnaire (Appendix B) asked about neighbourhood characteristics (e.g., safety, access to services), the parents' own PA habits, and demographics (i.e., parent gender, relation to child, education, income, parent height and weight, and if they own a dog). In the following, I describe the variables that were included in the analyses for this thesis.

Demographics. The child's age, date of birth, and gender were obtained at the fitness assessment. Questionnaire 2 (Appendix B) included questions about the parent's gender (i.e., male, female), height, and weight, relationship to the child (i.e., mother, father, grandmother, grandfather, other), household income, and education status. Household income responses included: <$20,000, $20,000-39,999, $40,000-59,999, $60,000-79,999, $80,000-99,999, or >$100,000. Educational status responses included: some high school, completed high school, some university or college, completed university/college, some graduate school (e.g., master's or PhD), and completed graduate school. The height and weight of the responding parent was self-reported, although they were free to use the height standiometer and scale available in the room. In addition, to ensure that the records were up to date, the parents were asked to record their current address (on the consent form).

Pedometers. Unsealed SC-T2 steps and activity time pedometers (Steps Count, Deep River, Ontario) were used as the PA measure for both the children and parents. While no validity or reliability data are available for the SC-T2, it is mechanically identical to the Walk for Life (WL) pedometer which has been shown by Schneider, Crouter, Lukajic, and Bassett (2003) to have good reliability (Cronbach's α = 0.89) and moderate to good accuracy (+/- 20% of actual steps taken during 400-m walk) in adults. Further, with 5 – 11 year-old children, Beets, Patton, and Edwards (2005) found the WL to have high agreement with observed steps (intraclass correlation coefficient [ICC] ≥ .99) across three trials around an outdoor track, with an error rate of less than 0.9%. On a treadmill, the authors found high agreement with actual steps taken (ICC = .97) and an error rate of 5% at speeds greater than 67 meters/min^{-1}. The SC-T2 differs from the WL pedometer in that it is orange, and has a larger display, a delayed reset button, and also records activity time. The orange colour makes it easily identifiable if dropped on playgrounds and other outdoor areas. Overall, the pedometer can count up to 999,999 steps and collect 99 hours of activity time.

Participants were asked to wear the pedometers for four consecutive days, including three weekdays and one weekend day. The literature shows that four days of pedometer measurement in children (Trost, Pate, Freedson, Sallis, & Taylor, 2000; Vincent & Pangrazi, 2002) and one day in adults, is adequate for determining habitual PA (i.e., Intercorrelation Coefficient [ICC] > .7). Due to concerns around loss of data, cases with three or fewer days of measurement were included in the analyses. The possibility that reactivity (i.e., increase in PA due to the awareness of monitoring) could confound the children and parent's steps was considered. Studies show that reactivity is not an issue when measuring pedometer steps in children (Ozdoba, Corbin, & Le Masurier, 2004; Rowe, Mahar, Raedeke, & Lore, 2004; Vincent & Pangrazi, 2002). In adults, some studies have shown evidence for the effect of reactivity (Clemes, Matchett & Wane, 2008; Clemes & Parker, 2009) others have found no effect (Behrens & Dinger, 2007; Matevey, Rogers, Dawson & Tudor-Locke, 2006), or an effect that is not clinically significant (i.e., approximately 400 steps/day; Marshall, 2007).

The parents recorded theirs and their child's steps in a log book each night for four days. Within the log book, the parents were asked their gender (i.e., mother or father), what time both the child and parent woke up and went to bed, if a 20-step test was completed in the morning (i.e., to check if the device was working), whether it was an average day of activity (i.e., less, same, more), and if the pedometer was taken off and why. The parents were also asked to record the general activities performed by both the adult and child that day, the amount of time spent doing the activities, and the degree of effort exerted in each activity on a scale from 1 - 4.

Average steps were calculated by summing the available days of measurement and dividing by the total number of days. Due to the low numbers of fathers who participated in the study ($n = 83$), mothers' and fathers' steps were combined together and labelled "parents steps" in the final analyses. For descriptive purposes, parent and child steps were classified as "active" or "inactive" based on the 10,000 step/day (Tudor-Locke & Bassett, 2004) and 13,500 step/day (i.e., equivalent to 60 min of MVPA; Colley et al., 2011b) cut-off criteria, respectfully. However, parent and child steps were used as a continuous variable in the final analyses.

Anthropometric measurements. Although each child was given a complete fitness assessment, height and weight (and subsequently BMI) were the only components included in this study. Weight was measured to the nearest 0.1 kg using a calibrated scale while height was measured to the nearest 0.1 cm using a height stadiometer. Two measurements were taken, and if the scores were within 0.05 cm for height and 0.2 kg for weight they were subsequently averaged. If the difference between the two measures was greater than 0.05 cm for height and 0.2 kg for weight, a third measure was taken and the three measures were subsequently averaged.

Child BMI *z*-scores were calculated based on the WHO's growth reference, which is based on age and sex (de Onis et al., 2007; WHO, 2007). For descriptive purposes, *normal weight* was defined as a BMI *z*-score below 1, *overweight* was defined as a BMI *z*-score between 1 and 1.99 (approximately the 84^{th} percentile), and *obese* was defined as a BMI *z*-score greater than or equal to 2 (approximately 97.7^{th} percentile). Child BMI *z*-score was used as a continuous variable in the preliminary and final analyses.

Parent BMI was calculated by dividing the individual's weight in kilograms by the square of their height in meters (i.e., kg/m^2). For descriptive purposes, *overweight* was defined as a BMI equal to or greater than 25, while *obese* was defined as a BMI equal to or greater than 30 (Health Canada, 2003). Parents with a BMI below these thresholds were classified as *normal weight*. Parent BMI was used as a continuous variable in the preliminary and final analyses.

Season. The season was determined from the first day of the completed pedometer log. Other studies based in the northern hemisphere define the seasons as: winter (December to February), spring (March to May), summer (June to August), and autumn/fall (September to November; Carson & Spence, 2010; Carson, Spence, Cutumisu, Boule & Edwards, 2010). For ease of interpretation, winter and autumn/fall were combined into one category and coded as "1", while spring and summer were combined into a second category and coded as "2".

Area-level socioeconomic status. The addresses of the parent-child participants were used to determine area-level SES. Each address was assigned a spacial reference using the GeoPinPointTM Suite software (DMTI Spatial Inc., 2008), and located within a dissemination area, defined as one or more adjacent blocks of 400 – 700 people (Statistics

Canada, 2009). Based on the 2006 Canadian Census (Statistics Canada, 2006), area-level SES was calculated by subtracting the proportion of people, aged 15 years and older, with low education from the proportion of people with high education in each dissemination area. Therefore a negative score indicates greater proportions of low educated people, a positive score indicates greater proportions of high educated people, and a score of zero indicates there are equal proportions.

Analyses

To minimize errors in data entry, the data for each participant was first entered into the computer and then double checked for accuracy. Each of the continuous variables was then examined for the presence of outliers. For the pedometer data, child steps below 1000 or above 30,000 (Rowe et al., 2004), and adult steps below 1000 or above 25,000 (Tudor-Locke, Bassett, Shipe, & McClain, 2011) were deemed outliers and deleted. There were 16 adult pedometer step outliers (day 1 = 6, day 2 = 3, day 3 = 5, day 4 = 2), and 10 child pedometer step outliers (day 1 = 2, day 2 = 2, day 3 = 3, day 4 = 3). These cases were excluded when calculating the average steps for both parents and children.

BMI *z*-scores were used to locate BMI outliers, defined as values greater than 3.29 or less than -3.29 (i.e., $p < .001$, two-tailed test). Although the height and weight of the children were measured (rather than parent reported), and thus the outliers are in fact “true” scores, the identification and removal of BMI outliers is important, to ensure that the assumptions of regression are met (i.e., normal distributions, linear relationships between variables). There were two child BMI outliers, one with a *z*-score of 4.55 and the other 3.54. For adult BMI, there were three outliers, $z = 3.79$ (BMI = 41.6 kg/m^2), $z = 4.86$ (BMI = 46.2 kg/m^2). These outliers were truncated into a score equivalent to a *z*-score of 3.29 to minimize their influence on the statistical tests performed. In our sample of adults, a *z*-score of 3.29 was equivalent to a BMI of 39.42 kg/m^2.

To avoid issues pertaining to systematic errors resulting from sickness, improper wear, or dysfunctional pedometers, we examined the comments within each pedometer log. If participants mentioned that they or their child was sick, the pedometer counted inaccurately due to clothing (e.g., skirts), they forgot to wear the pedometer for a large portion of the day, or they questioned the reliability or accuracy of the pedometers (e.g., had difficulty getting an accurate 20-step count), the cases were carefully examined. For instances of sickness and inaccurate wearing of the pedometer, if the daily steps were significantly different from the participants mean steps across the three other days, that day was omitted when calculating average steps. In regards to accuracy comments, participants who reported being unable to get an accurate 20-step count or who provided a strong case for why their pedometer was not working were coded as "unreliable" (9 parents, 3 children). The mean steps of the cases with reliability issues (parents steps = 4546, child steps = 4049) were then compared to the total average number of steps of the parents (7775) and children (8633) in the whole sample. Two independent samples *t*-tests revealed significant differences between the unreliable and reliable cases for both parents, $t(8.13) = 2.95$, $p < .001$, and children, $t(466) = 2.74$, $p < .01$. As a result, these cases were omitted from further analyses. After making these adjustments and deleting outliers, 467 children and 459 parents (458 dyads) had at least one day of measurement. Further, 459 children and 448 parents (447 dyads) had at least one weekday measurement while 356 children and 339 parents (330 dyads) had at least one weekend day of measurement.

Violations of statistical assumptions were investigated using both univariate and multivariate procedures, separated by child gender and weekend/weekday. Specifically, the univariate process involved examining each variable on its own and in accordance with the other variables, while the multivariate process involved inspecting the residual plots and relevant statistics obtained from the regression output. First, the means and standard deviations were scanned for plausibility, and frequency histograms observed for the presence of normality. Household income was highly negatively skewed, with most cases existing in the ">$100,000 per year" category. Skewness and kurtosis values were examined and deemed extreme if greater than 3. No problems with skewness were evident, although kurtosis was an issue in a few cases (all children, total steps = 3.22; girls, total steps = 7.29, weekday steps = 6.36). According to Waternaux (1976), with samples over 100, positive kurtosis is less of a concern than with smaller samples. For example, the problem of underestimation of variance that is typically associated with positive kurtosis is diminished with larger samples. Linearity and homoscedasticity (continuous variables) or homogeneity of variance (grouped variables) were inspected within bivariate scatterplots between each variable. Violations of homogeneity of variance were found between household income and many of the other variables. The decision around whether to keep this variable is described in the following sections.

Multivariate assumption violations were considered through the regression analyses. An examination of the tolerance and Variance Inflation Factor (VIF) scores as well as the condition index in combination with the variance-decomposition proportions revealed no issues of singularity or multicolinarity. The residual scatterplots were further studied for issues of normality, linearity and homoscedasticity, and no issues were evident.

