THE IMPACT OF SOCIAL COMPETENCE BETWEEN PHYSICAL ACTIVITY AND MOTOR PERFORMANCE

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Abstract

Objective

To identify the association of low physical activity (PA) participation in children with various motor performances (MP) and to establish the impact of social competence (SC).

Methods

Sixth grade children from PHAST study at Brock University (n=1958; 50.53% males) had MP test results from Bruininks-Oseretsky Test of Motor Proficiency, Participation Questionnaire (PQ) used for PA and Harter Social Competence Scale for self-perceived SC. Comparative tests, multiple and logistic regressions were performed.

Results

Significant differences in PQ measures in MP quartiles and SCs. MP and SC are independent predictors of PA ($p<.05$) except with SES on free play activity, making MP not significant. Lower MP increased the odds of low total PA and organized sport participation but not for free play activities (OR~1). Higher SC reduced the risk of low participation in all PA measures.

Conclusions

SC improves PA participation, including free play and organized sports, despite the child's MP.

Key words: motor performance, PHAST, social competence

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Chapter 1: Introduction

1.1.0 Preamble

It is important to promote a healthy lifestyle in childhood in order to establish those habits into adulthood and prevent future disease. Evidence has accumulated that lifestyle choices established in childhood are maintained in adulthood (Daniels, Greer & Committee of Nutrition, 2008; Singer, Moore, Garrahie & Ellison, 1995). One example of this relationship is physical activity patterns, which track from childhood into adulthood (Kemper, Vente, van Mechelen & Twisk, 2001). Globally, cardiovascular diseases (CVD) are the leading cause of death with an estimated 26.3 million expected deaths by 2030 (WHO, 2011). Low physical activity and its concurrent poor physical fitness are significant risk factors for CVD among adults (Dewey & Mahoney, 1999). Increasing evidence has shown that the atherosclerotic processes that result in coronary heart disease among adults have their origins during childhood (Daniels et al, 2008; Newman, Freedman & Voors, 1986; Kavey, Allada, Daniels, Hayman, McCrindle Newburger, Parekh & Steinberger, 2006). Therefore, the importance of promoting healthy active lifestyles among children is clear. The development of active lifestyles in children is crucial for future cardiovascular health (Williams et al, 2002).

Nevertheless, only 7% of children and youth in Canada are meeting the recommended levels of physical activity for the promotion and maintenance of health, those being at least 60 minutes of moderate-to-vigorous physical activity for children ages 5 to 11 and youth 12 to 17 (Tremblay et al, 2011). A lack of physical activity is also associated with lower psychological well-being and social skills among children and adolescents, as well as poorer cardiovascular health. The health benefits associated with an active lifestyle in childhood include better weight control, lower blood pressure, improvements of psychological well-being, as well as the predisposition to increased physical activity in adulthood (Williams et al, 2002). The rising trend of sedentary lifestyles in childhood has been linked with a similar increase in prevalence of childhood obesity (Mitchell, Mattocks, Ness, Leary, Pate, et al, 2009; Wong & Leatherdale, 2009; Thibault, Contrand, Saubusse, Baine & Maurice-Tison, 2009). Obese children and adolescents are at greater risk of adult obesity, Type II diabetes and coronary disease

(Eckel & Krauss, 1998; Epstein, Valoski, Vara, McCurley, Wisniewski et al, 1995). Children who are obese display lower levels of confidence in their ability to conquer physical activity barriers, leading to a preference of a sedentary lifestyle. (Trost, Kerr, Ward & Pate, 2001). By choosing sedentary activities, these children are reducing their energy expenditure; a key element in treating childhood obesity (Epstein et al, 1995). This increased prevalence of sedentary children predilects a more obese adult population with increasing, but preventable, health care costs for Canada. Anis et al (2009) stated that the total direct costs linked to overweight and obesity in Canada was $6.0 billion in 2006, with 66% directly spent on obesity, corresponding to 4.1% of the total health expenditures in Canada. Since physical inactivity is considered a significant contributing factor to the rising prevalence of obesity, it stands to reason that increasing physical activity levels should lead to a decrease in obesity and a concomitant reduction in the burden of care.

In order to develop effective healthy lifestyle interventions for children, an understanding of factors that influence adoption is necessary. According to the Canadian Institute for Health Information (2012), three key factors influence a child's likelihood of being healthy. These are; environmental (such as social support, housing), socioeconomic (such as income, education), and lifestyle (such as nutrition, physical activity). Of these factors, the least investigated in relation to the adoption of healthy lifestyles are those associated with having a social support system and development of social competence (CIHI, 2012; Aber, Jones, Brown, Chaundry & Samples, 1998).

Social competence has been described as the foundation for future interactions with others and an awareness of one's own behaviour; it has been conceptualized as the interaction between one's environment and their biologically determined abilities (Semrud-Clikeman, 2007). Every year, more than 200 million children under the age of five fail to reach full social competence, exposing these children in later years to difficulties in challenging and complex social environments (WHO, 2012). As a result of this underdevelopment, children are at increased risk of developing unhealthy lifestyles as adults, with poorer health care and nutrition. In children, poor social competence promotes their belief that they are incapable of adjusting their lifestyle and making appropriate choices to better their health. This is an example of a negative feedback loop leading to increasingly poor health.

One factor that directly influences a child's physical activity levels, and hypothetically could affect their social competence, is motor performance. Developmental Coordination Disorder (DCD) is defined as a chronic and normally permanent condition found in children characterized by motor impairment that interferes with their daily activities, as well as academic achievement (Barnhart, Davenport, Epps & Nordquist, 2003). Depending on the rigor of diagnostic criteria applied, a prevalence of 3 to 9% of school-aged children has been reported making DCD one of the most common childhood disorders (Cairney, Hay, Faught, Corna & Flouris, 2006a; Lingam, Hunt, Golding, Jongmans & Emond, 2009). As previously established, the general population has lower physical activity levels than the recommended levels. Children with DCD have an activity deficit even when compared to this increasingly inactive population, with this subpopulation being even more likely to choose a sedentary lifestyle (Wrotniak, Epstein, Dorn, Jones & Kondilis, 2006). Children with DCD believe they are less able to perform a task since they perceive themselves as incapable of being physically competent (Cairney, Hay, Wade, Faught & Flouris, 2006b). Due to their physical inactivity, children with DCD are also more vulnerable to lower cardiorespiratory fitness status compared to their peers (Wrotniak et al, 2006; Silman, Cairney, Hay, Klentrou & Faught, 2011; Cairney, Hay, Faught, Flouris & Klentrou, 2007a). This is another example of a negative feedback loop where poorer cardiorespiratory fitness depresses physical activity levels, further cornering these children into an overweight status and its related inactive state (Silman et al, 2011). These children may exist in an "activity ghetto" lacking the social structures, competence, and skills necessary to engage in physically active pursuits in spite of their motoric limitations (personal communication, J Hay, April 23, 2012). Social support has been shown to enhance the regular activity levels in children via improvements on self-efficacy (Rovniak, Anderson, Winett & Stevens, 2002).

Social competence and physical activity affect the health of children, with this relationship maintained in their adult years. Since motor competence affects physical activity participation, an understanding is needed of how the inter-relationship between motor competence and social competence may have on the physical activity levels of children. The relationship between motor impairments and physical activity deficit is well established (Wrotniak et al, 2006). Many studies have also found significant relationships between children with DCD and impairments in social skills. Dewey et al (2002) found that DCD patients were more immature, socially isolated and passive compared to their healthy peers. These same patients were also reported to have lower levels of self-worth and higher anxiety levels due to more stress. Lingam, Golding, Jongmans, Hunt, Ellis & Emond (2010) also concluded that children with motor impairments displayed a greater risk for problems in reading, spelling, social and nonverbal skills. Barnhart et al (2003) stated that children with DCD were more likely to act out in the classroom, were less socially desirable and had fewer friendships, more feelings of anxiety and low self-worth compared to their healthy peers. These findings complement the previous studies that concluded that children with DCD are at risk for psychosocial dysfunction, further worsening their general health status.

Social competence is protective in the adoption of a healthy lifestyle of which physical activity is a key element. The relationship between motor performance and physical activity has been well established with motor impairments reducing physical activity levels in children (Wrotniak et al, 2006; Cairney et al, 2006a; Cairney et al, 2006b). It is also clear that children with DCD demonstrate poor social competence as a whole (Dewey et al, 2002; Lingam et al, 2010). However, it is unclear whether the relationship between physical inactivity and motor incompetence is moderated by social competence, as depicted in Figure 1 below. This investigation aims to determine the potential moderating role of social competence on this relationship.

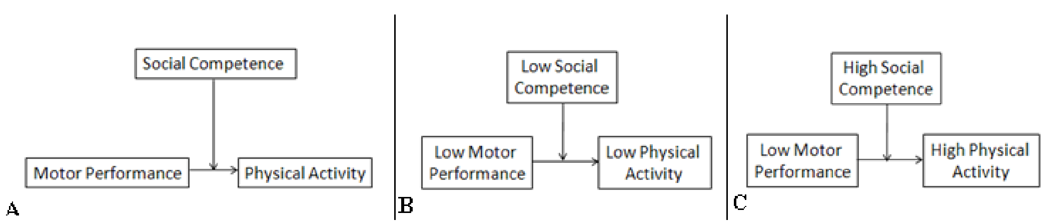


Figure 1. A. Moderating role of social competence on motor performance and physical activity. B. Proposed role of low social competence on motor performance and physical activity. C. Proposed role of high social competence on motor performance and physical activity.

1.2.0 Objective

The objective of this study is to identify the association of low physical activity participation in boys and girls with various motor performances while establishing the potential moderating role of self-perceived social competence. The long term objective is to provide context for the development of successful physical activity promotion programs for children.

Chapter 2: Review of Literature

2.1.0 Review of Literature

From a public health perspective, being able to influence behaviors that effect long-term health is vital. If these behaviors have been shown to track from childhood into adolescence and adulthood, early intervention is essential. This review will examine the evidence that cardiovascular disease tracks throughout the lifetime, that cardiovascular risk factors track from childhood, that physical activity is a protective factor of cardiovascular disease which tracks, the barriers in childhood to physical activity, and the relationship between physical activity, motor performance and social competence in children. In the discussion on the barriers of physical activity, the understudied, but vital, concern of motor impairments will be discussed. It has been suggested that social competence plays a role in the participation of physical activity levels and this relationship will be reviewed as well.

2.2.0 Tracking the Health Status

The elements of tracking as summarized by Foulkes and Davis (1981) are (1) prediction of future measures from earlier values and (2) the constancy of an individual's expected measures relative to the population percentiles (Guo & Chumlea, 1999). Tracking children's health status has been investigated using various variables including cardiovascular markers, body mass index (BMI), and nutrition status. There is increasing evidence that cardiovascular risk factors track from childhood to adulthood. Research has focused on risk factors that predict the onset of cardiovascular disease in the healthy population (Fuentes, Notkola, Shemeikka, Tuomilehto & Nissinen, 2003; Daniels et al, 2008; Guo & Chumlea, 1999). It is recognized that cardiovascular risk factors are amenable to change, however it is critical to understand which of these factors are pre-eminent in predicting the onset of cardiovascular disease. A study by Ulmer et al (2003) enrolled 149, 650 participants in a 15-year longitudinal study with an age range of 19 to 96. Measurements of fasting blood samples, height, weight, and blood pressure were obtained, including total cholesterol, triglycerides, gamma-gt and blood glucose. The study calculated tracking coefficients for the individuals to verify if they maintained their rank within their designated group. Their results confirmed a significant tendency for risk factors in adults to track over time, particularly for BMI, followed by cholesterol levels and blood pressure (Ulmer, Kelleher, Diem & Concin, 2003). Although this study used adults, it is important to note that these markers continue to track throughout adult years. Therefore, establishing healthy living habits in childhood may be crucial to avoid entering a long-term track toward cardiovascular disease.

Hyperlipidemia in adults requires aggressive management; especially direct attention to lowering low-density lipoprotein (LDL) cholesterol levels (Kavey et al, 2006). In childhood, hyperlipidemia is secondary to conditions including obesity and medication use. High lipid profiles have been shown to be associated with a greater extent of vascular involvement of fatty streaks and fibrous plaque buildup, as well as higher presence of coronary artery calcium and reduced arterial distensibility in childhood (Kavey et al, 2006; Urbina, Brinton, Elkasabany & Berenson, 2002). Therefore, the prevention of these vascular pathologies in early childhood is important. Daniels et al (2008) identified that the prevalence of metabolic syndrome was most prevalent in overweight children along with an increased prevalence of obesity, pre-diabetes and type II diabetes. These risk factors were also associated with increased fatty streaks and fibrous plaques in the aorta and coronary arteries. Children with heterozygous familiar hyperlipidemia (FH) are asymptomatic and have no findings in a physical examination relatable to hypercholesterolemia. Children with FH maintain this profile throughout adulthood due to their asymptomatic status. It has been shown that 33% of adults with heterozygous FH have at least one atherosclerotic cardiovascular event (Jansen et al, 2004). Children with congenital heart disease are also prone to the development of atherosclerosis and adverse cardiovascular events (Kavey et al, 2006). Children with heart defects are at risk of premature cardiovascular disease, with ongoing management required to prevent further heart concerns in adult years.

It is apparent that the atherosclerotic cardiovascular disease process begins early in life and progresses throughout the life span. While there is a genetic component to the disease process, environment factors are as important (Daniels et al, 2008). These environmental factors include excessive intake of saturated and trans fats and cholesterol and decreased levels of physical activity and fitness. The dominant risk factors leading to adult-onset of cardiovascular disease are a low concentration of high-density lipoprotein (HDL), high concentration of LDL, elevated blood pressure, diabetes, cigarette smoking and obesity. Research has demonstrated that the majority of these factors appear at a young age and it is critical to initiate the prevention of cardiovascular disease during childhood (Webber et al, 1995; Daniels et al, 2008). The earliest pathologic finding of atherosclerosis at a young age is fatty streaks, which later develop into fibrous plaque and are responsible for adverse outcomes, including heart attack or stroke. The Bogalusa Heart Study demonstrated, through autopsy analyses, the extent of the presence of fatty streaks and plaque increased with age throughout childhood, reaching a prevalence of almost 70% in young adults (Berenson et al, 1998). Subject's HDL, LDL and total cholesterol levels significantly influenced these atherosclerotic processes. However, Berenson et al (1998) did not measure the physical activity levels of their participants and it is unclear whether physical activity played a role in these processes. The Cardiovascular Risk in Young Finns Study investigated adolescent risk factors and measures of atherosclerosis in adulthood. They reported on over 2000 young adults and were able to conclude that cardiovascular risk factors in childhood were predictive of increased carotid intima-media thickness, independent of adulthood risk factors (Raitakari et al, 2003).

An elevated level of blood pressure predicts the development of coronary artery disease, and significantly contributes to the pathogenesis of cerebrovascular accidents, heart failure and renal failure. Hypertension has been stated as the most dominant risk factor for cardiovascular diseases, and is thought the most dangerous as it is often asymptomatic (Williams et al, 2002). During childhood, blood pressure normally rises with age; however elevated blood pressure in these years is a predictor of hypertension in adult years. Therefore, clinicians are responsible for identifying elevated blood pressure in children, particularly children above the age of three, and to treat to prevent hypertension in these patients. The evaluation of blood pressure in children is commonly misleading since they are normally non-cooperative and fidgety during the measurements. The National High Blood Pressure Education Program recommended the use of blood pressure standards based on sex, age and height in order to identify blood pressure status in children above the age of one; the identification of elevated blood pressure in children is defined as systolic and diastolic blood pressure above the 95th percentile (Williams et al, 2002). Due to the high correlation of childhood obesity and hypertension in adult years, weight control and prevention of obesity with a physically active lifestyle is the strongest preventative behavioural measure (Williams et al, 2002). These preventative strategies are also vital in childhood years by reduction in weight and improvements of cardiovascular factors from physical activity have been shown to lower blood pressure in adolescents.

Another significant risk factor for cardiovascular events is high blood cholesterol. Cholesterol has been shown to track overtime, indicating that children with higher levels of LDL cholesterol are more likely to become adults with high levels. There is also a high correlation between LDL cholesterol and atherosclerotic processes in children and adults (Daniels et al, 2008; Berenson et al, 1998). Therefore, due to this high association, it is sensible to minimize the adult risk factors in the young to prevent this tracking of atherosclerotic processes into adulthood. Strategies to reduce the high blood cholesterol in childhood include adequate nutrition including a variety of foods low in saturated fat and cholesterol, sufficient caloric intake, and consumption of plenty of fruit, vegetable and grain servings (Daniels et al, 2008; Salo et al, 1999). Although diet is an essential factor of cardiovascular disease, this will not be addressed in this investigation as it is outside the scope of this project. The Bogalusa Heart Study also identified that children with low HDL profiles were highly correlated with coronary artery disease in adulthood; however that has not been a correlation between elevated triglyceride levels in childhood and cardiovascular risk in adulthood (Berenson et al, 1998). It is also been shown that children with one risk factor are more likely to contain multiple risk factors, magnifying their tracking of cardiovascular events into adulthood. Therefore, the best approach for children is to promote cardiovascular health by identifying methods to modify their lifestyle factors mainly via physical activity levels.

Another measure used to track an individual's health status overtime is BMI. Childhood obesity has been associated with increased morbidity due to the chronic diseases developed in adulthood, as well as its association with premature mortality due to coronary heart disease in early years (Gunnell, Frankle, Nanchahal, Peters & Smith, 1998). The most prevalent disorder associated with obesity in childhood is type II diabetes or metabolic disorder (Williams et al., 2002). BMI values have been shown to be associated within child years and adulthood; however BMI values that are above or at the 75th percentile have been associated with an increased mortality and morbidity in adulthood. Therefore, from a Public Health lens, it is critical for children to maintain a healthy BMI value in order to reduce preventable deaths. BMI values in adulthood are highly dependent on values during infancy, however they are also related to the pattern changes around age 6. The change of BMI at age 6 has been highly associated with BMI values at age 16, indicating the rapid growth of BMI from age 6 to 16 has been highly associated with a high BMI value in adulthood (Guo & Chumlea, 1999; Rolland-Cachera et al, 1984). The study by Guo & Chumlea (1999) used 277 males and 278 females with annual data for height and weight from age 1 to 18 and from age 30 to 39. It is crucial to note that all BMI values were adjusted for age. The results demonstrated that the odds of being overweight in adulthood when childhood BMI was at the 95th percentile were 1.3-6.1 and 1.4-4.9 times as great compared to BMI at the 75th percentile for males and females, respectively (Guo & Chumlea, 1999). Therefore, the use of BMI is a simple and reliable measure for levels of body fatness, although this correlation varies between populations.

This use of tracking to predict the health status of adults from their risk factors in childhood has become a well-known method when assessing the health of individuals. Tracking methods have also been used for the key variables in this investigation including physical activity, motor performance and social competence in childhood to later years.

2.2.1 Tracking Physical Activity

Physical activity is a well-known health benefit in all age groups, with more than 3.0 kcal/kg daily needed to achieve the optimal benefits. However, the prevalence of physical inactivity remains high with a proportion of approximately 80% of Canadians 12 years or older not achieving this goal (Liu, Wade, Faught & Hay, 2008; Statistics Canada, 2012). Physical activity in adolescent years has been a predictor for physical activity levels in adulthood, although research on tracking of physical activity is limited. Once an individual reaches adolescence, most of these adolescents already have inadequate levels of physical activity and engage in excessive amounts of sedentary activity, hindering their achievement of recommended activity levels (Azevedo, Araújo, Cozzena de Silva & Hallal, 2007; Gordon-Larsen, Nelson & Popkin, 2004). In regards to the higher levels of inactivity of adolescence, tracking of inactivity is more valuable than tracking of physical activity indicating the importance of evolving children's inactive status to an active lifestyle (Gordon-Larsen et al, 2004). From a public health perspective, it is crucial for programs to be implemented prior to adolescence to improve physical activity levels in young adulthood.

The terminology used in research has not be consistent when defining physical activity and has caused confusion when expressing activity patterns, choosing measurement methods, as well as interpreting the study findings. The definition used in this analysis will be any voluntary movement requiring skeletal muscle and resulting in energy expenditure (Bar-Or & Rowland, 2004). Bar-Or & Rowland (2004) states that physical activity can be viewed from three perspectives including mechanical, physiological and behavioural. In our investigation, we will be looking through the eyes of a behaviouralist, where the interest lies in the type of activity, the environment of the activity was in and the volitional aspects of the child's activity (Bar-Or & Rowland, 2004).

The purpose of the study by Azevedo et al (2007) was to evaluate the association of physical activity in adolescence and adulthood, with respect to gender differences. The study consisted of 2,570 individuals with complete questionnaire data of the International Physical Activity Questionnaire from adolescence and adulthood. This data was based on the participants' recall over the past six months, in an attempt to reduce the risk of recall bias. A Kappa statistic of 0.62 was calculated to express the reliability of the adolescent's engagement in physical activity. There were relevant differences in types of activities in men and women in adolescent years with higher prevalence in soccer in men and volleyball in women. The prevalence of regular activity in adolescence was found to be negatively related to their adult age, which reflects the reasoning behind the spread of knowledge on health benefits of physical activity in adult years to provide a more diverse activity spectrum to enhance more physical activity opportunities. The main subjective reason to participate in physical activity was reported as entertainment in men and benefits of health in women (Monteiro et al, 2003). In conclusion, this study stated that regular physical activity was a protective factor against physical inactivity in adulthood. The promotion of school programs for physical activity can work against the inactivity concern in adulthood. As previously mentioned by Williams et al (2002), physical activity has shown benefits in the maintenance of lowering blood pressure and increase an individual's life expectancy by reducing their risk of cardiovascular disease. Therefore, the incorporation of physical activity at a young age will likely track into adulthood and further reduce their risk of developing adverse health concerns.