The analyses were conducted with SPSS version 18.0. Descriptive statistics were calculated for all variables including means and standard deviations, stratified by gender. Potential confounders were considered for inclusion based on (1) the child PA literature, (2) correlations with child steps, and (3) practical considerations around retaining as many cases as possible. Specifically, variables known to influence children's PA and/or to moderate the parent-child PA relationship were considered for inclusion in the analysis. Correlations between the potential covariates (i.e., child BMI, child gender, parent BMI, parent gender, weather, parent income, parent education) and child pedometer steps were inspected, and those with significant relations were considered for inclusion. Finally, variables with numerous missing cases (i.e., parent education, BMI, and gender) were included in the analyses initially, and excluded if their removal had a minimal impact in the results.

To examine Hypothesis 1, that positive correlations will exist between parent and child steps on each day of measurement (i.e., day 1, 2, 3, 4), four Pearson correlations were conducted. Testing Hypothesis 2, that a positive relationship will exist between the average total steps of parents and children, preceded as follows: First, bivariate correlations were run between all variations of parents (all, mothers, fathers) and child steps (all, boys, girls). Second, two step-wise linear regressions were executed (boys and girls separately), with parent steps as the predictor variable and child steps as the criterion variable, and controlling for confounders. To test Hypothesis 3, that a positive relationship will exist between average parent and child steps on both weekdays and weekend days, preceded as follows: First, bivariate correlations were run between parents' (all, mothers, fathers) average weekday and weekend day steps and child (all, boys, girls) average weekday and weekend day steps. Second, two stepwise linear regressions, with parent weekday/weekend steps as the predictor variables and child weekday/weekend steps as the criterion variables (controlling for covariates) were executed. See Table 5 for a description of each hypothesis and the associated statistical tests.

The strength of the bivariate correlations was determined from Cohen's (1992). Accordingly, a correlation of .1 was deemed small, a correlation of .3 was deemed medium in size, and a correlation of .5 was deemed a large effect size.

For each regression analyses, the variables were entered in a sequence consistent with the Ecological Model of Physical Activity (EMPA). The EMPA describes PA as influenced by intra-individual and extra-individual factors (Spence & Lee, 2003). Thus, individual level variables, including child gender (for weekend/weekday analyses), age and BMI, were entered on step 1. Factors external to the child, including area-level SES and season, were entered on step 2. Finally, the main predictor variable, average parent steps, was entered on step 3.

Power considerations. The number of participants required to achieve sufficient power for correlational analyses, and multiple regression was determined from Cohen's (1992) power tables. With a moderate effect size and an alpha of .05, 80% power would have been achieved with 85 participants in the correlations, 91 participants in the multiple regressions with five independent variables (total step analyses for boys and girls), and 97 participants in the multiple regressions with six independent variables (weekday/weekend analyses). Thus, the study was sufficiently powered for Hypothesis 1 (day 1 *n* = 426, day 2 *n* = 429, day 3 *n* = 429, day 4 *n* = 413). For Hypothesis 2, there was sufficient power for 78% of the bivariate correlations. With correlations between fathers and boys steps (*n* = 43) and fathers and girls steps (*n* = 41) being insufficiently powered. Adequate power, on the other hand, was present for the multiple regression analyses with both boys (*n* = 211) and girls (*n* = 246). For Hypothesis 3, adequate power existed for 72% of the bivariate correlations with insufficient power existing for all combinations with fathers steps (weekday steps, fathers- all children *n* = 83, fathers-boys *n* = 43, fathers-girls *n* = 40; weekend steps, fathers-all children *n* = 67, fathers-boys *n* = 35, fathers-girls *n* = 29). Finally, ample power existed in the weekday (*n* = 446) and weekend (*n* = 329) multiple regressions.

Chapter 4: Results

We did not require the parent who brought the child to the assessment to also complete the pedometer log book; the decision was left up to the family. In 12% of the cases (*n* = 54), a different parent conducted the pedometer portion of the study. Because height, weight and education were provided in a questionnaire completed at the child's fitness assessment, for 12% of the sample, these variables (i.e., parent BMI and education) were not available. Further, 7% of the parents did not provide their gender. Because only 18% of the parents were fathers, and parent gender was missing in numerous cases, father and mother steps was examined together (i.e., parent steps) in the final regression analyses.

Demographic information is given in Table 6. The mean age of the children was 7.75 years-old with 93% of the children being either 7- or 8-years-old. Based on the WHO guidelines (WHO, 2008), 15% of the children were classified as overweight (*z*-score > 1) and 7% as obese (*z*-score > 2), with no differences between gender. For adults, 29% were classified as overweight (BMI > 25 kg/m^2) and 13% as obese (BMI > 30 kg/m^2), with the fathers being significantly more likely to be classified as overweight or obese than the mothers. Parent education was available in 384 cases (fathers, *n* = 50; mothers, *n* = 334), with 80% having at least completed university or college, and with more fathers who reported having some experience or having completed graduate school (father's = 26%, mother's = 14%). Household income was available for 437 cases (father's, *n* = 80; mother's, *n* = 328) with 91% of the families making over $60,000 per year and 58% making over $100,000 per year. Area-level SES was available in 470 cases with values ranging between -49.28 to 69.84 and 69% occurring above a value of "0", indicating higher proportions of highly educated people resided around the family's home. Finally, 42% of the dyads completed the pedometer log in the winter and autumn/fall category and 59% in the spring and summer category. The proportions of participants in each category did not differ by adult (χ^2 = 1.27, *ns*) or child gender (χ^2 = 2.34, *ns*).

The means and standard deviations for total, weekday, and weekend parent and child steps are presented in Table 7. Independent sample *t*-tests comparing average steps between genders revealed significant differences between boys and girls on average total, weekday and weekend days, with boys taking on average 1026, 1051, and 1112 more steps per day, respectively. When the children were classified as active/inactive based on the 13,500 step cut-off criteria (i.e., equivalent to 60 minutes of MVPA per day; Colley et al., 2011b), 93% of the children were classified as inactive and 6% as active (see Table 6). No differences were found between mothers' and fathers' steps, although mothers tended to take more steps in total (320 steps), on weekdays (500 steps) and on weekend days (282 steps). Based upon the 10,000 step cut-off criteria (Tudor-Locke & Bassett, 2004), 76% of the adults were classified as inactive and 21% as active (see Table 6). Paired-sample *t*-tests comparing weekday and weekend day steps revealed significant differences for all children and parents, as well as boys, girls, and mothers, with participants taking more steps on the weekdays than on the weekend days (differences of 1011, 759, 1003, 1064 and 842 steps/day, respectively).

Inclusion of Covariates

To aid in the decision of which variables to include as covariates in the main analyses, Pearson correlations were conducted between the potential covariates and child and parent steps/day (see Table 8). For boys, child age was related to total and weekday steps, while BMI *z*-score was related to total and weekend steps. For girls, parent BMI was related to weekday steps. For the parents, parent BMI and area-level SES were related to total and weekday steps, while household income was related to total and weekend steps. When separated by gender (i.e., mothers, fathers), parent BMI, household income and area-level SES were related to mother's PA only.

The literature indicates that SES is an important factor in determining children's PA (Craig et al., 2010; Temblay & Willms, 2003). Due to problems surrounding multicollinearity, it is important not to include variables in a multiple regression that are highly correlated or that represent a similar construct. Because area-level SES, parent education, and household income are related and similar variables, we decided to retain only one of these variables in the final analysis. Parent education did not correlate with parent or child steps, and if included, would have resulted in a loss of cases (n = 384), therefore it was excluded. As descried previously, household income was responsible for a few assumption violations, and if included, would have resulted in a loss of cases (n = 437) and was therefore excluded. Area-level SES was chosen because it positively correlated with parent steps and because it helped to maximize our sample size.

Apart from the significant negative correlation between parent gender and girls weekend steps ($r = -.18$, $p < .05$), parent BMI and gender were not significantly correlated with child steps (see Table 8). Careful consideration was taken in deciding whether to include or exclude these variables because both have a large number of missing cases (parent BMI n = 382, parent gender n = 384). The regressions were run with and without these variables included. Parent gender did not significantly contribute to the final models. Further, the contribution of parent BMI was attenuated when parent steps was added to the models, and minimal changes were observed in the main predictor variables (i.e., total, weekday and weekend day parent steps). In order to maximize the number of included cases and therefore maximize the ability to detect an effect, we excluded these two variables in the final analyses. Child age, BMI and season were included in the final analyses because the literature shows they are important and/or because they were significantly related (particularly age and child BMI) to child steps. Therefore, the covariates included in the linear regression analysis were: child gender (for weekend/weekday analyses), age and BMI, area-level SES, and season.

Hypothesis 1

Hypothesis 1 was examined using Pearson correlations between average parent and child steps on each day of measurement. Significant small-to-moderate positive correlations were found between child and parent steps on day 1 (r = .24, p < .001), day 2 (r = .24, p < .001), day 3 (r = .19, p < .001), and day 4 (r = .33, p < .001).

Hypothesis 2

Bivariate correlations between average total steps of the parents and children by child and parent gender are presented in Table 9. Moderate correlations were observed, with the largest relationships existing between fathers and girls steps, and boys and parents steps (all, mothers, and fathers).

The results of the step-wise linear regressions predicting average child steps from average parent steps, by child gender, are displayed in Table 10. After controlling for the covariates, average parent steps remained a significant predictor of average boys' steps (p < .001), accounting for 9% unique variance. This translates as, for every 1,000-step increase in parent steps; boys took approximately 330 additional steps. The complete model accounted for 14% of the variance in boys' steps, with age (p < .01) significantly contributing to the model. Similar results were found for girls. After controlling for the covariates, average parent steps remained a significant predictor of average girls' steps (p < .001) accounting for 9% unique variance. For every 1,000 step increase in parent steps the estimated average increase in girls' steps was 260. The complete model accounted for 9% of the variance in girls' steps.

Hypothesis 3

In the preliminary analysis, positive small-to-moderate bivariate relationships were found between parent and child weekday steps across parent and child gender (see Table 9). For weekend steps, positive moderate-to-large bivariate relationships were revealed across parent and child gender. Thus, stronger relationships existed on the weekend days than on the weekdays.

Hypothesis 3 was examined with two step-wise linear regressions. The first regression predicted child weekday steps from parent weekday steps, and the second predicted child weekend steps from parent weekend steps. The results are displayed in Table 11. In the weekday analysis, parent weekday steps contributed 6% unique variance in child steps after controlling for the covariates. The final model accounted for 10% of the variance in children's weekday steps with child age ($p < .05$) and gender ($p < .001$), and parent weekday steps ($p < .001$) significantly contributing to the model. This translates into an approximate 240-step increase in child steps per 1,000-step increase in parent steps. In the weekend day analysis, parent weekend day steps accounted for 11% unique variance in child weekend day steps. The final model predicted 15% of the variance in child weekend day steps, with gender (p < .01) and parent weekend day steps ($p < .001$) providing significant contributions. This translates into an approximate 390-step increase in child steps per 1,000 step increase in parent steps.