The interrelationship between physical activity and cardiovascular diseases has become well established in adults (Mora, Cook, Buring, Ridkar & Lee, 2007; Boreham & Riddoch, 2001). With that being said, the promotion of physical activity in early years will allow tracking of physical activity into adult years to prevent the onset of cardiovascular disease at a later age. Janz, Dawson & Mahoney (2000) used two physical fitness measures and two physical activity measures (sedentary and vigorous) over a five-year time span from childhood to adolescence to track their activity levels. Both physical activity measures were self-reported in an interview style with sedentary activity having a recall period of one day and vigorous activity of three days which therefore gives them an acceptable reliability and validity due their short recall periods. The sedentary activity was reported as number of minutes watching TV and video games while vigorous activity was reported as number of times the child sweat using the national Youth Risk Behaviour survey comparable to accelerometer-derived counts (Janz et al, 2000). This survey consisted of movement periods of sports, games, play, work and movements lasting 20-90 minutes long. A total of 126 subjects were used in the analysis and they were all pre- or early pubertal stage at baseline. Through a tracking analysis, vigorous and sedentary activity considerably tracked in boys with an unchanged activity level in girls. Therefore, this tracking of physical activity is potentially modified with a genetic factor as well as unidentified environmental factors between the genders. Due to the sample's rapid psychosocial and biological development stages, vigorous and sedentary activities are reasonably stable variables that track into adolescence. Due to the ability of sedentary activity to track into adolescence, programs should be implemented to reduce the levels of using the television or video games at an early age to improve the moderate to vigorous physical activity (MVPA) in children and to further progress into a healthy cardiovascular state.

A study by Telama, Leskinen & Yang (1996) reviewing the stability of leisure-time physical activity and sport participation was done on 4320 children of age 9 and tracked to age 30. Physical activity was reported in a short self-reported questionnaire in conjunction with their medical examination. The questionnaire obtained the child's frequency of leisure-time physical activity, intensity of the activity, frequency of participation in sports clubs training, participation in sport competitions, and their most frequent type of leisure activity. A total sum score was computed after individual scores were recorded. The reliability of the questionnaire was reported by each gender and age group throughout the study and ranged from r=0.55 to 0.89 (Telama et al, 1996). It was concluded that the intensity of physical activity tracked more than the frequency of physical activity and less than sports club training (Telama et al, 1996). This is an important finding that the intensity of physical activity tracked significantly into adulthood since healthy levels of physical activity have been reported to have energy expenditures above the resting level of approximately 50-60% of maximal exertion (William et al, 2002). With the intensity of physical activity being able to track into adulthood, the use of school programs where intensity level is of focus is extremely important for children. With more intense activities being implemented into school-aged children, their activity levels of high intensity will further track into adult years and improve their cardiovascular health.

Tammelin, Näyhä, Hills & Järvelin (2003) evaluated the association between participating in multiple types of sports in adolescences and forms of physical activity in adulthood. An assessment on 11, 399 children aged 14 was done through self-reported questionnaire, with a follow-up questionnaire completed by 8767 adults when they reached age 31. At age 14, they were asked the frequency of activity participation in sports after school and report any club memberships they hold. The questionnaire at age

31 questioned the adults' participation in light and brisk activities weekly, how long one bout of activity is, and were classified into activity groups. It was concluded that participation in sports at least once a week in adolescent females and twice a week in adolescent males was greatly associated with high levels of physical activity in adult life (Tammelin et al, 2003). The most prevalent tracking of activity from adolescence to adulthood was high intensity sports, which has been identified as one of the best predictors of adult activity (Telama, Yang, Laakso & Viikari, 1997). As previously stated, by highlighting the importance of high intensity activities into childhood, it potentially will enhance the tracking of physical activity into their adult life and strengthen their cardiovascular status.

An additional study reviewing the sedentary and activity patterns of children discussed the importance of activity and diet in adolescence; a statistic of approximately 400,000 annual deaths due to inactivity and poor diets, which has the potential of becoming the leading cause of death in developed countries (Mokdad, Marks, Stroup & Gerberding, 2004). This study by Gordon-Larsen et al (2004) used a study sample of 15,197 adolescents that were followed from grade 7 to grade 12. These individuals were assessed on their physical activity levels and sedentary activities with covariates including race, parental education and income. Self-reported questionnaires from Add Health were used to determine the physical activity levels which has been previously identified as a reliable measure (Baranowski, Thompson, DuRant, Baranowski & Puhl, 1993; Gordon-Larsen et al, 2004). It was found that the majority of adolescents failed to reach the recommended levels of moderate physical activity per week and continued to fail during adulthood. Among those adolescents who recorded active levels, there was a large decline in activity that was age-related. In regards to sedentary activity, of those adolescents who engaged in less than 14 hours of screen time per week, 17% further increased their screen time into adulthood (Gordon-Larsen et al, 2004). This is a large public health concern as the sedentary activity levels track with age. The implementation of school programs with more MVPA can provide children with the opportunity to be active with their peers and reach the appropriate level of five times per week. Also, by schools reducing the amount of televised programs in the classroom can allow more time to use for active lesson plans for children to increase their heart rate and enhance their health status for later years.

2.2.2 Barriers and Facilitators of Physical Activity in Children

There are many factors that children need to adjust to in order to get adequate levels of physical activity. Many of these could be influenced to some extent by their personal or their parents' level of social competence. According to the Centre of Disease Control and Prevention (CDC), these barriers include transportation, resources, expenses and motivation (CDC, 2011a). All children need some sort of transportation in order to participate in out of school clubs or sports teams. This transportation may be limited due to their parent's work hours or inability to afford a vehicle. In 2002, a study done by CDC reported an average of 26% of parents had transportation as a barrier for their child's physical activity needs. This percentage escalated to 37-43% among families, with the higher increase in Hispanic ethnicity. From this limitation, the parent may feel socially unaccepted and restrain them from transportation opportunities. This social rejection may be developed due to their socioeconomic standings; a family without available transportation may be perceived as a poorer socioeconomic status (SES) and feel belittled in the community. From a public health perspective, we should scatter sports clubs throughout our community in order to overcome this barrier and promote children to walk, take the bus or carpool with another family to their desired club. This transportation problem was also shown through lack of parental support for physical activity in adolescence in a study done by Trost et al (2003) consisting of 380 students. It was found that low parental support was a high correlate with low physical activity levels in their children. Parents who provide limited support to their children may do so due to their diminished level of social competence and feel they are unable to socially support their child in activities.

Lack of resources and expenses were also shown to be barriers including resources from schools, communities or parents (CDC, 2011a). CDC recommends for children to look into activities provided by a local park or community center if the school has insufficient funds, or if the centers are too far away to arrange an activity with neighborhood children (CDC, 2011a). However, if a child does not feel they are socially accepted with their neighbourhood playmates, it may further reduce their participation levels. Estabrooks, Lee & Gyurcsik (2003) displayed that children in lower SES have a limited ability to control their physical activity due to inaccessible environments. Schools play a major role in activity levels and habits, where physical education class is an average of 3.1 times weekly, however enrolment rates decrease each successive grade (Kohl & Hobbs, 1998; Ross, Dotson, Gilbert & Katz, 1985). Public Health officials may want to consider improving school funding to enhance physical activity programs, to better the health of our children and promote a healthy lifestyle. The Child and Adolescent Trial for Cardiovascular Health increased the students' MVPA in class from 37.4% to 51.9% after implementing a modified physical education class design (Luepker et al, 1996).

According to Kohl & Hobbs (1998), the three potential determinants of physical activity behaviors in children are physiological/developmental (such as the growth and maturation of the child), environmental (such as safety, activity distractions and facilities available for the child) and psychological/social/demographical (such as the child's self-efficacy, peer influences and gender). A body of literature has discussed the role of physical activity on growth and maturation, physiological factors, rather than how they affect physical activity (Malina, 2001; Sallis, McKenzie & Alcaraz, 1993). However, it has been hypothesized that children are spontaneously active (Kohl & Hobbs, 1998). The most prominent biological factor of physical activity would be gender, where boys have been expressed as nearly twice as active in girls in regards to moderate-to-vigorous or more intense activity, displayed by Trost et al (1996). It has been suggested that this gender difference may be due to the different development of motor skills, body composition and socialization in sports. Along with gender, another physiological factor would be age. Specific motor skill development increases dramatically between ages of 9 and 16 compared to the age range of 4 to 9 (Haywood, 1986).With regards to capabilities and development, children who have delayed development or disabled capabilities, they are less likely to participate in physical activity and receive the health benefits of being active (Kohl & Hobbs, 1998). Children with developmental disorders, such as DCD, have shown to be less physically active than their healthy developed peers which may be due to their lack of confidence in their physical abilities, their lower sense of self efficacy towards physical activity or exclusion from their peers (Cairney et al, 2006a; Hay & Missiuna, 1998; Cantell, Smyth & Ahonen, 1994; Losse et al, 1991; Hay, 1992; Piek, Dworcan, Barrett & Coleman, 2000; Rose, Larkin & Berger, 1997; Skinner & Piek, 2001; Schoemaker & Kalverboer, 1994). These delayed motor developments also put these children at risk of social exclusion and being teased by their peers, further perceiving themselves as incapable of participating with their peers (Cairney et al, 2006a).

An environmental factor includes the amount of time spent watching TV. It has been shown by Klesges, Eck, Hanson, Haddock & Klesges (1990) with reports that television watching decreased the resting energy expenditure in both normal-weight and obese children, indicating their metabolism is at risk with increased television watching. This is of high concern on the cardiovascular health of children since resting energy expenditure is a predictor of aerobic health, a factor of cardiovascular health throughout the life span (Hunter, Weinsier, Bammam, & Larson, 1998; Gutin, Yin, Humphries & Barbeau, 2005). Children who are less socially active with their peers are hypothesized to isolate themselves and lead them into more individual and detached activities, such as television watching. School physical education programs are also an environmental concern for children with motor impairments. Children with delayed motor performance have been shown to be less participative in activities such as physical education class or organized sports due to the "challenging learning and performing environments" (Wall, 2004; Cairney et al, 2006a). With this reduction in participation, these children are restrained from developing motor skills, and potentially lead to complete disengagement of physical activity and cause an obstacle in gaining its health benefits (Cairney et al, 2006a). Seasons and geographic area also influence the physical activity behaviors in children. According to the National Children and Youth Fitness Study II (Ross, 1987), activity was highest in summer, a drop in the fall with the lowest level in the winter and an increase again in the spring. Therefore, it can be said that children living in cities with milder winters are more likely to be active than those who reside in colder climates. Climate also correlates with the time spend outside, which has been shown to be highly related to physical activity levels (Baranowski et al, 1993; Klesges et al, 1990). However, some geographic regions are considered to be unsafe so children are less likely to be outside. These factors may also play a role in the motivation of children to be active, where they would be less likely motivated to participate in an unsafe environment. Motivation has been shown to be an imperative barrier in childhood in regards to being active. Multiple factors need to be taken into consideration when looking at motivation including peers, family and environment (Kohl & Hobbs, 1998).