Chapter 5: Discussion

This study sought to explore whether parental PA was an influential factor in determining children's PA as measured via pedometers. Parent and child steps were related on each day of measurement (i.e., day 1, 2, 3, 4) with correlations ranging in the small-to-moderate range (Hypothesis 1). Linear regressions demonstrated that average total parent steps was a significant predictor of both boys and girls average total steps, after controlling for multiple covariates (Hypothesis 2). Finally, linear regressions predicting average child weekday and weekend day steps, illustrated that parental modeling of PA is important on both weekdays and weekend days, although weekends appear to have a greater influence (Hypothesis 3).

The findings for Hypothesis 1 and 2 are in line with previous research using direct measures of PA (for both parents and children), with children in the 5- to 10-year-old age range. Moore and colleagues (1991) found that active mothers were 2 times more likely to have an active child (4 – 7 years-old) and fathers 3.5 times more likely. When both parents were classified as active, the children were 5.8 times more likely to be active. Similarly, Freedson and Evenson (1991) observed 67% family resemblance between father and child PA and 73% family resemblance in mother and child PA. However, this resemblance appears to be age specific. Overall, studies examining this relationship in children between 10- and 12-years-old, using direct measures of PA (for both parent and child), found no association (Jago et al., 2010; Loucaides & Jago, 2006) while studies with children younger than 10 years-old did find a relationship (Freedson & Evenson, 1991; Moore et al., 1991; Oliver et al., 2010; Taylor et al., 2008). Similarly, a meta-analysis examining the influence of parental PA modeling demonstrated an interaction effect, with significant relationships existing for children below 9.75-years-old and adolescents over 12-years-old and a non-significant relationship existing with children between the ages of 9.75- and 12-years-old (Pugliese & Tinsley, 2007). A potential explanation for this pattern is that around 10 years of age, children slowly gain more autonomy and independence from their parents (Jago et al., 2010) and spend more time with their peers and alone (Larson & Richards, 1991). As a result, they may begin to look to their peers as role models more frequently than their parents (Pugliese & Tinsley, 2007). However, parents may resurface as an important influence in middle to late adolescence or young adulthood (Lau, Jacobs Quadrel, & Hartman, 1990; Pugliese & Tinsley, 2007).

Research has consistently demonstrated that boys are more active than girls (Sallis et al., 2000; Van der Horst et al., 2007) and men are more active than women (Trost, Owen, Bauman, Sallis & Brown, 2002), therefore it is possible that the parent-child PA relationship also differs by gender. Most parent PA modeling studies using direct measures have failed to examine gender differences in both children and parents. While many looked at differences between mothers and fathers (i.e., Freedson & Evenson, 1991; Fummeler et al., 2011; Loucaides & Jago, 2006; Moore et al., 1991; Taylor et al., 2008), fewer have compared girls and boys (Fummeler et al., 2011; Moore et al., 1991, Jago et al., 2010). Of the five studies that included parental PA modeling in children under 10 years, only two (Fummeler et al., 2011, 4th-5th grade; Moore et al., 1991, 4-7 year-olds) examined child gender differences in the final analyses. Moore et al. (1991) found different odds ratios by child gender with active father's being 4.4 times more likely to have an active girl and 3.1 times more likely to have an active boy. Active mothers were just as likely to have an active girl as an active boy (i.e., 2.0 times more likely). On the other hand, Fummeler et al. (2011) did not find child gender effects in a factorial ANOVA with mothers and fathers MVPA combined (i.e., both active, one active, both low active). However, they did find stronger gender-specific correlations in their preliminary analyses with stronger relationships existing between mothers and daughters, and fathers and sons MVPA, particularly on the weekend and after school periods. In support of this pattern, Gustaftson and Rhodes' (2006) systematic review reported evidence for stronger mother-daughter and father-son PA relationships. The bivariate correlations between child and parent steps by gender in the current study did not support this gender-specific pattern (see Table 9). Further, total parent steps, with mother and father PA examined together, was an equal and strong predictor of both boys and girls total steps. Therefore, mothers and fathers PA when examined collectively appears to influence boys and girls PA in a proportionate fashion. Because both the father and mother were not required to wear the pedometers, this limited the examination of the gender-specific pattern using more advanced procedures. Therefore, future studies should make an effort to measure equal proportions of mothers/fathers and girls/boys and to further investigate this pattern.

Different authors have mentioned that future studies need to explore the contexts (e.g., day of the week, type of activity) to which parent PA and child PA are related (Fuemmeler et al., 2011; Pugliese & Tinsley, 2007). To our knowledge, this is the second study to investigate the parent-child PA relationship using direct measures of child and parent PA on weekend days and weekdays separately. With 45 child-parent triads in Southwest US, Fuemmeler and colleagues (2011) found that fathers and mothers MVPA predicted children's MVPA, after controlling for covariates, on the weekends from 6am to 12am, and on the weekdays from 6am to 12am and 3pm to 7pm. Similarly, our study found that parent steps predicted child steps on both weekdays and weekend days, but unlike Fuemmeler et al., we found a stronger relationship on the weekend days than weekdays. A possible explanation is that because there are less work and school responsibilities on the weekends, parents and children have more opportunities to be active together and for children to see their parents being active (i.e., parental modeling). Future research should replicate and explore this finding further to confirm and better understand the mechanisms involved. Regardless, this is a unique contribution to the literature and suggests that parents need to be conscious of how active they are on the weekends.

The findings of this study are consistent with Spence and Lee`s (2003) ecological model of physical activity, the guiding framework for the study. According to the model, the more proximal layers of influence have the most immediate effects and the more distal layers have the broadest effects. Consistent with the model, we found the individual level variables (i.e., age, gender, BMI *z*-score) contributed a greater amount of variance to the prediction of boys and child weekday steps than did the environmental variables (i.e., area-level SES, macrosystem; season, physical ecology). Inconsistent with the model, the environmental and individual level variables contributed nothing the prediction of girl's steps, and provided equal contributions to the prediction of weekend day steps. Further, parent steps, a microsystem factor, had a greater influence on boys, girls, and child weekday and weekend day steps, than the more distal environmental factors. Contrary to the model, the individual level variables, although more proximal to child behaviour, did not exert a greater influence than did parent steps. This finding highlights the important role that parents play in determining child PA.

Differences existed in the contributions of the individual level factors to the prediction of child steps across girls, boys, weekday and weekend day steps. For boys, age was an important factor in determining child steps, but for girls it was not. On the weekdays, age and gender appeared to be important in determining how active the children were, while on the weekend days only gender was important. Season and area-level SES contributed virtually nothing to the prediction of child steps (boys, girls, weekday, weekend day).

Strengths

This study has multiple strengths. First, the fact that PA was measured in parents and children using a direct measure is advantageous as pedometers are a more reliable and valid measure of child PA than self-report or parent-proxy measures. Therefore, issues around social desirability and memory biases are greatly reduced. Second, this is the first Canadian study to examine the parent-child PA relationship in children 12 years of age and younger, using direct measures of PA for both the children and parents. Third, Edmonton is a northern city in Canada that experiences harsh winters. Therefore the replication of the parent-child relationship in this northern climate is a unique addition to the literature. Forth, our sample size was the largest of the seven aforementioned studies. The large sample size allowed us to examine boys and girls separately and weekend days and weekdays separately. Finally, the age of our sample is an additional strength. The other two parent-child PA relationship studies (using direct measures for parents and child PA) conducted with children in our age range (i.e., 6 – 10 years-old; 93% 7 or 8 years-old) are Moore et al. (1991; 4 - 7 years-old) and Freedson and Evanson (1991; 5 - 8 years-old). These studies were completed 20 years ago, and involved very small sample sizes (*n* = 100 children, *n* = 30 triads, respectfully). As children of different ages are influenced by different factors within their environment, it is important to conduct research with children of all ages so that we can determine if and when parental modeling has the greatest influence (e.g., before 10-years-old). Further, it is important to replicate past studies as many changes occur throughout the decades (e.g., advancements in PA measurement technology, differences in family structure). Our study provides evidence for the role of parent PA modeling in a large present day sample of 6- to 10-year-old children.

Limitations

There are a few limitations of this study that should be mentioned. As this was a convenient sample, it is possible the individuals who volunteered to participate are somewhat different from the general population of parents and children in Edmonton. Because the participants are volunteers and therefore may have been more eager and motivated than the general population, a self-selection bias could exist. It is also possible that active families were more likely to participate in the study due to a greater understanding of the importance of health and PA research. We are aware that the parents in our sample were more educated and had a higher income than the general population in the Capitol Health region (i.e., Edmonton and surrounding areas). In 2006, the median family income was $74,900 per year (Statistics Canada, 2007). Further, in 2006 19% of women and men over 15 years of age held a university certificate (diploma or degree), while 24% of males and 32% of females aged 25- to 34-years-old held a certificate (Statistics Canada, 2007). In this study, almost 80% of the sample reported having a household income of at least $80,000 per year (median of $100,000 per year) and an education of at least a university degree or college diploma. Thus, readers should be cautious in generalizing the findings to less affluent and educated populations.

In comparison to adults aged 20- to 39-years-old in the CHMS (2007-2009), the proportion of mothers and fathers classified as overweight or obese (i.e., 39%, 62%, respectfully) was similar to national levels (i.e., 44%, 56%, respectively; Shields et al., 2010). Although it is important to keep in mind that these statistics are representative of the average Canadian adult rather than the average Canadian parent (i.e., it is possible that parents are different from the general adult population). In comparison to 5- to 11-year-old children the Canadian Community Health Survey (CCHS), the current study had a smaller proportion of children classified as overweight or obese (22% versus 35%, respectively; Shields & Tremblay, 2010). Therefore, the reader should be careful in generalizing the findings to more overweight/obese child populations.

It is difficult to compare the mean steps/day from the children and parents in our study to national surveys because our pedometers slightly underestimate steps per day in comparison to other types of pedometers (Tudor-Locke et al., 2011; Scruggs, 2007). To reduce erroneous steps due to jostling, the Walk4Life pedometers (identical to our SC-T2 steps and activity time pedometers) were designed to record activity and steps lasting longer than 3 seconds (i.e., 3 epochs). Therefore, it is difficult to know for certain whether the participants were more or less active than the average Canadian child and adult populations. Regardless, using the 13,500 step per day cutoff (i.e., equivalent to 60 minutes of MVPA per day), a smaller proportion of children in this study were classified as active, than in the Canadian Health Measures Survey (CHMS; 6% were active versus 27% active [ages 6 – 10 years-old], respectfully; Colley et al., 2011b). Using the 10,000 step per day cut-off for adults (Tudor-Locke & Bassett, 2004), 21% were classified as active, which is significantly less than the levels reported in the CHMS (35% active; Colley et al., 2011a).

The study is cross-sectional and non-experimental; therefore we cannot assume that parent steps “caused” the children to take more steps themselves. Rather, we can only say there is a relationship between child and parent steps and a bidirectional association is very probable.

While pedometers are more reliable and accurate than self-report or parental-proxy PA measures, there are still limitations surrounding their use (Marshall & Welk, 2008). Unlike accelerometers, pedometers do not capture PA intensity, and thus we do not know whether the steps taken were done at a light, moderate, or vigorous intensity (DeVries et al., 2009). Pedometers cannot be worn in the water, so activities such as swimming at the beach and playing at the water park were not recorded. Also, pedometers do not accurately capture activities such as biking, skating, and martial arts (Trost, 2001), and accordingly, these types of activities were not reflected in the step count. Similarly, the extra load of certain activities such as climbing stairs or lifting weights were not accurately captured in the total step counts. Regardless, pedometers are a reliable, valid, and cost-effective method for measuring free-living activity in field based studies (Tudor-Locke et al., 2011; Tudor-Locke et al., 2009).

As previously mentioned in the introduction, we do not know for certain that the relationship between parent and child PA is a reflection of parental modeling. For instance, a child may not directly see their parents being active or they may not "perceive" their parent as being active if a majority of their activity is of low intensity (e.g., gardening, housework, walking dogs). Thus we recognize that the use of this term is a limitation. But further stress that examining the parent-child PA relationship is still an important topic of interest. Future studies should explore whether the parent-child PA relationship is in fact reflective of parental modeling.

Finally, it should be noted that although there were non-significant findings between fathers-boys weekday steps and fathers-girls weekend steps in the bivariate correlations, there were few participants in these categories due to the small number of fathers in the study. Therefore, the non-significant findings are likely due to a low probability of finding an effect (i.e., inadequate power), as the correlations were in the small-to-moderate range.

Implications

Our study provides support for the involvement of parents in interventions aimed at increasing child PA. Parents also need to be aware of the impact their own behaviours can have on their children, and that they need to provide support (i.e., transport, pay fees, encouragement) *as well as* model an active lifestyle. As parents and children typically have more time to spend together on the weekends, the findings from this study suggest that parents should plan active events together (e.g., baseball at the park, bike ride along the river, hiking) on the weekend days.

Furthermore, the results suggest that interventions that involve parental PA modeling as a component will be just as effective with boys as with girls. Further, these interventions may benefit from having an increased focus on the weekend days, by providing extra encouragement of parental PA on the weekend days, or by providing resources that allow or facilitate parental activity (and subsequently child activity) on the weekend days. In relation to the ecological model, these resources can be provided at different levels of the environmental such as the family, school or community settings and/or at the level of policy. Further, making changes at multiple levels would be more effective than simply making changes at one level (Spence & Lee, 2003). Resources could include programs for families (e.g., weekly classes involving different activities each week such as yoga, baseball, capture the flag, nature walks) and/or events held at different points of the year (e.g., family fun days involving sports and games). These could be developed by communities and/or supported by or funded by the government. Finally, interventions aimed at increasing adult PA (e.g., media campaigns, support for PA in the workplace) may also result in children being more active.

Conclusions

This study demonstrated a correspondence between parent and child free-living activity, as measured by pedometers, in children aged 6- to 10-years-old. No differences in these associations existed between boys and girls, although a stronger relationship existed on weekend days compared to weekdays.

Future Directions

Future studies should take steps to determine whether greater parent PA “causes” children to be more active. Causality has three requirements (1) temporal precedence, (2) covariation between cause and effect, and (3) no other likely explanations (Trochim & Donnelly, 2008). Therefore before we can make such cause-and-effect type inferences, experimental designs are needed. An experimental design could involve inactive parents who join a weight loss or fitness program, and to measure whether an increase in parent PA affects their children’s PA. Another experimental design could involve a media campaign aimed at increasing the PA of parents whose children attend a school. If the media campaign works (i.e., the parents increase their PA), and the children’s activity also increases, this would be evidence for parental PA modeling. A final idea for an experimental design would include testing a well-known PA intervention with three groups (1) typical intervention, (2) typical intervention plus a parental modeling component (e.g., tools to help parents become active), and (3) diet intervention (control group). If the parent involvement group shows greater increases in child activity than the other two groups' this would provide evidence for the inclusion of a parental modeling component in PA interventions for children. Current childhood obesity interventions sometimes involve a parental modeling component (e.g., as a discussion topic; Golan, Weizman, Apter, & Fainaru, 1998), but when combined with other components such as diet, behaviour modification, and problem solving, it is impossible to distinguish if modeling was a significant factor in explaining any changes in children's PA.

Longitudinal designs allow us to investigate whether a change in parental PA is related to a change in child activity over time. Following a cohort of individuals over many years (e.g., over 10 years) would allow researchers to determine the ages at which parental modeling has an impact and when it does not. This knowledge is crucial as interventions incorporating parental influences such as modeling, may be less effective at certain ages. Population based studies are typically more representative of the general public and therefore the results are typically more generalizable. One population based study in Canada (i.e., CANPLAY) observed the association between child pedometer steps and parent's self-reported PA in a large sample of 5- to 19-year-olds (Craig et al., 2010). It examined the influence parent PA as a whole rather than comparing across ages, and used a self-report measure of parent PA. As such, a similar study using a direct measure of PA for the children and parents, and comparing the relationship across the developmental years, would be beneficial.

An avenue that would be interesting to explore further is the role of context and activity type within parental PA modeling (Fuemmeler et al., 2011; Pugliese & Tinsley, 2007). For instance, does parent participation in sport solely influence child participation in sport or does it affect other contexts as well (e.g., active play, active transportation)? Such questions could be explored indirectly with self-report questionnaires or directly with time stamped pedometers (e.g., have the participants start the pedometer when they are participating in active transport). Another viable method could involve time use measures such as the Multimedia Activity Recall for Children and Adolescents (MARCA; Ridley, Olds, & Hill, 2006), where the specific activities of adults and children can be compared in various time frames.

Future studies should also explore the joint relationship between social support and parental modeling in determining children's activity, as only a few studies (using recall PA measures only) have examined this topic (Trost et al., 2003; Welk et al., 2003). For example, Trost and colleagues (2003) looked at both parental modeling and social support with 380 students in grades 7 through 12 using self-reported child/adolescents and parent PA measures. They found that parent PA did not directly influence child/ adolescents PA, but instead was indirectly related through support and encouragement. They further concluded that active parents simply provide more support for PA. However, other studies have failed to support this contention, and instead observed that parental modeling is the important variable (Cleland et al., 2011; Oliver et al., 2009).

Further, exploring the mechanisms or mediators by which parental modeling operates (e.g., by building the child's self-efficacy) is important as this could help inform the development of interventions. Models such as Taylor and colleagues (1994) socialization model of child behaviour, Welk's Youth Physical Activity Promotion Model, or Spence and Lee's (2003) Ecological Model of PA, are ideal for exploring this topic. These ideas should be thoroughly explored using direct measures of PA and with children in the elementary years.

Table 1

Reviews Articles Summarizing the Literature on Parent-Child Physical Activity Relationship

Authors	Type of review	Range of years published	Age of children/ adolescents	Findings- children	Findings-adolescents
Edwardson & Gorely, 2010	Systematic review	Up until September 2009	6 – 11 yrs (children) 12 – 18 yrs (adolescents)	MVPA - mother (+), father modeling (0) MPA - mother, (0) father modeling (0) - mother (0), father PA (0) VPA - mother (0), father modeling (0) - parental (0), mother (?), father PA (0) Overall PA - parental (0), mother (?), father PA (?) Leisure time PA - mother (0), father modeling (+) - parental PA (?) steps - mother (0), father PA (0)	MVPA - parental (+), mother (0), father modeling (0) - mother PA (?) MPA - mother (0), father PA (?) VPA - parental (0), mother (0), father modeling (0) - parental (0), mother (?), father PA (+) Very hard PA - mother (0), father PA (+) Overall PA - parental (0), mother (?), father modeling (?) - parental (0), mother (+), father PA (+) Leisure time PA - mother (?), father PA (0) Organized PA - mother (0), father modeling (?)
Ferreira et al., 2007[a]	Systematic semi-quantitative review	January 1980 – December 2004	3 – 12 yrs (children) > 12 – 18 yrs (adolescents)	- parents PA: 10 (+), 1(-), 18 (0) = 00 -fathers PA: 15 (+), 14 (0) = +? -mothers PA: 10 (+), 21 (0) = 00	- parents PA: 6 (+), 25 (0) = 00 - mothers PA: 14 (+), 17 (0) = 0? -fathers PA: 12 (+), 21 (0) = 00

Gustafson & Rhodes, 2006[a,b]	Systematic review	1985 - 2003	3 – 12 yrs (children) 13 – 18 yrs (adolescents)	6 (+), 1 (-), 7 (0) = ?	
Hinkley et al., 2008	Systematic review	Peer-reviewed journals 1980 – March 2007	2 – 5 yrs	Examined parental PA and familial interaction together 4 (+), 6 (0) = ++	
Peugliese & Tinsley, 2007[b]	Meta-analysis	1960 - 2005	2 – 18 yrs	Influence of parental modeling (parent PA and sedentary behaviours, parent-child co-activity): 10% risk difference, 1.22 relative risk *Moderator for parental modeling:* age- larger effect sizes were found in adolescents +12 yrs and children < 9.75 yrs than in children between 9.75-12 yrs *Moderators for parental influence (modeling, encouragement, instrumental behaviours):* - Sampling: convenience vs. principled (p < .05) - Measure of parental behaviour: self-report vs. other report (p < .05)	
Sallis et al., 2000[a]	Systematic semi-quantitative review	1970 - 1998	4 – 12 yrs (children) 13 – 18 yrs (adolescents)	11 (+), 1 (-), 17 (0) = ??	M/F: 9 (+), 18 (0) = 0

Van der Horst, Paw, Twisk, & Mechelen, 2007[a]	Systematic review	1999 – January 2005	4 – 12 yrs (children) 13 – 18 yrs (adolescents)	F: 1 (+), 4 (0) = 00 M: 4 (+) = +		F/M: 2 (+), 6(0) = 0

Note: yrs = years; PA = physical activity; MVPA = moderate-to-vigorous physical activity; MPA = moderate physical activity; VPA = vigorous physical activity; 0 = lack of association; + = positive association; **-** = negative association; ? = indeterminate.

[a]in these semi-quantitative review articles boys and girls were treated as separate samples.

[b]results with children and adolescents were presented together.