Self-efficacy, a psychological factor, refers to the confidence level the child has to change or maintain their behaviors, and is closely linked with health-related behaviors (Ajzen & Fishbein, 1980). This concept has been correlated with not only physical activity participation but also predicts weekly physical activity participation in school-based programs (Reynolds et al, 1990). Cairney et al (2005) found that children with delayed motor capabilities are less likely to be physically active, measured using the Participation Questionnaire (PQ) due to their lower generalized self-efficacy, measured by Children's Self Perceptions of Adequacy in and Predilection for Physical Activity (CSAPPA). Strong predictive and construct validity, along with high test-retest reliability (r=0.84 to 0.90) was demonstrated by CSAPPA scale, along with strong construct validity for PQ (Cairney, Hay, Faught, Wade, Corna & Flouris, 2005a). It was also found that children with DCD were not only perceiving themselves as less physically competent, but also perceived themselves as less adequate in overall physical abilities, leading to the selection of a sedentary lifestyle (Cairney et al, 2005a). These results have been expressed in an additional study where both genders perceived themselves as physically incapable, possibly indicating that developmental delayed children of both genders have lower self-efficacy towards physical activity (Cairney et al, 2005a). In some physical ability tests with a competitive and social nature, this would negatively affect the performance on children who perceive themselves with poor general physical ability, especially children with motor impairments who are more likely to give up quicker than their peers (Cairney et al, 2006a; Cairney et al, 2006b). Implementing school-based programs to enhance self-efficacy of children can potentially improve their participation in physical education class, as well as outside of school activities.

Parental activity levels, an additional psychological factor, have also been shown to highly correlate with their child's activity levels. Active parents have nearly six times more active children than inactive parents (Kohl & Hobbs, 1998; Moore, Lombardi, White, Campbell, Oliveria & Ellison, 1991; Freedson & Everson, 1991). This finding can easily be implemented into public health programs through parent-child programs to enhance their relationship and physical activity levels together. Higher levels of parent-child interactions can be hypothesized to increase the social competence of both the parent and their child, opening more opportunities for them to be physically active. Peer activity levels have also appeared to be an influence on a child's activity levels, especially in organized sports. However, children who perceive themselves as socially incompetent will avoid sport teams where interaction with other children occurs. In addition, self-perceived barriers including lack of time, lack of interest, unfavorable weather or access to resources have been shown to potentially determine the activity levels of children. However, these factors have not been significant throughout findings and are inconsistent in literature (Tappe, Duda & Ehrnwald, 1989).

Social competence has not been considered as a barrier to physical activity until recently. Lower SES has been well established as a risk factor but our understanding of the role of social competence is incomplete and largely hypothetical. Lower social status has been identified as a moderator on the effects of stress, which is known to cause further health issues in individuals of all ages (Garmezy, Masten & Tellegen, 1984). Poorer self-perceived competence can result in increases in cortisol levels and has been related to a 12-13% smaller volume of the hippocampus, the area of the brain involved with higher cognitive process (McEwen, 2008). A body of evidence favours the finding that stress and social adjustments relate bi-directionally to each other. Broadhead et al (1983) stated that a social support network has a positive effect on an individual's health status and acts as a buffer on the effects of psychosocial and physical stress. A social support network was also found to have protective effects for disease outcomes when measured using self-reported symptoms and illness behaviours. The Trial of Activity in Adolescent Girls demonstrated that a supportive friendship was a positive mediator in the level of physical activity adjustments in childhood (Jago et al, 2011). Children with higher social competence are more capable of having supportive friendships, which highlights the importance of a strong support system for the adoption of healthy lifestyles. Research examining the relationship between social adjustments and allostatic load (a measure of biological risk) has provided evidence that positive social experiences improve a range of health outcomes (Seeman, Singer, Ryff, Love & Levy-Storms, 2002). These studies support the hypothesis that poorer social competence significantly weakens the health status of individuals through an increase in stress levels.

2.2.3 Tracking Motor Performance

As previously addressed, fitness levels in adolescence is a strong predictor of fitness levels in adult years. For that reason, improving the cardiovascular fitness of adolescents through increasing physical activity levels is an essential public health priority. However, a possible determinant of lower physical activity levels in adolescents is motor performance. Children with motor impairments, such as disorders like DCD, have been associated with the development of health conditions that increase their risk for cardiovascular disease in future years, such as obesity or poor cardiorespiratory fitness (Cairney, Hay, Velduizen, Missiuna & Faught, 2009a). Current research on children with DCD has reported that children do not outgrow their clumsiness and without intervention, they will not improve (Coleman, Piek & Livesey, 2001). Losse et al (1991) tested 17 children all of age 6 and followed them until age 16 (Barnhart et al, 2003). These children continued to exhibit the same motor coordination difficulties after the ten year follow up, as determined by their teacher's reports. The mastery of fundamental motor skills provides a foundation for the development of more activity-related skills (Haubenstricker & Seefeldt, 1986). Children with poorer motor skills have lower cardiorespiratory fitness, which tracks into adolescent years. This deteriorated fitness level further leads to less active adolescents with poorer fitness levels (Barnett, van Beurden, Morgan, Brooks & Beard, 2008). Barnett et al (2008) designed the Physical Activity and Skills Study to evaluate 1045 children on their childhood motor coordination and adolescent cardiorespiratory fitness. The motor skills measurements consisted of object control and locomotion assessments, each having specific features the child must obtain with a reliability of r=0.70 or greater, except for insignificant reliabilities of leap (r=0.13) and run (r=0.17). The cardiorespiratory fitness measures were evaluated through a 20-metre Shuttle Run Test with a reliability measure of r=0.17, however this study had a small sample size (Barnett et al, 2008). The final results demonstrated that childhood object control proficiency predicted the fitness levels in adolescence, where the locomotion skills did not; the object control proficiency explained 26% of the variance in adolescent cardiorespiratory fitness. A suggestion as to why only object control skills significantly predicted fitness was how they are associated with MVPA. Therefore, students who were more proficient in these skills may have joined in on more activities and further increased their fitness levels in later adolescent years (Barnett et al, 2008). In a public health perspective, it would be of high importance to incorporate skill-oriented activities in childhood to help address health-related concerns in later years, such as lower cardiorespiratory fitness in adolescence. Barnett et al (2008) recommend incorporating such activities in primary or elementary school years where children are at the most optimal age in terms of motor skill learning.

A study on the association between gross motor functions, fine motor function and joint hypermobility was reviewed throughout childhood. Their objective was to assess the gross and fine motor proficiency in children with joint hypermobility, and prospectively assess after five years (Tirosh, Jaffe, Marmur, Taub & Rosenberg, 1991). The reproducibility (0.96) and reliability (0.90) was previously established on the joint assessment of children (Jaffe, Tirosh, Cohen & Taub, 1988). They concluded that children with motor delays were at greater risk of both gross and fine motor problems in later childhood, indicating the difficulty level of outgrowing motor delay obstacles. Public Health should take into consideration the barriers that motor delayed children have and implement therapeutic strategies in school education programs or community centers to enhance their physical activity experiences while providing opportunities for them to enhance their physical activity levels for future years.

Although this next study was not done on children, this study population reviewed adults aged 18 to 65 with possible DCD or motor difficulties. The sample consisted of 19 adults with eight adults being diagnosed with DCD as a child or adult and two parents of children with DCD who experienced the same symptoms as their child. The remaining participants were used as controls (Cousins & Smyth, 2003). Each participant underwent a protocol involving non-motor and motor tasks, using the Boder dyslexia test and Movement Assessment Battery for Children (MAB-C). MAB-C is a popular test used by researchers and clinical practitioners, however there have been no norms in the adult population, reducing the reliability of this test for this study (Cousins & Smyth, 2003). Additional measurements included gross motor skills and balance, block construction, ball skills, movement time and reaction time. The findings supported that persons with coordination impairments are affected by their disorder throughout their adult lives. This result was apparent in all motor measurement, with slower performances across all ranges of tasks compared to age-matched controls (Cousins & Smyth, 2003). These findings are consistent with child DCD literature. Gross motor skills were the most dominantly affected variable, with the participants performing poorly on balance and ball tasks. Losse et al (1991) examined 15 to 17 year old with and without DCD and found that of people with coordination impairments, their ball skills will not continue to improve beyond this age group (Cousins & Smyth, 2003). The most noteworthy finding of Cousins & Smyth (2003) was how these tests are highly relatable to the difficulties in activities of daily living, including their driving capability. Therefore, those with motor difficulties are more likely to not be able to drive, limiting them to social and occupational experiences. From this study, it can be said that motor impairments follow patients throughout their adult years. This is important in a public health lens because this population is more prone to an inactive lifestyle, exposing them to more cardiovascular risk factors compared to their typically developed peers.

2.2.4 Relationship between Motor Performance and Physical Activity

It has been repeatedly reported that there is an association between lower levels of motor coordination, including children with DCD, and lower physical activity levels. This activity deficit is persistent over time, sincerely affecting girls more than boys. With this persisting deficit of participation in activity, there is potential for expanding the gap of skill development, especially in those with DCD (Cairney, Hay, Velduizen, Missiuna & Faught, 2009b). The lower levels of physical activity can be a consequence of the earlier onset of fatigue in children with motor impairments, due to the mechanically inefficient movements (Rivilis et al, 2011). Motor skills predict a child's engagement in physical activity and lead to higher levels of activity when these skills are more pronounced, while children with poorer motor skills are more likely to choose a sedentary lifestyle (Petrolini, Iughetti & Bernasconi, 1995; Rivilis et al, 2011). Three components of the

Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) test were shown to have a relationship with physical activity: running speed and agility, broad jump and copying overlapping pencils in boys and girls. BOTMP was reported to be a product-oriented assessment where the potential for detecting certain aspects of motor skill difficulties is limited, although this test is commonly used in children (Reid, 1987). Physical activity was determined through the completion of the Children's Self-Perceptions of Adequacy in and Predilection for Physical Activity (CSAPPA) scale. This scale is a reliable and valid measure of adequacy in and predilection for physical activity in children (Hay & Missiuna, 1998). This was also shown through greater scores on BOTMP which depicted greater average activity levels and percentage of time engaged in MVPA, along with lower levels of sedentary activity compared to children within the lower BOTMP scores (Wrotniak et al, 2006; Petrolini et al, 1995). Children with greater motor skills, measured by the standing broad jump, were shown to be more involved in extracurricular organized physical activities compared to those not partaking in organized activities after an adjustment for age, height, and body mass and organized extracurricular activities. Children with poorer motor skills result in greater energy expenditure due to their higher level of difficulty when completing a task, leading to lower amounts of intense activity and greater levels of fatigue (Puyau, Adolph, Vohra & Butte, 2002; Wrotniak et al, 2006). Accelerometry data has also shown a positive relationship between amounts of physical activity performed and motor performance. Silman et al (2011) used accelerometers to distinguish the difference in participation of physical activity between children with motor impairments and typically developed peers. It was found that children with developmental motor delays were less active compared to their peers, along with lower cardiorespiratory fitness levels. These findings indicate that physical activity and fitness are interrelated to one another, and together affect a child's participation levels. Baerg et al (2011) also used accelerometry data to determine the difference in physical activity between gender and motor abilities. They found that boys have significantly higher levels of physical activity compared to girls. However, when separated by motor abilities, the findings varied between comparisons. Girls with DCD and attention deficit hyperactivity disorder (ADHD) had greater amounts of steps compared to typically developed girls and DCD only girls, supporting the hypothesis that children with hyperactivity are more physically active. Boys with only DCD and DCD/ADHD had significantly less amount of activity compared to typically developed boys (Baerg et al, 2011). These results are difficult to explain since poor motor performance associated with DCD and DCD/ADHD has a potential negative influence on activity in boys but not in the girls. However, it is possible that the hyperactivity affects girls to a greater extent than boys. Further investigation has been needed in determining the differences in activity preferences between genders since accelerometry does not allow adequate representation between genders (Baerg et al, 2011).

Children with delayed motor development, including children with DCD, are at greater risk for being overweight, having lower overall fitness levels, perceiving themselves as physically incompetent, having lower activity levels and reduced motivation in participating in activities (Cairney et al, 2005a; Cairney, Hay, Faught, Flouris & Klentrou, 2007a). Cairney et al (2010) discovered that children with developmental motor delays have poorer cardiorespiratory fitness compared to their typically developed peers, along with a confirmation that the difference in cardiorespiratory fitness between children with and without motor impairments persists over time, magnifying the issue that children with development disorders, such as DCD, are at greater risk for poor cardiovascular health. Although this difference doesn't increase between these children, it is important to recognize their raised risk for cardiovascular disease (Cairney, Hay, Velduizen & Faught, 2010). Further investigation was done on the cardiorespiratory fitness of these individuals with motor impairments and was found that children with DCD have a slower rate of increase in cardiorespiratory fitness with age compared to their typically developed peers (Rivilis, Liu, Cairney, Hay, Klentrou & Faught, 2012). Interventions should aim to improve the cardiorespiratory fitness for children with motor impairments to allow improvements in their physical activity levels, especially when their rate increase of fitness is drastically slower compared to their peers.

Barnett et al (2009) showed a strong association between regular participation in physical activity and significant health benefits in children and adolescents. These benefits have been shown through direct improvement of a child's health status, continuing into adulthood (Barnett, van Beurden, Morgan, Brooks & Beard, 2009). However, children with DCD inconveniently are exposed to more barriers to properly meet the recommended levels of regular activity. Using 1045 children, the relationship between a child's motor proficiency and subsequent adolescent physical activity was examined for a longitudinal evaluation. The method of measurement for motor skills was similar to MAB-C through a battery of fundamental skills along with a recall questionnaire for physical activity levels (Okely, Booth & Patterson, 2001; Barnett et al, 2009). It was concluded that a greater motor proficiency in childhood extensively improves later physical activity. This magnifies the importance of motor skill programs in school-aged children to enhance the motor control in children (Barnett et al, 2009).

Hands, Larkin, Parker, Straker & Perry (2008) highlighted that due to the increase focus of physical activity benefits at a young age, the need for development of motor skills in children with DCD are being masked. Using 1585 adolescents in Western Australia, this study was used to further examine children with various motor skills and their physical activity and fitness. Physical activity was measured via pedometers for seven days, physical fitness was measured through field tests, and motor competence was measured with a neuromuscular development assessment test, similar to MAB-C (Hands et al, 2009). The pedometers were shown to have convergent (Tudor-Locke et al, 2002), construct validity (Tudor-Locke et al, 2004) and reliability (Bassett et al, 1996) for this investigation. Physical fitness measures were validated previously (Rowland, Rambusch, Staab, Unnithan & Siconolfi, 1993; Patterson, Wiksten & Ray, 1996; Shrier, Feldman, Klvana, Rossignol & Abenhaim, 1998; Boreham, Twisk, Murray, Gallagher & Savage, 2003; Tsimeas, Tsiokanos, Koutedakis, Tsigilis & Kellis, 2005) in similar forms. The significant finding was the importance of aerobic fitness on motor competence and physical activity behavior. These results magnified the interrelationship between physical fitness, activity and motor competence and how all three variables correlate within each other.

The effects on physical activity levels in children with DCD have become an emphasized concern in child health research. Green et al (2011) explored the presence of DCD and its relationship with physical activity levels. Motor coordination was evaluated through a derived test from MAB-C and physical activity was analyzed with accelerometers (r=0.70). Concluded results express that motor impairments at a young age are a potential risk factor for diminished levels of MVPA, especially in boys. However, there was minimal difference in MVPA in girls with and without motor impairments, possibly reflected from the lower baseline of MVPA compared to boys (Green et al, 2011). These findings have been consistent with previous literature concluding that poorer motor skills at a young age significantly impact a child's physical activity in later years (Barnett et al, 2009; Lopes, Rodrigues, Maia & Malina, 2009; Osika & Montgomery, 2008).

2.2.5 Tracking Social Competence

Social competence is a widely used term with multiple definitions, therefore it is critical to gain a clear understanding of this concept. The initial definition in literature was the child's behavioural tactics while entering an interaction and has been simplified to efficacy in interaction (Shin et al, 2011; Halberstadt, Denham & Dunsmore, 2001). This concept has been conventionally used in four universal approaches including social skills, peer status, relationship success and functional goal-outcome assessments (Halberstadt, Denham & Dunsmore, 2001). Recently, developmental scientists have notified through research that becoming socially competent is a critical goal within preschool years. Measurement approaches of social competence have used behavioural tactics, integration in peer groups, supportive relationships with peers and adults, interpersonal and intrapersonal outcomes and achievements in social goals in particular contexts. (Shin et al, 2011). For this investigation, perceived social competence is of interest. The definition used for the purpose of this paper is one's perception about his/her own ability to engage in effective social interactions from Lee, Hankin & Mermelstein (2010). This definition fits well with the nature of the data as children are self-reporting their level of competence. Individuals with lower levels of perceived social competence are associated with poorer social skills or interpersonal deficits, leading to further increased levels of conflicts with society (Lee, Hankin & Mermelstein, 2010). A child's sense of classroom belonging reflects the child's sense of acceptance, value and encouragement received from others in the setting, along with the feeling of a significant aspect of the life in the classroom (Faircloth & Hamm, 2011). This internal feeling of self-worth within the classroom is a familiar reflection for many children whom are frequently exposed to this setting.

Over the past decade, there has been a focus on developing early prevention programs for children that cover topics including violence, drug prevention, social skill training, and academic skill enhancement. The antisocial domain is the area of most concern that has received the most attention (Aber et al, 1998; Greenburg & Kusché, 1998). Measurements were taken through self-reports of teachers, parents and children with internal consistency reliability as 0.92, 0.79 and 0.68, respectively. Without an intervention, it has been shown that early antisocial behavior will have a high degree of continuity in both genders, with the most severe being reluctant to change (Cote, Zoccolillo, Tremblay, Nagin & Vitaro, 2001; Tremblay, Pihl, Vitaro & Dobkin, 1994). Many programs are being implemented to focus on the pro-social and social competence of the behavior spectrum. Although much antisocial behavior is resistant to change, the use of programs in early development has been shown to develop a social bond between children (Catalano et al, 2003). Antisocial behavior has been more widely associated with males, however females did not show any significant reduction in antisocial behavior compared to males in Catalano et al's (2003) study. Therefore, it is important for our health care system to recognize that antisocial behavior is prevalent in both genders, and can reduce a child's participation rate in organized sports with other children.

The co-occurrence of behaviour, affect and cognition is needed when obtaining a set of social skills and a successful use of these skills is presumed to enhance self-esteem, social self-efficacy and peer acceptance. The purpose of the study done by Shin et al (2011) was to test a difference between peer social competences at different time intervals, as well as whether one time predicts the second time's social competence measure. This study consisted of 491 children who were categorized as younger and older based on their age groups. Social competence was determined through visual attention to peers and direct observations of initiated interactions (r=0.79). The main finding was that there were large amounts of individual differences for each social competence variable, including social engagement-motivation, peer acceptance and classroom observation of social competence. However, it was evident that the growth of social competence across consecutive years was possible in preschool years with maturation and experiences with peers as the most contributable factors. Furthermore, it was concluded that social competence is a stable concept that is relatable to both young and old preschool children (Shin et al, 2011). Early childhood education can therefore be seen as a reliable tool to enhance the social competence of children at an early age. By implementing these educational programs, children are more exposed to learning experiences where they can adapt to various social cues and improve their social competence for future years.

It has been made clear that interpersonal experiences, such as friendships, shape the development of one's social behavior. A study done by Glick & Rose (2011) prospectively examined the relationship between youths' social strategies and adjustments in friendships, which was used to predict changes in friendships over the school year. Strategy assessments were made through the youth's responses to hypothetical vignettes and friendships were measured through the completion of a friendship-nomination measure with internal reliabilities of 0.88 to 0.92 and 0.83 to 0.92, respectively. The underlying purpose of this study was to share the contribution of friendships on the development of social competence. It was concluded that high quality friendships do positively affect a youth's social interactions, including help-giving and help-seeking tasks, as well as emphasize the interplay between social competence and valuable friendships at a young age (Glick & Rose, 2011). Many studies have demonstrated correlations between low pro-social behavior and friendless, along with additional studies concluding that children with stronger interpersonal skills were more likely to form friendships within four weeks (Wojslawowicz Bowker, Rubin, Burgess, Booth-LaForce & Rose-Krasnor, 2006; McGuire & Weisz, 1982; Glick & Rose, 2011). Buhrmester & Furman (1986) stated that youths' participation in friendships forces them to expand their skills used in relationships. It can be further stated that the more friendships a child obtains, the more social skills are used, enhancing their social competence. This has been revealed in Howes' (1983) study, where children who maintained a playmate for over one year showed higher social competencies, expressed through direct observation based on the amount of interactions between children (Glick & Rose, 2011).

There have been limited studies on how the quantity of friends predicts one's social competencies. It has been hypothesized that having to spread time across multiple playmates may lead children into engaging in positive but less emotional strategies. This may also lead to more awareness that the uses of negative interactions are not the best approach to maintain friendships (Glick & Rose, 2011). It is important to note that there have been no reported gender differences in friendships and social competencies in children. Glick & Rose (2011) followed 912 students to review their friendships and social competencies over time; this was the first study to indicate that youths' friendship experiences predict changes in both boys' and girls' social competencies over 8-week time intervals for one year, after controlling for peer acceptance. By incorporating social skills into the learning experience of children at a young age, this can teach children to be open to talk to new friends, say kind things and help friends with their problems, along with actions the children should not do when interacting with peers. Public Health needs to be aware of the social competencies of children since lower self-perceived social competence reflects lower social skills and interactions between peers. These lower social skills elevate a child's social anxiety (Ali-Ali, Pratap Singh & Smekal, 2011) and further leads to incline in stress levels, which have been addressed as a health concern for elevated blood pressure. Therefore, the social competence in a child has been underestimated for its harmful effects on child health.

A widely used measure of perceived social competence is Harter's Perceived Competence Scale for Children (Harter, 1982). This scale provides an estimation of a child's self-reflection within nine domains: scholastic competence, athletic competence, behavioural conduct, romantic appeal, social acceptance, physical appearance, work competence, close friendships and self worth (Cantell et al, 1994). Through the use of this scale, three factors emerge: cognitive, social and physical competence. The response format allows for accurate responses by using a true-false, like me-unlike me layout, or a 'structure alternative format'. The purpose of this question design is to avoid the tendency for young children to give a 'socially desirable' answer (Harter, 1982). The questions are scored from one to four, with one being a low perceived competence. Each question consists of a statement, along with a 'really true' or 'sort of true' option per statement. No responses provide a 'negative' or 'false' answer, so the child is able to provide an answer that is most true for them (Harter, 1982). The scores are then summed within each subscale. The social subscale refers dominantly to peers; however, it also includes items referring to people (Harter, 1982).