Table 2

Parent-Child Relationship Studies Using Parent(s) and Child Objectively Measured Physical Activity

Authors/ Year	Study Design	Sample Characteristics	Measure(s) Used/ Categorization	Control Variable(s)	Results
Freedson & Evenson, 1992	Cross-sectional	- 5 to 9 yrs - 30 children (13 girls, 17 boys) - 30 mothers - 30 fathers - study location not reported.	- Caltrac accelerometer - wore for 3 consecutive days (1 weekend day, 2 weekdays) *Operationalized as:* counts per day - classified as low active/high active via a 50th percentile split		*Chi-square analyses:* - familial resemblance (similarity of high active/ low active between child and parent) occurred in 67% of fathers & child ($\chi^2 = 3.45$, $p < .06$), 73% of mothers & child ($\chi^2 = 6.72$, $p < .05$). *Frequency descriptions:* - when both parents were low active, 76% of children were active (24% were low active). - when one parent was high active, 76% were high active (24% were low active). - when both parents were high active, 97% were high active (3% of children were low active).
Fuemmeler et al., 2011	Cross-sectional	- 4th and 5th grade - *M* age for girls = 10.6 ± .63 yrs - *M* age for boys = 10.6 ± .76 yrs) - 57 parent-child triads - Southwest US	- MTI Actigraph accelerometer (60 sec epochs) - *Operationalized as:* mean minutes of MVPA/day - 4 consecutive days (Thursday to Sunday)	-minority status -child age -gender -BMI of parents and child -maternal and paternal education -wear time	*Linear regression analyses* - fathers MVPA was related to child's MVPA on the weekend days ($p = .01$) and weekdays ($p = .03$), and during after-school hours ($p < .01$). - mothers MVPA was related to child's MVPA during the weekends ($p = .02$) and weekdays ($p = .04$), and after school hours ($p = .01$). *3 X 2 ANOVA:* - children who had 2 high active parents were more active than children with 2 low active parents.

Jago et al., 2010	Cross-sectional	- 10 to 11 yrs (year 6 in UK) - 340 parent-child dyads - participating parent identified as the primary caregiver	- Actigraph accelerometer (children at 10 sec epochs; parents at 1 min epochs) - wore for 5 days (2 weekend days) - *Operationalized as:* Mean counts per min (volume) and mean min of MVPA (intensity)	- hours of daylight on the first day, child BMI, parental BMI, and household deprivation - also adjusted for clustering within schools	*Bivariate correlations:* - *ns* for girls and boys PA and parents PA for either counts/min or mean min of MVPA. - therefore parent PA was not entered into the successive regression models.
Loucaides & Jago, 2006	Cross-sectional	- 11 to 12 yrs - 104 children - 70 parents - Lemesos, Cyprus	- Yamax Digiwalker pedometers - 5 consecutive days		*Bivariate correlations:* - no statistically significant association between children's and father's or mother's step counts
Moore et al., 1991	Longitudinal - measured 2 times approximately 6 months apart	- 4 to 7 yrs - 100 children - 99 mothers - 92 fathers - Massachusetts, USA	- Caltrac accelerometer for both parents and child PA - 5 consecutive days (2 times) *Operationalized as:* mean number of counts per hour - categorized as active/ inactive based on whether their counts/hour was above or below the median for their generation and sex-specific distribution.	- gender of child - relative weight of child - parents age	*Contingency table analysis:* - active mothers = 2 X more likely to be active - active fathers = 3.5 X more likely to be active (therefore stronger for active fathers) *Standard odds ratio analysis:* - when both parents were active = 5.8 X more likely to be active - estimated effect was stronger for boys than girls

Oliver et al., 2010	Cross-sectional	- 2 to 5 yrs - 78 children - 62 mothers - 20 fathers (mothers and fathers combined into one score because not enough fathers) - Auckland, New Zealand	- Actical accelerometer (15 sec epochs) for both parents and children - wore for 7 consecutive days - *Operationalized as:* median average daily PA counts per sec	- child age, child BMI, and number of days the child was taken outdoors (e.g., playground/park/beach) were entered into the model.	*Multivariate Generalized Estimating Equation Regressions:* - parental PA significantly contributed to the model (p = .01) - for every 60 count/min increase in parental PA the estimated average increase in child counts was 5.4 counts/min - of the control variables entered into the model only child age (p = .03) was a significant contributor.
Taylor et al., 2008	Longitudinal	- Children were measured at age 3, 4 and 5 yrs. - Parents were measured one time. - New Zealand - 244 children (44% female) - 166 mothers - 170 fathers	Mini-Mitter omnidirectional Actical accelerometer - 5 consecutive days in children - 7 consecutive days in parents - *Operationalized as*: counts per min, overall activity counts	In mixed model: -sex -weight status -time awake	*Spearman rank-order correlations:* - parental PA was weakly associated with child PA at 3 (r = .18, p = .03 for mother; r = .28, p = .001 for father) and 4 yrs (r = .17, p = .05 for mother; r = .23, p = .01 for father) but not 5 yrs (using counts/min) *Mixed model analysis:* - fathers activity significantly influenced the children's activity (β = .11, p = .02) and mothers activity approached significance (β = .21, p = .06) (using overall counts)

Note: yrs = years; PA = physical activity; MVPA = moderate-to-vigorous physical activity; BMI = body mass index.

Table 3

Studies Examining the Parent-Child Physical Activity Relationship Using an Objective Measure of Child Physical Activity and a Child-Proxy Measure of Parent Physical Activity

Authors/ Year	Study Design	Sample Characteristics	PA measure-children	PA measure-parent(s)	Results
Trost et al., 1999a	Cross-sectional	- African American 6th grade students - *M* age = 11.4 ±.5yrs - 108 (57 girls, 51 boys) - South Carolina, USA	- CSA 7164 Accelerometer for child PA (vertical acceleration) - 7 consecutive days *Operationalized as:* mean min of MVPA per day - Were classified as active if exhibited 3 or more 20-min bouts of MVPA over the 7 days	- child perceived PA of both parents (active vs. low active)	*Chi-square:* - active boys were more likely to perceive their *mother* as active ($p < .05$). - results were *ns* for girls.
Trost et al., 1999b	Cross-sectional	- 198 6th grade students (103 girls; 95 boys) - 11.4 ± .6 yrs - South Carolina, USA	- children wore a CSA WAM 7164 uniaxial accelerometer (1 min epochs) - 7 consecutive days *Operationalized as:* mean daily min of MPA and VPA	- child perceived PA of both parents (yes/no)	*Pearson-product-moment correlations*: - VPA of boys ($p < .05$) correlated with mothers activity, while boys MPA ($p < .05$) correlated with fathers activity - girls PA correlated with neither. *Hierarchical Multiple Regression Analysis:* - when these findings were entered into multiple regressions for boys/girls, the contribution was no longer significant. - father PA for boys was approaching significance ($n = 95$, $p = .13$)

Trost et al., 2001	Cross-sectional	- 133 non-obese, 54 obese - Grade 6 (*M* age = 11.4 ± .6 years) - South Carolina, USA	- children wore CSA 7164 uniaxial accelerometers - 7 consecutive days *Operationalized as:* obese/ non-obese *not* active/ inactive.	- Child reported (categorized as active via yes/no)	*Chi-square:* - Obese children were less likely ($p < .05$) than non-obese to report their father as being not active. - findings were *ns* for mother PA - obese children were more active (daily count, MVPA, VPA)

Note: yrs = years; PA = physical activity; MVPA = moderate-to-vigorous physical activity; MPA = moderate physical activity; VPA = vigorous physical activity.

Table 4

Studies Examining the Parent-Child Physical Activity Relationship Using an Objective Measure of Child Physical Activity and a Self-Report Measure of Parent Physical Activity

Authors/ Year	Study Design	Sample Characteristics	PA measure-children	PA measure-parent(s)	Control Variables	Results
Cleland et al., 2011	Longitudinal	- 190 children 5 – 6 yrs - 350 children 10 – 12 yrs - Australia	- children wore Actigraph uniaxial accelerometer - 8 days - separated into critical window (after school until 6:00 pm) and weekends *Operationalized as*: average change of min in MVPA (> 3.0 METS)	- one parent self-reported the usual duration and frequency of their own and their partners PA. - therefore mother and father PA was known	- maternal education, parental marital status, # of siblings	*Crude Model (bivariate relations, controlling for covariates)* Significant relations found for: - mother PA & boys MVPA in critical window ($p < .05$) - mother PA & girls MVPA in critical window ($p < .01$) - mother PA and girls MVPA on weekends ($p < .05$) - mother PA and younger boys MVPA on weekends ($p < .01$) *Generalized Estimating Equations:* - during the critical hours period, mothers MVPA correlated with the young and older boys PA. - no other relationships were found with mother/father PA.
Craig et al., 2010 (CANPLAY)	Cross-sectional	- 11404 children/ adolescents (5823 boys, 5581 girls) - aged 5 – 19 yrs - 11404 parent or legal guardian - Canada	- children/ adolescents wore a nonsealed Yamax SW-200 pedometer - 7 days (logged steps) *Operationalized* as: mean steps per day	- parent self-reported PA- "Compared to other people your age and sex, would you say you are much more active, just as active, somewhat less active or much less active?		- daily steps were reduced for children/ adolescents whose parents rated themselves as significantly less active (~1700 steps/day) than other adults their age and sex (no statistics reported)

Griffith et al., 2007	Cross-sectional	- 109 children/ adolescents (55 boys, 54 girls) - 10 - 14 yrs -88 parents (92% mothers) - Kentucky, USA	- Children/ adolescents wore a Yamax SW-200 Digi-Walker step counter - 7 days (logged steps) *Operationalized as:* mean steps per day	- parent self-reported PA -includes 17 questions scored on a 5-point scale resulting in three scores: PA at work, sport participation during leisure time, and PA during leisure (not sports)	- adjusted for intrafamily correlation (i.e., a parent who had 2 children in the study)	*Bivariate correlations:* - pedometer counts correlated with parents sports score ($p < .01$) but not parents leisure score.
McMinn et al., 2008	Cross-sectional	- 397 children aged 8 - 10 yrs - 213 adolescents, aged 14 - 16 yrs - Odense, Denmark	- MTI accelerometer (model 7164) *Operationalized as:* average daily counts/min - wore for 4 days (2 weekend days and 2 weekdays)	- both parents reported their own PA quantified as regularly participating in exercise/sport (≥ 2 X/wk, yes/no)	In the multivariate analyses: - gender - BMI - pubertal stage	*Univariate linear regressions* - significant effects were found for grade 3 children and mother regularly active ($p < .01$) but not for father regularly active. - results *ns* for grade 9. *Multiple linear regressions*: - significant effects were found for grade 3 children mother regularly active ($p < .01$), and father regularly active ($p < .05$). - There was an interaction for gender X father regularly active with a positive association in girls ($p < .05$) and an *ns* negative finding in boys. - the regression was *ns* with the grade 9's.

Sallis et al., 2002	Cross-sectional	- 200 children/ adolescents - grades 1 – 12 - Massachusetts, USA	- CSA model 7164 accelerometer for child PA - vertical plane - 1 min sampling interval *Operationalized as:* min of vigorous activity (≥6 METS)	- parent self-reported PA - 8 questions reporting min walking, house chores, gardening, and sports participation (Min X METS)	-age	*Partial correlations* - all correlations were *ns* - younger males (r = .32), younger females (r = .27), older males (r = .24), older females (r = -.11)
Sallis et al., 1992	Cross-sectional	- 297 children (148 girls, 149 boys) - 4th grade children - girls *M* age = 9.2 ± .49 yrs - boys *M* age = 9.3 ± .5 yrs - California, USA	- children Caltrac accelerometer (vertical axial) - 1 weekday (given at end of school day and taken off at the beginning of school the following day) and 1 weekend day (given at the end of school on Friday and taken off at the beginning of school on Monday) *Operationalized as:* total activity counts	- Up to 3 adults in the household could report their PA - number of minutes engaged in mild (3 METS), moderate (6 METS), and vigorous PA (9 METS) per week.	- BMI - ethnicity (white/non-white)	*Pearson correlations:* - *ns* findings for boys and girls

Note: yrs = years; PA = physical activity; MVPA = moderate-to-vigorous physical activity; MPA = moderate physical activity; VPA = vigorous physical activity, BMI = body mass index.