The validity of the social subscale was determined through the relationship of the subscale itself and sociometric standing (r=0.59); the sociometric standing was measured by each child was provided a class list and were requested to rate each classmate in regards to how good of a friend they are in a scaled form from one to five (Harter, 1982). Although social competence is a complex model to handle, the use of the Harter scale depicts a child's social competence relatively well, given it is self-reported. Palmen, Vermande, Deković & van Aken (2011) demonstrated a buffering hypothesis of friendship stating a negative association between feeling lonely and having a friend. Having a close friendship in the younger years reduces the risk of social isolation in older years (Palmen et al, 2011). With that being said, the Harter Scale questions the child's close friendships, interactions with peers and other social interactions, which have been shown to be greatly associated with the child's social competence.

Cole, Jacquez & Maschman (2001) utilized the Harter scale with all domains, including social. The purpose of the study was to determine the influence parents, teachers and peers have on a child's self-perceptions on their competencies. All subscales have been reported with good internal consistencies, ranging from 0.71 to 0.86 for children in grades three to eight, along with a high three-month test-retest reliability (0.70-0.87) (Cole et al, 2001). The Harter scale was completed every six months for four years with research assistants reading each item aloud to the students. The results of the Harter domains were expressed in means by grade level and gender, along with analyses of hierarchical linear modeling and structural equation models (Cole et al, 2001). It was concluded that self-appraisals became increasingly stable as a function of age. Also, the results reflect that children create views of their own competencies based on other's opinions of their performances (Cole et al, 2001). Another significant finding was that more positive self-perceptions were correlated with lower levels of self-reported depressive symptoms longitudinally, whereas negative self-perceptions increased the self-reported depressive symptoms. One's actual competencies, including their motor performance, create positive and negative outcomes regardless of other's perceptions. Therefore, motor delayed children are more likely to initially have a lower self-perceived physical competence, and possible social competence.

Social competence is a complex term commonly used throughout literature. Edward Zinger (1972) suggested that a socially competent individual has the ability to make appropriate decisions when dealing with certain environments, able to perform well in school, stay out of trouble, and relate well to all age groups (Anderson & Messick, 1974). An absolute measurement of social competence would need to consist of observation, ratings, records, social indicators and self reports (Anderson & Messick, 1974). This study only interpreted the child's self-perceived social competence. The Harter Scale, previously mentioned, contains subscales, which are classified as levels of competency. Although the social subscale is entitled 'social competence', it is demonstrating the child's personal perceptions, compared to a clinical measure. Dodge, Pettit, McClaskey, Brown, & Gottman (1986) reported that a child's rating of their own behavior significantly predicted the rating of group-entry success (Meece & Mize, 2010), indicating a correlation between self-reports and actual occurrences. The use of an assessment of social self-perceptions has been suggested as a critical component for clinicians', educators' and researchers' evaluation of a child's competence (Harter, 1982).

In this study, social competence is being investigated as a moderator between physical activity and motor performance. A moderator is a variable that may reduce or enhance an existing relationship between two other variables, and may potentially change the direction of the relationship (Kim, Kaye & Wright, 2001). A moderating effect can sometimes be confused with a mediating effect, which is when a variable explains the existing relationship between two other variables. Therefore, when examining the relationship between two variables with a positive association when adding a third variable into the relationship, the positive association disappears; this result is a mediating effect as the positive association is due to the third (mediating) variable. In contrast, when a third variable is added and the positive association becomes stronger than before, the third (moderating) variable enhanced the existing relationship. For this investigation, it is of interest to see if and how social competence moderates the relationship between motor performance and physical activity.

2.2.6 Relationship between Social Competence and Physical Activity

Wrotniak et al (2006) have reported self-efficacy as one's ability to overcome barriers of physical activity, perceptions on physical competence, positive attitudes towards physical education, enjoyment of physical activity and parent/peer support as positive factors associated with higher physical activity in young children (Wrotniak et al, 2006; Cairney, Hay, Mandigo, Wade, Faught & Flouris, 2007b). Children with a lower self-perception of their abilities in physical activity have had poor coordination skills and report lower physical activity compared to their peers (Okely et al, 2001). Social cognitive theory, a dimension of social competence, contains key determinants of physical activity levels including social/environmental supports, self-efficacy, outcome expectations and self-regulation. All of these determinants have been shown to influence a child's decision on choosing to be active, with self-efficacy having the strongest correlation when predicting the maintenance of regular exercise (Rovniak et al, 2002). Social cognitive theory has been used to evaluate social support (r=0.91), self-efficacy (r=not reported), outcome expectations (positive – r=0.88; negative – r=0.81) and self-regulation (goal-setting – r=0.89; planning and scheduling – r=0.87). The strong impact that self-efficacy has on physical activity is due to the use of self-regulatory strategies the individual uses. A positive support system can make it easy for a child to be involved regularly with physical activity and maintain an active lifestyle (Rovniak et al, 2002). In order to develop and maintain a positive support system, one must have a relatively high social competence.

Gender is a focal feature associated with both physical activity and social competence, emphasizing the differing values that boys and girls place on physical activity and sport participation, with social norms being more influential on boys physical activity participation compared to girls (Trost, Pate, Ward, Saunders & Riner, 1999). It is commonly known that boys and girls differ on their choices of physical activities, as well as their social worth on being active (Cairney et al, 2010). Cairney et al (2005a) previously mentioned that the motor impairments may impact boys and girls differently, however this hypothesis is not well understood. External (social) and internal (self perceptions) pressures account for the participation choices of being active in boys. However, for girls, an absence of either an external or internal pressure does not greatly change their participation over time (Cairney et al, 2010). Even though the participation levels are lower in boys with motoric difficulties compared to their typically developed peers, their level of participation does not appear to decrease over time (Cairney et al, 2010). Due to the various values that boys and girls place on physical activity, it is crucial to recognize that it is more than just their motor capabilities that affect their physical activity.

Jago et al (2011) explored the influence of friendship on a child's physical activity through the completion of a social network questionnaire. This questionnaire contained information on which their best friend was, how often they participate in physical activity with this friend, where they are active together, if they are on a sports team together, if they ask the friend to play with them, and if the friend has ever asked them to play. It was found that engagement of physical activity with a friend is correlated with the self reported physical activity in middle-school girls; indicating a friend's support has a mediating effect on the child's physical activity. However, Jago et al (2011) did not report on the reliability and validity of their measurements. This pattern was also shown in 10 to 11 year old children of both genders. For boys, the exposure to a home or local environment with a best friend was associated with higher levels of physical activity rather than just being active on school grounds. In girls, the frequency of being physically active with their best friend was associated with greater volume and intensity of physical activity (Jago et al, 2011). Overall, the message displayed for young girls would be to partake in physical activity with their best friend outside of school hours to elevate their physical activity levels and duration. Physical activity has also been shown to be associated with improving mental well-being and development of social skills (Bailey, 2005; Parfitt & Eston, 2005). There has been limited research on how physical activity influences a child's social competence.

2.2.7 Relationship between Social Competence and Motor Performance

As previously mentioned, DCD consists of multiple domains including psychosocial. At school, these children are more susceptible to learning disabilities or reading difficulties and increased risk for lower intelligence. They are also more likely to act out in a classroom setting, are less socially desirable when choosing friends, leading to less friendships and greater feelings of anxiety and low self-worth, compared to their healthy peers (Barnhart et al, 2003). In a follow-up study done on 15 year old children, it was reported that in environments where high levels of physical skills are valued, clumsier children with DCD have been socially isolated (Cantell et al, 1994). This study consisted of the completion of the Harter Self-Perception Scale along with an interview on the participants, discussing hobbies, pastimes and other potential outcomes. Harter subscales including cognitive, social, physical and general had their reliabilities reported by Harter (1988) as 0.76, 0.78, 0.83 and 0.73, respectively. Although these children did not perceived themselves as socially excluded compared to their peers, they took part in less social spare-time activities, were not as active socially, did not play team games and spent more time alone watching and playing video games. This group also reported fewer amounts of weekly activities compared to their peers, due to their lower amount of hobbies (Cantell et al, 1994; Evans & Roberts, 1987). The differences shown between children with and without motor impairments demonstrate that clumsier children have poorer social and educational outcomes.

Longitudinal investigations have reported that children with DCD are more immature, socially isolated and passive compared to healthy peers, along with lower self-worth and higher anxiety levels (Dewey et al, 2002; Schoemaker & Kalverboer, 1994; Skinner & Piek, 2001). There has been limited exploration on the co-occurrence of problems with attention, learning and psychosocial adjustments in children with varying levels of motor difficulties. Dewey et al (2002) hypothesized that children with DCD would display greater amounts of impairments in attention, reading and psychosocial compared to their healthy peers. In this study of 403 children, the use of BOTMP, MAB-C and DCDQ were tools in assessing motor coordination, while psychosocial adjustment was assessed through parental reports. No reliability or validity measures were reported on any of the motor performance assessment tools or psychosocial adjustments. It was found that children with motor difficulties reported significantly higher scores on the parental reports, indicating more social problems. However, the study highlighted the issue that the parents evaluated the psychosocial status of the children; therefore it was not a direct measurement (Dewey et al, 2002). These findings complement the previous studies that concluded that children with DCD are at risk of psychosocial dysfunction.

Developmental coordination disorder has become a significant concern for school-aged children, enhancing the body of literature that explores potential risk factors associated with the disorder. Lingam et al (2010) used 6902 children with motor proficiency data to assess the association between DCD and difficulties in attention, language, short-term memory, social skills and academic ability. Motor skills were assessed within the available sample of children via MAB-C (r=0.80) and social skills were identified through self-report checklists, including the Social and Communication Disorders Checklist (r=0.91) (Lingam et al, 2010; Henderson & Sugden, 1992; Skuse, Mandy & Scourfield, 2005). The authors concluded that the motor delayed children displayed greater risk of problems of reading, spelling, social and nonverbal skills, after adjustments for IQ and other developmental traits. This study is a valuable addition to literature as it contains prospectively collected data, exhibiting a causal relationship between motor impairments and poorer social skills.

2.3.0 Summary

Studies have addressed many factors including SES, ethnicity, gender, age, motor performance and social competence, which have an impact on a child's level of physical activity. However, there is minimal research investigating the interrelationships between physical activity, motor performance, and social competence. Motor performance greatly predicts a child's social acceptance and competence in a classroom setting (Cantell et al, 1994), motor performance also significantly impacts a child's level of physical activity (Cairney et al, 2010) and limited findings have shown that social interactions enhance the physical activity participation in a child (Jago et al, 2011). Because of our limited knowledge on the potential moderating role of social competence on the relationship between motor performance and physical activity, these interrelationships may have been overlooked. It is well established that physical activity positively affects an individual's health and lifestyle, however many children and adolescents fail to meet recommended levels. Therefore, it is necessary to develop a full understanding of the relationships between motor performance, physical activity and social competence in order to inform the development of successful physical activity promotion programs for all children regardless of motor performance standing.

Chapter 3: Methods

3.1.0 Research Design

This is a cross-sectional investigation using data from a longitudinal study by the Physical Health Activity Study Team (PHAST) at Brock University. PHAST was funded by the Canadian Institutes of Health Research (CIHR) and followed students for six years from grade 4 (2004) to grade 9 (2010) in the District School Board of Niagara (DSBN). The PHAST study received Research Ethics Board approval from Brock University and the DSBN. All elementary schools in the DSBN were eligible to participate in the study and of 92 schools, 75 (83%) participated with informed parental consent provided for 2278 (96.8%) of 2395 children. This investigation examined data from Winter term of Grade 6 in 2007. The testing and training protocols were established, assembly of a cadre of trained assistants was done and completion of pilot testing occurred in the fall of 2004. This wave was chosen as students were familiar with the study protocols, scores of the BOTMP were available for all participants and the recall period of physical activity contains the entire school year.

3.2.0 Study Participants

The study population included 2211 children in the sixth grade of 2007 with 2035 (92.04%) who received motor testing, with age range of 11 to 13 years. However, 90 children were excluded from the multivariable models due to missing critical data from our key outcome measurements, leaving a total of 1958 subjects (96.22%) for the investigation with 982 males and 976 females (Appendix A). After removing children with had missing data, the mean age slightly changed from 11.89 years to 11.91 years, with the proportion of males changing from 48.94% to 50.15%. Therefore, the demographics of the sixth grade children remained relatively the same.

3.3.0 Review of Measurements

After reviewing the various methods of measurements used in previous literature, an overview of the validity and purpose of measurement tools for this investigation are addressed here. Measures of physical activity, motor performance and social competence are discussed.

3.4.0 Assessing Physical Activity

Physical activity is the main outcome variable in this investigation. Due to discrepancies in literature on defining physical activity, it is crucial to determine a valid method for evaluation. As previously mentioned, the majority of children are not meeting the recommended levels of physical activity and from a public health perspective, it is important for our community to strive to meet these levels in childhood. In this investigation, the child's present activity levels were evaluated, not whether they meet the recommended levels or not. This will allow for an examination on what impedes these children's activity levels and furthermore, if social competence is one of these factors. The following measurement tool was completed in the children's classroom with trained assistants monitoring their completion and was used to evaluate the child's activity levels.

3.4.1 Participation Questionnaire

The Participation Questionnaire (PQ) is a 61-item scale, which includes various forms of physical activity that the child is able to report on. These forms include free-time play, seasonal recreational pursuits, school sports, community sports teams and clubs, and sports and dance lessons over a year's time. This questionnaire allows the child to accurately report their physical activity levels in order to sum up their overall score. The PQ measures activity units, defined as an active pursuit that is selected in free play/recreational conditions and/or involvement in an organized sport team, club, or lesson. The free-time play activities are included within and outside of school hours during the week, as well as the weekend. Questions are also used to address the level of sedentary activity the child is involved in daily, including watching TV or reading a book. Sport team/club/lessons are reported for both school and community settings. Subtotals are recognized for unorganized activity (free play) and organized activity (sports teams, lessons). These scores provide an estimation of the child's frequency and nature of physical activity; however it does not determine the duration or intensity (Cairney et al, 2005a). The PQ has displayed strong construct validity with expected gender differences, overweight and obese status, and urban/rural differences present, along with consistency of test-retest reliability of 0.81 (Hay, 1992). Table 1 displays the mean PQ scores of the participants, along with standard deviation, separated by gender, while Table 2 depicts the median PQ scores, with the range of scores, also separated by gender. These tables demonstrate that the distribution of these scores are skewed and will be further accounted for in later analysis.

Table 1. Mean PQ Scores by Gender

	Males (n=982) **Mean (SD)**	**Females (n=976)** **Mean (SD)**
PQ Total Score	17.47 (7.39)	16.88 (6.73)
PQ Free Play	11.74 (3.42)	11.35 (3.28)
PQ Organized Sports	5.73 (5.30)	5.53 (4.96)

Table 2. Median PQ Scores by Gender

	Males (n=982) **Median (Range)**	**Females (n=976)** **Median (Range)**
PQ Total Score	17 (3 – 43)	16 (1 – 43)
PQ Free Play	12 (2 – 19)	11 (1 – 19)
PQ Organized Sports	5 (0 – 29)	4 (0 – 29)

3.5.0 Assessing Motor Performance

Motor performance is a predictor variable in this investigation. It is common for children to score within the healthy range of one test of motor functioning, but to be impaired in another (Dewey et al, 2002). Due to the inconsistency between tests, the use of more than one test is beneficial when diagnosing probable-DCD (p-DCD). In order to be diagnosed with p-DCD, the poor motor skills must negatively affect another aspect of the child's life (Barnhart et al, 2003). However, there is no one test that can accurately identify a child with DCD or replace the clinical interpretation of a therapist whom examines several sources of information about the child's functional abilities (Crawford, Wilson & Dewey, 2001). When a child scores within the low percentile of a motor assessment test, they are often diagnosed with p-DCD. However, this investigation is not intended to classify children as p-DCD, rather to explore children with various motor capabilities.

For the purpose of this study, children were screened for their motor performance and ranked among the study population.

3.5.1 Bruininks-Oseretsky Test of Motor Proficiency (BOTMP)

Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) is the most commonly used standardized test for diagnosis of DCD in North America, examining the full scope of motor ability (Cairney, Hay, Faught & Hawes, 2005b). BOTMP has been used as an assessment tool of motor skills in children aged 4.5 to 14.5 years (Flegel & Kolobe et al, 2002). The short form of BOTMP (BOTMP-SF) has also been validated against the long form of the test with correlations between 0.90 and 0.91 among children of ages 8 to 14 years (Cairney et al, 2010). This test contains eight subsets including running speed and agility, balance, bilateral coordination, strength, upper-limb coordination, response speed, visual-motor control and upper-limb speed and dexterity, along with 46 separate items to ensure a comprehensive index of motor proficiency (Flegel & Kolobe, 2002; Wrotniak et al, 2006). The use of these scaled items allows for an assessment of both gross and fine motor skills. BOTMP permits verbal communication between the examiner and participant, and is more favourable for children who require external controls for monitoring their motor performance (Crawford et al, 2001). Miyahara & Clarkson (2005) stated that BOTMP is a well-established valid and reliable test for movement skill ability. The BOTMP-SF was administered in the school's gymnasium. Table 3 displays the mean and median BOTMP-SF percentile rank of the participants, along with standard deviation and range, separated by gender.

Table 3. BOTMP-SF Percentile Rank by Gender

	Males (n=982)	**Females (n=976)**
Percentile Rank Mean (SD)	71.55 (29.98)	62.39 (30.49)
Percentile Rank Median (Range)	84 (1 – 99)	72 (1 – 99)

3.6.0 Assessing Social Competence

Social competence is the moderating variable in this investigation. As a reminder, in this investigation the child's perceived social competence is of interest. Responses reflect the child's own ability to engage in effective social interactions.

3.6.1 Harter Scale

The Harter Self-Perception Scale was used for this analysis. The subscale of social competence describes the child's amount of friends, how likeable they are and also how important they feel they are within the classroom setting. It is important to note that the judgments evolved from self worth are not qualified from the outlined responses; they are reviewed through items, which directly question how the child likes himself or herself as a person (Harter, 1982). In the social competence domain, six items were used to form the social competence subscale with the items reflecting the child's ability to make friends, popularity, ease of making friends, and other social aspects in childhood years (Harter, 1982). The responses are scored from one to four, with one being a low perceived competence. The scores are then summed within each subscale. Although the Harter social subscale is entitled 'social competence', it is demonstrating the child's personal perceptions, compared to a clinical measure. Children completed the Harter scale in the classroom, monitored by research assistants. Children with a z score (calculation in Section 3.8.3) of less than 0 on the Harter scale indicate that they consistently perceive themselves as socially incompetent. In our investigation, we have a total of 837 individuals whom computed a z score of less than 0 (421 males and 416 females), with a range of scores consisting of 6 to 24. Table 4 displays the mean and median Harter Social scores of the participants, along with standard deviation and range of scores, separated by gender.

Table 4. Harter Social Score by Gender

	Males (n=982)	**Females (n=976)**
Harter Score Mean (SD)	19.68 (3.86)	19.56 (3.99)
Harter Score Median (Range)	21 (6 – 24)	20 (6 – 24)

3.7.0 Assessing the Confounding Variables

There are many variables that may confound the relationship between motor performance and physical activity. As previously mentioned, these variables include ethnicity, pubertal stage, SES, BMI, and gender. The measures for these variables in this analysis are discussed below.

Ethnicity has been shown to be a significant predictor of physical activity, where Caucasian children have been shown to have reportedly higher physical activity levels than other ethnicities (CDC, 2011b). Social competence is also affected by ethnicity, where Black children perceive themselves as more socially competent and Asian children perceive themselves as less socially competence when compared to White and Latin children (Lamborn, Mounts, Steinberg & Dornbusch, 1991). Unfortunately, the PHAST study was not permitted to gather data regarding a participant's ethnicity. Although the PHAST study is not able to control for ethnicity for the investigation of this relationship, the DSBN has a distinct homogeneity among their students with the large majority being Caucasian and is therefore not a major concern for this study.

Pubertal stage has been shown to be associated with physical activity, motor performance and social competence (Kohl & Hobbs, 1998). Unfortunately, only a subsample of our study population has their pubertal stage documented. However, our study participants are all within the same age group of 11-13 years old where the majority of boys are Tanner Stage II with a minimal amount of girls entering Tanner Stage III. Therefore, similar to ethnicity, pubertal stage is not a concern in this study. Another potential confounding variable is SES.

As examined by Estabrooks et al (2003), individuals within the lower SES have limited accessibility to physically active environments, with the greatest factor of physical inactivity in this status being a low proportion of free for use resources. This indicates that a major component of SES limiting these children to being active is their family income (Estabrooks et al, 2003). This relationship was also examined by Gorden-Larsen et al (2004) where higher family income was significantly associated with increased levels of MVPA and decreased inactivity. Parental education is commonly used as a partial measure of SES (Davis-Kean, 2005). Therefore, a proxy measure for SES, parental education, was collected through a questionnaire administered to the participant's parent in Wave One. It can be assumed that the parent with the greatest responsibility was the child's parent who filled out the questionnaire, with 84.77% of these parents being mothers. The parent or primary guardian was asked of their highest level of education that they have attained with possible responses being: less than high school, high school (or GED), some college, trade certificate college, college, undergraduate degree (BA, BSc), professional degree (MD, LLB, MBA) and graduate degree (MA, PhD). Although this is not a complete measure of income, it will provide a suitable indication of the child's SES.

Gender and age were also taken into account since both have been associated with physical activity levels, along with the different social worth of being physically active (Cairney et al, 2010). A higher BMI status has also been shown to reduce a child's active state due to their reduce energy expenditure and higher fatigue levels (Silman et al, 2011).Also, children with lower motor performance are also at greater risk of being overweight or obese, which may be due to their reduce participation in physical activity compared to peers (Cairney et al, 2005a). Children who perceive themselves as socially incompetent may be influenced by their weight status, as children who are overweight may perceive themselves as physically incompetent, as well as socially unaccepted (Cairney et al, 2005a; Ikeda, Crawford & Woodward-Lopez, 2006). Therefore, it is important to consider these confounding variables in the analyses of this investigation. Table 5 provides a summary of the potential confounders on each key component in this investigation.