Table 5

The Hypotheses and Associated Analyses

Hypothesis	Variables	Analysis
H1: Positive correlations will exist between parent and child steps on each day of measurement.	*Parents*: pedometer steps from day 1, day, 2, day 3, and day 4 *Children*: pedometer steps from day 1, day 2, day 3, and day 4	Four bivariate correlations
H2: A positive relationship will exist between the average total steps of parents and children (both boys and girls).	*Predictor variable:* Average parents steps *Criterion variables:* 1. Average boys steps 2. Average girls steps *Covariates:* Child age and BMI, area-level SES, season (winter/fall, spring/summer)	*Preliminary analysis:* Bivariate correlations between child (all, boys, girls) steps and parent (all, mothers, fathers) steps *Main analyses:* Linear step-wise regressions
H3: A positive relationship will exist between parent and child pedometer steps on both weekdays and weekend days.	*Predictor variables:* 1. Average parent weekday steps 2. Average parent weekend day steps *Criterion variables:* 1. Child weekday steps 2. Child weekend day steps *Covariates:* Child age, BMI, and gender, area-level SES, season (winter/fall, spring/summer)	*Preliminary analysis:* Bivariate correlations between child weekend/weekday and parent weekend/weekday steps *Main analysis:* Linear step-wise regressions

Note. BMI = body mass index; SES = socioeconomic status.

Table 6

Demographic Information

Child Characteristics	Boys (n = 220)	Girls (n = 251)	Overall (n = 471)	Difference between boys and girls
Mean Age in years (SD)	7.72 (.63)	7.77 (.63)	7.75 (.63)	$t(469) = -.88$, *ns*
Overweight Status				$\chi^2(2) = .42$, *ns*
Normal (z-score > 1.0)	77%	79%	78%	
Overweight (z-score between 1.0 – 1.99)	16%	14%	15%	
Obese (z-score > 2.0)	7%	6%	7%	
Activity Status				$\chi^2(1) = 6.17$, $p < .05$
Active (> 13,500 steps/day)	4%	9%	6%	
Inactive (< 13,500 steps/day)	96%	91%	93%	
Parent Characteristics	**Fathers' (n = 83)**	**Mothers' (n = 356)**	**Overall (n = 471)**	**Difference between mothers' and fathers'**
Overweight Status	n = 50	n = 331	n = 381	$\chi^2(2) = 11.22$, $p < .01$
Underweight	0%	1%	1%	
Normal (BMI < 25 kg/m^2)	38%	60%	58%	
Overweight (BMI > 25 kg/m^2)	40%	28%	30%	
Obese (BMI > 30 kg/m^2)	22%	11%	12%	

Activity Status				$\chi^2(1) = 2.09$, *ns*
Active (> 13,500 steps/day)	24%	17%	22%	
Inactive (< 13,500 steps/day)	76%	83%	78%	
Education	*n* = 50	*n* = 334	*n* = 384	$\chi^2(5) = 13.36$, $p < .05$
Some high school	0%	.3%	.3%	
Completed high School	12%	8%	8%	
Some university or College	10%	12%	12%	
Completed university/ college	52%	67%	65%	
Some graduate School	16%	5%	6%	
Completed graduate School	10%	9%	9%	
Household Income				$\chi^2(5) = 3.19$, *ns*
< $20,000	1%	1%	1%	
$20,000-39,999	0%	2%	1%	
$40,000-59,999	5%	6%	6%	
$60,000-79,999	16%	11%	12%	
$80,000-99,999	23%	22%	21%	
>$100,000	55%	60%	58%	
Mean Area-level SES (SD)	11.72 (20.66)	11.24 (18.79)	11.03 (19.18)	$t(436) = -.21$, *ns*

Note. BMI = body mass index; SES = socioeconomic status.

Table 7

Means and Standard Deviations for Average Total, Weekday, and Weekend Parent and Child Steps

	Average Steps (SD)	Difference between Weekend/ Weekday	Difference between Males and Females
Children (all)		$t(355) = 4.55$, $p < .001$	
Total Steps	8633 (2891)		$t(465) = 3.89$, $p < .001$
Weekday Steps	8854 (3076)		$t(444.35) = 3.69$, $p < .001$
Weekend Steps	7842 (3905)		$t(354) = 2.71$, $p < .01$
Boys		$t(174) = 2.89$, $p < .01$	
Total Steps	9180 (2842)		
Weekday Steps	9410 (3115)		
Weekend Steps	8408 (4050)		
Girls		$t(180) = 3.64$, $p < .001$	
Total Steps	8154 (2853)		
Weekday Steps	8359 (2960)		
Weekend Steps	7296 (3689)		
Parents (all)		$t(335) = 4.24$, $p < .001$	
Total Steps	7775 (3079)		$t(457) = -1.54$, *ns*
Weekday Steps	7923 (3302)		$t(446) = -1.55$, *ns*
Weekend Steps	7163 (3554)		$t(337) = -.35$, *ns*
Mothers		$t(247) = 4.28$, $p < .001$	
Total Steps	7887 (3060)		
Weekday Steps	8096 (3293)		
Weekend Steps	7254 (3501)		

Fathers		$t(66) = .81$, *ns*
Total Steps	7568 (3469)	
Weekday Steps	7596 (3632)	
Weekend Steps	6972 (3914)	

Table 8

Bivariate Correlations between Child and Parent Steps and Potential Covariates

	Age	Child BMIz	Parent BMI	Parent Gender	Household income	Parent education	Area-level SES	Season
n (covariates)	471	470	382	439	437	384	470	471
Total steps								
Children (all)	.05	-.12*	-.10	-.06	.01	.01	.04	.08
Boys	.18**	-.14*	-.13	-.01	.04	.07	.09	.06
Girls	-.06	-.10	-.08	-.12	-.02	-.03	-.05	.08
Weekday Steps								
Children (all)	.08	-.09	-.09	-.06	.01	.03	.03	.03
Boys	.21**	-.10	-.13	-.01	-.01	.10	.09	-.02
Girls	-.02	-.10	-.06	-.09	-.02	-.02	-.08	.06

Weekend steps								
Children (all)	-.02	-.10	-.07	-.04	-.01	-.04	.06	.11*
Boys	.05	-.15*	-.01	-.004	.08	-.002	.08	.13
Girls	-.09	-.05	-.18*	-.13	-.11	-.06	-.02	.06
Parent Steps								
Parents (all)	.002	-.05	-.22***	-.05	.18***	.01	.10*	.07
Weekday (all)	.01	-.04	-.29***	-.07	.17	-.003	.09*	.07
Weekend (all)	.04	-.04	-.10	-.03	.16**	.001	.09	.06
Mothers	.01	-.03	-.26***	-.06	.20***	.02	.15**	.07
Fathers	.04	-.07	-.07	-.07	.06	-.01	-.09	.06

Note. BMI = body mass index, BMIz = body mass index *z*-score, SES = socioeconomic status.

*$p < .05$. ** $p < .01$. *** $p < .001$.

Table 9

Bivariate Correlations between Parents and Children's Mean Total, Weekday and Weekend Steps

	Children (all)	Boys	Girls
Total Steps			
Parents (all)	.29*** (*n* = 458)	.34*** (*n* = 212)	.30*** (*n* = 246)
Mothers	.28*** (*n* = 350)	.33*** (*n* = 164)	.27*** (*n* = 184)
Fathers	.29** (*n* = 84)	.33* (*n* = 43)	.39* (*n* = 41)
Weekday			
Parents (all)	.24*** (*n* = 447)	.25*** (*n* = 216)	.27*** (*n* = 239)
Mothers	.18** (*n* = 252)	.25** (*n* = 160)	.23** (*n* = 180)
Fathers	.22* (*n* = 83)	.16 (*n* = 43)	.35* (*n* = 40)
Weekend			
Parents (all)	.36*** (*n* = 330)	.39*** (*n* = 161)	.36*** (*n* = 169)
Mothers	.35*** (*n* = 247)	.38*** (*n* = 125)	.35*** (*n* = 125)
Fathers	.34** (*n* = 67)	.40* (*n* = 35)	.34 (*n* = 29)

Note. *$p < .05$. ** $p < .01$. *** $p < .001$.

Table 10

Step-Wise Linear Regression Predicting Average Total Steps for Girls and Boys

	Variables	B	β	Adjusted R^2
Boys, *n* = 211				
Step 1				.04**
	Age	861.30**	.19	
	Child BMIz	-288.63	-.10	
Step 2				.05
	Area-level SES	7.74	.06	
	Season	447.60	.08	
Step 3				.14***
	Average total parent steps	0.33***	.31	
Girls, *n* = 246				
Step 1				.00
	Age	-207.70	-.05	
	Child BMIz	-260.49	-.09	
Step 2				.00
	Area-level SES	-14.69	-.09	
	Season	205.57	.04	
Step 3				.09***
	Average total parent steps	0.26***	.31	

Note. BMIz = body mass index *z*-score; SES = socioeconomic status.

*$p < .05$. ** $p < .01$. *** $p < .001$.

Table 11

Step-Wise Linear Regressions Predicting Child Weekday and Weekend Day Steps

	Variables	B	β	Adjusted R^2
Weekdays all children, *n* = 446				
Step 1				.04***
	Age	463.82*	.09	
	Child gender	-1221.95***	-.20	
	Child BMIz	-232.28	-.07	
Step 2				.04
	Season	85.97	.01	
	Area-level SES	-2.72	-.02	
Step 3				.10***
	Parent weekday steps	0.24***	.25	
Weekend days all children, *n* = 329				
Step 1				.02**
	Child age	-15.63	-.003	
	Child gender	-1271.24**	-.16	
	Child BMIz	-244.43	-.06	
Step 2				.04
	Season	273.00	.07	
	Area-level SES	3.83	.02	
Step 3				.15***
	Parent weekend steps	0.39***	.35	

Note. BMIz = body mass index *z*-score; SES = socioeconomic status.

$^*p < .05$. $^{**} p < .01$. $^{***} p < .001$.

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Appendix A: Parent Questionnaire 1

UNIVERSITY OF ALBERTA

Faculty of Physical Education and Recreation

E-488 Van Vliet Center
Edmonton, AB T6G 9Z9
780-248-1123

Determinants of Health and Growth among Children:

My Child - A questionnaire for parents

ID#__________

Alberta Health Services
Capital Health

Determinants of Health among Children

We are doing a study about the growth of preschool children. The purpose of the study is to measure the height and weight of preschool children and to look at how those measures link to other factors in a child's life. We would appreciate it if you would answer a few questions about your child's eating patterns and activity levels. The results of the study will help us to better understand the health of children in our region and to plan services.

1. Thinking back over the past couple of weeks, how many servings has your child had of the following foods and beverages? Estimate the number of servings for each food or beverage, either over an average day or over an average week. If your child rarely or never has the food or beverage, write zero per day or per week.

You do not need to fill in both columns, choose the easiest one to calculate, for each food or beverage.

Food or Beverage	# Servings per day	OR	# Servings per wk
Fruit (1 fresh fruit, 125 ml or ½ cup canned fruit)	per day		per wk
Vegetables (125 ml or ½ cup cooked or fresh)	per day		per wk
Cheese and/or yogurt (1-2 pieces cheese, 175 g or ¾ cup yogurt)	per day		per wk
Bread/cereal/pasta/rice (1 slice bread, 1 muffin, 1 bowl cereal)	per day		per wk
Meat/poultry/fish (1 piece, 1 hot dog, 1 hamburger)	per day		per wk
Eggs (1 egg)	per day		per wk
Peanut butter, nuts, tofu (¼ cup nuts, 100 g or 1/3 cup tofu)	per day		per wk
Chips, tacos, cheesies (1 small bag)	per day		per wk
French fries, fried meats (10 fries, 3-5 chicken fingers)	per day		per wk
Candy (about ½ cup)	per day		per wk
Chocolate bars (1 regular size bar)	per day		per wk
Cookie/cake/pastry (1-2 cookies, medium sized pastry or piece of cake)	per day		per wk
Fruit bars/leather, granola bars (1 bar)	per day		per wk
Ice cream, sherbet, frozen yogurt (2-3 scoops)	per day		per wk
For beverages, think of a serving as 250 mL, which is the same as 1 cup, 8 ounces, or a small glass.			
Juice 100% pure	per day	OR	per wk
Juice drink or punch (Sunny Delight®, 5-Alive®)	per day		per wk
Milk (white or flavoured), soy or rice beverages	per day		per wk

Pop or slushes	per day		per wk
Water	per day		per wk
Other, please specify ______________________________	per day		per wk

2. Please read the following statements. Tick the boxes most appropriate to your child's eating behaviour.

Statements	Never	Rarely	Some-times	Often	Always
My child loves food	☐	☐	☐	☐	☐
My child eats more when worried	☐	☐	☐	☐	☐
My child has a big appetite	☐	☐	☐	☐	☐
My child finishes his/her meal quickly	☐	☐	☐	☐	☐
My child is interested in food	☐	☐	☐	☐	☐
My child is always asking for a drink	☐	☐	☐	☐	☐
My child refuses new foods at first	☐	☐	☐	☐	☐
My child eats slowly	☐	☐	☐	☐	☐
My child eats less when angry	☐	☐	☐	☐	☐
My child enjoys tasting new foods	☐	☐	☐	☐	☐
My child eats less when s/he is tired	☐	☐	☐	☐	☐
My child is always asking for food	☐	☐	☐	☐	☐
My child eats more when annoyed	☐	☐	☐	☐	☐
If allowed to, my child would eat too much	☐	☐	☐	☐	☐
My child eats more when anxious	☐	☐	☐	☐	☐
My child enjoys a wide variety of foods	☐	☐	☐	☐	☐
My child leaves food on his/her plate at the end of a meal	☐	☐	☐	☐	☐
My child takes more than 30 minutes to finish a meal	☐	☐	☐	☐	☐
Given the choice, my child would eat most of the time	☐	☐	☐	☐	☐
My child looks forward to mealtimes	☐	☐	☐	☐	☐
My child gets full before his/her meal is finished	☐	☐	☐	☐	☐
My child enjoys eating	☐	☐	☐	☐	☐
My child eats more when s/he is happy	☐	☐	☐	☐	☐
My child is difficult to please with meals	☐	☐	☐	☐	☐

Statements	Never	Rarely	Some-times	Often	Always
My child eats less when upset	☐	☐	☐	☐	☐
My child gets filled up easily	☐	☐	☐	☐	☐
My child eats more when s/he has nothing else to do	☐	☐	☐	☐	☐
Even if my child is filled up s/he finds room to eat his/her favorite food	☐	☐	☐	☐	☐
If given the chance, my child would drink continuously throughout the day	☐	☐	☐	☐	☐
My child cannot eat a meal if s/he has had a snack just before	☐	☐	☐	☐	☐
If given the chance, my child would always be having a drink	☐	☐	☐	☐	☐
My child is interested in tasting food s/he hasn't tasted before	☐	☐	☐	☐	☐
My child decides that s/he doesn't like a food, even without tasting it	☐	☐	☐	☐	☐
If given the chance, my child would always have food in his/her mouth	☐	☐	☐	☐	☐
My child eats more and more slowly during the course of a meal	☐	☐	☐	☐	☐

2. How many times does your family sit together for a meal during a typical WEEK?

________ times per week

3. Which of the following physical activities does your child USUALLY do during a typical WEEK?

During a typical WEEK what activities does your child usually do?	Does your child usually do this activity?	Monday - Friday		Saturday & Sunday	
		How many times Mon - Fri?	Average minutes each time Mon - Fri?	How many times Sat & Sun?	Average minutes each time Sat & Sun?
Example: Bike riding	No Yes	2	40 minutes	1	15 minutes
Swimming – lessons and for fun	No Yes				
Soccer	No Yes				

Ballet/Dance	No	Yes				
Gymnastics	No	Yes				
Skating	No	Yes				
Hockey	No	Yes				
Bike riding	No	Yes				
Gym activities	No	Yes				
Active play – including at a playground	No	Yes				
Other, please specify	No	Yes				

4. Which of the following leisure activities does your child USUALLY do during a typical <u>WEEK</u>?

During a typical WEEK what other leisure activities does your child usually do?	Does your child usually do this activity?		Total hours/minutes Monday-Friday	Total hours/minutes Saturday & Sunday
Example: TV/ videos	No	Yes	15 hours	6 hours and 30 minutes
TV/ videos	No	Yes		
Play station / Nintendo / X-Box/ Game boy	No	Yes		
Computer / internet / computer games	No	Yes		
Play indoors with toys	No	Yes		
Other, please specify	No	Yes		
____________	No	Yes		

6.At what time does your child usually go to sleep during:

Statements	1	2	3	4	5	6
	Before 7pm	7-7:30pm	7:30-8pm	8-8:30pm	8:30-9pm	After 9pm
The week	☐	☐	☐	☐	☐	☐
The weekend	☐	☐	☐	☐	☐	☐

7.At what time does your child usually wake up during:

Statements	1	2	3	4	5	6
	Before 7am	7-7:30am	7:30-8am	8-8:30am	8:30-9am	After 9am
The week	☐	☐	☐	☐	☐	☐
The weekend	☐	☐	☐	☐	☐	☐

8.In general, how would you rate your child's health?

☐ 1 Excellent ☐ 2 Very good ☐ 3 Good ☐ 4 Fair ☐ 5 Poor

9.Does your child have any problems that would hinder them from doing physical activities?

☐ 1 Yes, sometimes ☐ 2 Yes, often ☐ 3 No

If Yes, please explain the difficulty.

____

10. Do you have any concerns about your child's height or weight?

☐ 1 Yes ☐ 2 No If Yes, please describe your concern.

____

____

Thank you very much!

Appendix B: Parent Questionnaire 2

UNIVERSITY OF ALBERTA

Faculty of Physical Education and Recreation

ID# ________

Determinants of Health and Growth among Children:

My Neighbourhood – A Questionnaire for Parents

Alberta Health Services
Capital Health

We would like to find out more information about the way that you perceive or think about your neighbourhood. Please answer the following questions about your neighbourhood and yourself.

A. Types of Residences in your neighbourhood

Please check the box that best applies to you and your neighbourhood.

	1	2	3	4	5
	None	A Few	Some	Most	All
1. How common are detached single-family residences in your neighbourhood?	☐	☐	☐	☐	☐
2. How common are townhouses or row houses of 1-3 stories in your neighbourhood?	☐	☐	☐	☐	☐
3. How common are apartments or condos 1-3 stories in your neighbourhood?	☐	☐	☐	☐	☐
4. How common are apartments or condos 4-6 stories in your neighbourhood?	☐	☐	☐	☐	☐
5. How common are apartments or condos 7-12 stories in your neighbourhood?	☐	☐	☐	☐	☐
6. How common are apartments or condos more than 13 stories in your neighbourhood?	☐	☐	☐	☐	☐

B. Stores, facilities, and other things in your neighbourhood

About how long would it take to get from your home to the nearest businesses or facilities (e.g., schools) listed below if you walked to them? Please put only one check mark (√) for each business or facility.

Statements	1	2	3	4	5	6
	1-5 min	6-10min	11-20min	20-30min	30+min	Don't know
1. Example: shoe repair shop	☐	☐	☐	☐	☐	☐

Statements	1	2	3	4	5	6
	1-5 min	6-10min	11-20min	20-30min	30+min	Don't know
1. convenience or small grocery store	☐	☐	☐	☐	☐	☐
2.supermarket	☐	☐	☐	☐	☐	☐
3. hardware store	☐	☐	☐	☐	☐	☐
4. fruit and vegetable market	☐	☐	☐	☐	☐	☐
5. laundry/dry cleaners	☐	☐	☐	☐	☐	☐
6. clothing store	☐	☐	☐	☐	☐	☐
7. post office	☐	☐	☐	☐	☐	☐
8. library	☐	☐	☐	☐	☐	☐
9. elementary school	☐	☐	☐	☐	☐	☐

Statements	1	2	3	4	5	6
10. other schools	☐	☐	☐	☐	☐	☐
11. bookstore	☐	☐	☐	☐	☐	☐
12. fast-food restaurant	☐	☐	☐	☐	☐	☐
13. coffee place	☐	☐	☐	☐	☐	☐
14. bank/credit union	☐	☐	☐	☐	☐	☐
15. non fast-food restaurant	☐	☐	☐	☐	☐	☐
16. video store	☐	☐	☐	☐	☐	☐
17 pharmacy/drug store	☐	☐	☐	☐	☐	☐
18. salon/barber shop	☐	☐	☐	☐	☐	☐
19. bus or LRT train	☐	☐	☐	☐	☐	☐
20. park	☐	☐	☐	☐	☐	☐
21. recreation centre	☐	☐	☐	☐	☐	☐
22. gym/fitness facility	☐	☐	☐	☐	☐	☐
23. your job/school Check here__ if not applicable (Applies to 23 only)	☐	☐	☐	☐	☐	☐

C. Access to services

Please put a check mark on the answer that best applies to you and your neighbourhood. The terms local and within walking distance mean within a 10-15 minute walk from your home.

Statements	1	2	3	4
	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1. Stores are within easy walking distance of my home.	☐	☐	☐	☐
2. Parking is difficult in shopping areas.	☐	☐	☐	☐
3. There are many places to go within walking distance of my home.	☐	☐	☐	☐
4. A transit stop (bus, train) is within walking distance from my home.	☐	☐	☐	☐
5. The streets in my neighbourhood are hilly, making my neighbourhood difficult to walk in.	☐	☐	☐	☐
6. There are major barriers to walking in my local area that make it hard to get from place to place (for example, freeways, railway lines, rivers).	☐	☐	☐	☐

D. Streets in my neighbourhood

Please circle the answer that best applies to you and your neighbourhood.

Statements	1	2	3	4
	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1. The streets in my neighbourhood <u>do not</u> have many cul-de-sacs (dead-end streets).	☐	☐	☐	☐
2. The length of blocks in my neighbourhood is usually short (300 feet or less; the length of a football field or less).	☐	☐	☐	☐
3. There are many alternative routes for getting from place to place in my neighbourhood. (I don't have to go the same way every time.)	☐	☐	☐	☐

E. Places for walking and cycling

Please circle the answer that best applies to you and your neighbourhood.

Statements	1	2	3	4
	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1. There are sidewalks on most of the streets in my neighbourhood.	☐	☐	☐	☐
2. Sidewalks are separated from the road/traffic in my neighbourhood by parked cars.	☐	☐	☐	☐

Statements	1	2	3	4
3. There is a grass/dirt strip that separates the streets from the sidewalks in my neighbourhood.	☐	☐	☐	☐

F. Neighbourhood surroundings

Please circle the answer that best applies to you and your neighbourhood.

Statements	1	2	3	4
	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1. There are trees along the streets in my neighbourhood.	☐	☐	☐	☐
2. There are many interesting things to look at while walking in my neighbourhood.	☐	☐	☐	☐
3. There are many attractive natural sights in my neighbourhood (such as landscaping, views).	☐	☐	☐	☐
4. There are attractive buildings/homes in my neighbourhood.	☐	☐	☐	☐

G. Neighbourhood Safety

Please check the box that best applies to you and your neighbourhood.

Statements	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
1. There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighbourhood.	☐	☐	☐	☐
2. The speed of traffic on most nearby streets is usually slow (30 km/hr less).	☐	☐	☐	☐
3. Most drivers exceed the posted speed limits while driving in my neighbourhood.	☐	☐	☐	☐
4. My neighbourhood streets are well lit at night.	☐	☐	☐	☐
5. Walkers and cyclists on the streets in my neighbourhood are visible to people in their homes.	☐	☐	☐	☐
6. There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighbourhood.	☐	☐	☐	☐
7. There is a high crime rate in my neighbourhood.	☐	☐	☐	☐
8. The crime rate in my neighbourhood makes it unsafe to go on walks during the day.	☐	☐	☐	☐
9. The crime rate in my neighbourhood makes it unsafe to go on walks at night.	☐	☐	☐	☐

H. Physical Activity

Considering a 7-Day period (a week), how many times on average do you do the following kinds of exercise for more than 15 minutes during your free time (write on each line the appropriate number)?

Times Per Week

1. STRENUOUS PHYSICAL ACTIVITY (heart beats rapidly, sweating) ______________

(e.g., running, jogging, hockey, soccer, squash, cross country skiing, judo, roller skating, vigorous swimming, rigorous long distance bicycling, vigorous aerobic dance classes, heavy weight training)

2. MODERATE PHYSICAL ACTIVITY (not exhausting, light perspiration) ______________

(e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

3. MILD PHYSICAL ACTIVITY (minimal effort, no perspiration) ______________

(e.g., easy walking, yoga, archery, fishing, bowling, lawn bowling, shuffleboard, horseshoes, golf, snowmobiling)

I. Transportation

These questions are about how you travel from place to place, including to places like stores, movies and so on.

1. During the last seven days, did you:

Did you engage in any of these travel activities during the last 7days?	Did you do this?	Monday - Friday		Saturday and Sunday	
		How many times Mon - Fri?	Average minutes each time Mon - Fri?	How many times Sat and Sun?	Average minutes each time Sat and Sun?
Example: Bike riding	No Yes	2	40 minutes	1	15 minutes
Travel by LRT	No Yes				
Travel by bus	No Yes				
Travel by car	No Yes				
Cycle for at least 10 minutes at a time to go from place to place	No Yes				
Walk for at least 10 minutes at a time to go from place to place	No Yes				

J. Demographics

These questions are about you and your household.

1. What is your gender?

□ Male

□ Female

2. What is your relation to the child we are testing today?

□ Mother

□ Father

□ Grandmother

□ Grandfather

□ Other (please describe) ____________________

3. What is the highest level of education that you have attained?

□ Some high school

□ Completed high school

□ Some university or college

□ Completed university/ college

□ Some graduate school (e.g., master's degree or PhD)

□ Completed graduate school

4. What is your annual household income before taxes?

□ <$20,000

□ $20-39,999

□ $40-59,999

□ $60-79,999

□ $80-99,999

□ >$100,000

5. What is your height and weight?

Height: ____________ feet, or ____________cm

Weight: ____________ pounds, or ___________kg

6. Do you own a dog?

□ Yes

□ No

THANK YOU VERY MUCH!

Appendix C: Information Letter

UNIVERSITY OF ALBERTA

Information Sheet

Determinants of Health and Growth among Children

Principal Investigator
Dr John C. Spence, University of Alberta

Details about the study

Why are we doing the study?
This study is important because it will give us a better understanding about how children in the Edmonton area grow, how fit they are, and the link these factors have to overall wellbeing. One of the unique aspects of this study is that it follows children over time. This is a follow up to the study that your child took part in a few years ago. You and your child's participation in the study are very important and will help us to further our understanding of the healthy growth of children.

What will we be doing?
For the study, we will be measuring the height, weight, physical fitness, and physical activity of children. We will also be asking you to complete some questionnaires about your neighbourhood and about your child's eating and activity patterns.

Where will this be done? The fitness testing will take place on the South Campus of the University of Alberta. We estimate that you will be at the study site for approximately one hour. Parking is free at this site.

What will your child be doing?

- Your child will be asked to do simple exercises such as sit ups, partial jumps and a step test to measure fitness.
- Your child's height and weight will be measured.
- Your child will be given a pedometer to wear for four days. (A pedometer is a small electronic device that is used to count how many steps a person takes per day.)
- You will also be asked to keep track of their activities and the foods they eat during the 4 days they are using the pedometer.

What are we asking you to do?

Two copies of a consent form and a questionnaire are included in this package. The questionnaire asks about your child's activity and eating habits. If you agree to participate in the study, please complete the questionnaire and the consent forms. The questionnaire should take about 15-20 minutes to fill out. When you are finished, please keep one copy of the consent form and bring the completed questionnaire and the other copy of the consent form to the University study site.

Our University project coordinator, Mildred Masimira, will phone you in the next few days to arrange for you and your child to visit our study site. We will try to arrange a day and time that is convenient for you.

At the time of your child's fitness testing, we will ask about your weight and height and ask you to complete a questionnaire about your neighbourhood. You will also be given a pedometer to wear for four days.

How will we protect your child's privacy?

The information about your child will be kept private. No names will be used on the questionnaires or in reports from the study. Each participant will be assigned a four digit number that will be used to identify them. The study data will be kept for at least seven years and will be kept in a safe area and only the research team can see it. If the data are to be used for other studies, ethics approval will be obtained. At no point will any personal information from you or your child be available to any person outside of our research team.

There is no pressure for you or your child to agree to be in the study or answer the questions. If you want, you can skip questions you don't wish to answer. Also, if you decide not to be in the study, it will not affect the services your child receives now, or in the future in any way. However, we hope you and your child will be interested in participating in the study. And as a token of thanks, we will provide you and your child with small gifts.

If you have any questions, please call our project coordinator Mildred Masimira at 780-248-1123 before your visit to the study site. Or, you can send your questions by email to (masimira@ualberta.ca). We are hoping that we will be able to do this study again in two or three years. So, if you agree, we would like to be able to contact you from time to time to make sure that we have the correct address information.

If you have any questions about your rights as a research participant, you may contact the Health Research Ethics Board at 780-492-0302. This office is not connected in any way to the study investigators.

Co-Investigators:

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Appendix D: Consent Form

UNIVERSITY OF ALBERTA

Alberta Health Services (Edmonton area) – Public Health
#300 10216 – 124 Street, Edmonton, AB TT5N 4A3

University of Alberta, Faculty of Physical Education and Recreation
E488 Van Vliet Centre, Edmonton AB, T6G 2H9

Part 1 ID#______________

Title of Project: *Determinants of Health and Growth among Children*

Principal Investigator

Dr John C. Spence, University of Alberta

Part 2

Do you understand that you and your child have been asked to participate in a study on the growth of children?	Yes No
Have you read and received a copy of the Information Sheet?	Yes No
Have you had an opportunity to ask questions and discuss this study?	Yes No
Do you understand that you are free to refuse to participate or withdraw from the study at any time? You do not have to give a reason and it will not affect your child's health care.	Yes No
Has the issue of confidentiality been explained to you and do you Understand who will have access to your child's personally identifiable health information?	Yes No
Do you understand that if the data from this study are used in another study, this would only be done if research ethics approval were obtained?	Yes No
Do you understand that we would like to contact you in the future so that we can further assess your child's growth?	Yes No

I agree to have my child’s information used for the Determinants of Health and Growth among Children study.

____

Name of Child Date of Birth

____

Signature of Parent Date Witness

____

Printed Name Printed Name

____

Would you be willing to be contacted in the future for further assessment of your child’s growth?

Yes No

If yes, please sign your name and indicate your address and a number where you may be reached.

____

____

Signature of Parent

____

Appendix E: Assent Form

UNIVERSITY OF ALBERTA

Alberta Health Services (Edmonton area) – Public Health
#300 10216 – 124 Street, Edmonton, AB TT5N 4A3

University of Alberta, Faculty of Physical Education and Recreation
E488 Van Vliet Centre, Edmonton AB, T6G 2H9

CHILD ASSENT FORM

Title of Research Study
Determinants of Health and Growth among Children ***ID#___________***

Principal Investigator: Dr John C. Spence

What will you have to do? For the study, we're going to see how tall you are and see how much you weigh. We're also going to measure your waist and ask you to do a few little exercises. Does that sound ok so far?

Will it hurt? The exercises aren't hard at all and nothing should hurt. If you haven't done these kinds of exercises before they might just feel a little funny, but again, they shouldn't hurt.

Can you quit? You don't have to take part in the study at all, and you can stop at any time. No one will be mad at you if you decide you don't want to do this, or if you decide to stop at any point. You should tell your parents (or guardian) and the people who will be doing the study when you want to stop. Does that make sense? Will you feel ok telling your parents (or guardian) and the people doing the study?

Who will know? If you don't want anyone to know how tall you are or how much you weigh you don't have to worry, because all the information about you is linked to a secret number and not your name. Only the people doing the study know your information.

Your signature: Does everything make sense so far? Do you think this is something you feel ok doing? Your mom or dad (or guardian) will be asked to sign another form agreeing for you to take part in the study.

Do you have more questions? You can ask your mom or dad (or guardian) about anything you don't understand.

The child agrees to participate in the study.

Signature of data collector: _________________ Date:___________