Table 5. The impact of confounding variables on physical activity, motor performance and social competence.

Confounder	Influence on: Physical Activity	Motor Performance	Social Competence
Ethnicity	In North America, White children have higher physical activity levels compared to other ethnicities.	There have been no reported differences in childhood motor performance between ethnicities.	Perceived social competence varies between ethnic groups, with Blacks scoring high and Asians scoring low compared to White and Hispanic.
Parental Education (SES)	Higher SES allows for more physical activity opportunities.	Higher SES provides more possibilities for motor performance interventions.	Higher SES exposes children to more group activities such as clubs, teams, etc.
Gender	Males have higher levels of physical activity compared to females.	Males have significantly higher scores motor performance tests compared to females.	Antisocial behavior is more common in males.
Age & Pubertal Stage	Physical activity decreases with age and is associated with pubertal stage.	Motor performance gradually improves with age and pubertal stage.	Social competence is persistent overtime.
BMI	Higher body composition measurements are associated with lower levels of physical activity.	Poor motor performance is associated with poorer body composition, leading to a downward spiral for both components.	Higher body composition is associated with lower social competence.

3.8.0 Statistical Analyses

The purpose of the analyses is to distinguish the interrelationship between physical activity, motor performance, and social competence while discovering the risk of low physical activity participation in children with different motor performances, along with establishing the moderating role of self-perceived social competence. Specifically, our key research question is does social competence alleviate the risk of low physical activity participation in boys and girls with lower motor performances? Basic characteristics of the PHAST Grade 6 cohort (n=1958) are presented by gender for representation of the study population. As previously discussed, males' and females' physical activity levels are influenced differently (Kohl & Hobbs, 1998; Tammelin et al, 2003); therefore all analyses were run on genders separately to address them as individual conditions. Next, comparative tests on all physical activity measures were used to determine if there are any differences between motor performance quartiles or social competence groups. Furthermore, multiple regression models were run with each physical activity measure as the dependent variable to show the initial relationship of the key variables, as well as the impact from potential confounders. Logistic regressions were then performed to show the role that social competence plays on the well recognized relationship between physical activity and motor performance.

All statistical analyses were completed using SAS 9.3. The descriptive statistics by gender and motor performance quartile were of age, BMI, PQ scores averages, and Harter scale average, with statistically significant gender differences in some key variables (Appendix B). The most common parental education level in males and females was college with 31.93% and 33.82%, respectively. A t test was performed on BMI ($p=0.2304$), and age ($p=0.1749$) by gender and it has been found that there is no mean difference in these variables in this investigation. Normality checks have been done in all key variables with no variable being normally distributed ($p<0.005$). However, due to our large sample size, we continued the investigation with caution.

Physical activity measures were run as discrete variables in all analyses, each depicting a different perspective of the child's physical activity participation. Since PQ Organized Sports is very positively skewed (skewness value of 1.2997) and not normally distributed ($p<.0001$), the square root of this variable was taken in order to improve its skewness (new skewness value of -0.0315). Pearson correlation matrices were made on the key variables separated into pairs to help understand the existing relationships (physical activity vs. motor performance, physical activity vs. social competence, and motor performance vs. social competence) (Appendix C). Although PQ Organized Sports is highly skewed, it was still inputted in the correlation matrices as its original variable since the Pearson and Spearman correlation coefficients were very similar by being within 0.05 of each other. Simple linear regression (SLR) was performed on males and females separately to determine the direction of the individual relationships (Appendix D).

3.8.1 Comparative Tests

One-way ANOVA procedures were run on all PQ measurements with motor performance quartiles being the categorical variable, separated by gender. T tests were also run on all PQ measurements with high vs. low social competence being the classification variable, separated by gender. All comparative procedures, including one-way ANOVA and t tests, computed p values of <.0001, indicating significant differences of PQ measurements between all independent groups in both genders. Due to these significant differences, further analysis was done. As previously discussed, the social norm differences of physical activity between genders are important to address (Trost et al, 1999), therefore all final analyses were run on males and females separately.

3.8.2 Multiple Regression

Multiple regression models were performed to identify whether motor performance (BOTMP-SF percentile rank) and social competence (Harter's Perceived Social Competence Subscore) are independent predictors of physical activity participation after controlling for the previously discussed confounders, including age, BMI and SES (Wuensch, 2011). The rationale of using multiple regression models prior to identifying the odds of low participation in physical activity is to display the interaction of the key variables in their original continuous form. This reconciled the initial relationship prior to dichotomizing or categorizing the physical activity, motor performance and social competence measures. Appendix E illustrates the steps of multiple regression models and what is within each model. Each model was run on each dependent variable (PQ Total score, PQ Free Play, PQ Organized Sports).

The first model only included motor performance. By starting with this model, the original relationship between physical activity and motor performance is presented. This relationship is well recognized and it is important to view this relationship prior to later analyses. The second model added in social competence. If both of these measurements remained significant on the dependent variable, it indicates a potential moderating role, rather than a mediating role from social competence. The third model adjusts for the personal confounding factors including body composition and age. When these variables are included, it shows the impact that their maturity and physical factors have on their physical activity. If these variables lead to an insignificant motor performance or social competence, this indicates that children with the same age and same body type, their specific type of physical activity participation is not significantly affected by their motor performance or social competence. However, if when these variables are included in the model and our independent measures of motor performance and social competence remain significant, it can be said that even when children are in the same age group with the same body composition, their level of motor performance or social competence will still play a role on how physically active they are in regards to participation levels. The fourth model further adjusts for their parental education; our proxy measure of SES. If the inclusion of parental education leads to insignificant motor performance or social competence, it can be interpreted like age and body composition.

Assumption checks were done on linearity, independence, homescedasticity and normality. It has been confirmed that all measurements are reliable from previous literature. The null hypotheses to be tested are that all slopes of the regression line are equal to 0, indicating no effect from the independent predictors. Sample sizes varied based on the available observations in each model (Appendix E). All significant regression parameter estimates will later be entered into a logistic regression to estimate odds ratios for each of the independent variables in the model. The purpose of running multiple regressions prior to logistic regression is due to the nature of the key variables in the investigation; all physical activity, motor performance and social competence measurements are continuous. Because of this, multiple regressions allows for the initial relationship between the key variables and potential confounders to be shown prior to categorization.

3.8.3 Logistic Regression

Following multiple regression models, the significant parameters were entered into logistic regression procedures, where the following equation 1 is computed, with p/1-p being the odds ratio computed.

(1) $$\log (p/1-p) = \alpha + \sum b_i x_i$$

Assumption checks were done on reliability and independence. The null hypotheses to be tested are that all estimates (b) in the logistic model are equal to 0, indicating no effect from the independent variables. The dependent variables in these logistic models were identified as high and low with the use of z scores. Z scores were adjusted for gender. The calculation for a z score is shown below for equation 2.

(2) Z score = (child's score – mean score of sample) / standard deviation of score

This calculation was used on the dependent variables (PQ Total, PQ Free Play and square rooted PQ Organized Sports). A z score shows how much a child deviates away from the rest of the children, or shows where the child 'should be' in the sample. Therefore, a z score of 0 indicates the child has achieved exactly the average level of the specified score and a z score above 0 indicates a child is above the average level of the specified score. It can then be said that a z score of less than 0 identifies children who are below the average levels for this sample. With these z scores, cut offs were made to categorize children who have met the desired level of the specified score and those who have not. The cut offs included z scores of 0 or above for 'adequate levels achieved' and z scores less than 0 for 'adequate levels not achieved'.

The first logistic regression procedure computed unadjusted odds ratios to determine the odds of having low participation in physical activity in children in the 1st, 2nd and 3rd BOTMP-SF quartile compared to the 4th quartile ("high motor performance"), as well as the odds of low participation in physical activity in children with low social competence compared to those with high social competence. These odds ratios displayed the initial odds ratios of children prior to displaying the moderating role of social competence on physical activity participation. These odds ratios were then adjusted for the confounding variables addressed in the multiple regressions. Furthermore, children were grouped based on high (3rd or 4th quartile) or low (1st or 2nd quartile) motor performance and high or low social competence (z score cut offs), and odds ratios were computed with the reference group as high motor performance and high social competence. Again, these odds ratios were first computed as unadjusted values, then later adjusted for with the discussed confounders. This dichotomized approach will show the basic moderating relationship on low participation in physical activity by expressing the effect on high and low motor performance prior to showing motor performance in quartile form. These odds ratios were compared with the adjusted odds ratios computed from the logistic regression. The assumptions were previously checked with the logistic regression models. The final set of odds ratios is similar to the previous, however motor performance remained in the quartile form and categorized with high and low social competence. Seven indicator variables were created using reference group of high social competence and 4th BOTMP-SF quartile and were entered into each logistic regression model. These odds ratios show the final moderating role that social competence has on the risk of low participation in physical activity. The null hypotheses tested were that all odds ratios are equal to 1, indicating the children are at no increased odds of having low physical activity participation levels. Physical activity participation (dependent variable) was entered as z scores of PQ Total Score, PQ Free Play or square rooted PQ Organized Sports. Although these measures depict different aspects of physical activity, this has allowed us to enhance our interpretation of this drawback from participation in physical activity.

Chapter 4: Results

4.1.0 Sample Characteristics

As previously mentioned, the initial study population contained 2211 children in the sixth grade with 2035 (92.04%) with motor performance scores and an age range of 11 to 13 years. However, 90 children were excluded due to missing data from the outcome measurements (Appendix A), leaving a total of 1958 subjects (96.22%) for the investigation with 50.53% being males. Table 6 provides a breakdown of key measurement means based on gender.

Table 6. Descriptive Characteristics by Males and Females

	Males (n=982) Mean (SD)	**Females (n=976)** Mean (SD)
Age (years)†	11.92 (0.35)	11.90 (0.34)†
BMI (kg/m^2) £	19.95 (3.94)	20.14 (4.11)
PQ		
Total	17.47 (7.39)	16.88 (6.73)
Free Play*	11.74 (3.42)	11.35 (3.28)
Organized Sports	5.73 (5.30)	5.53 (4.96)
BOTMP Rank*	71.55 (28.98)	62.39 (30.49)
Social Competence	19.69 (3.86)	19.56 (3.99)
College Education (%)	31.93	33.82

**Statistically different means between genders ($p<0.05$); £5 males and 4 females did not have a BMI reading; †1 female did not a recorded age.*

It is recognized that gender differences are within measurements PQ Free Play and BOTMP-SF percentile rank. Due to these differences, all analyses were separated by gender to provide a clear depiction of the moderating role of social competence within each gender. Table B1 and Table B2 in Appendix B presents the key measurement means based on BOTMP-SF quartile group in males and females, respectively. Table B3 in Appendix B displays the key measurement means based on gender and high or low social competence groups. Table 7 compares the proportion of our dichotomized physical activity measurements and social competence levels based on motor performance quartile and gender.

Table 7a. Proportion of low participation in physical activity and low social competence among motor performance quartiles in males.

	Males (%)			
Motor Performance	**1st Quartile**	**2nd Quartile**	**3rd Quartile**	**4th Quartile**
Low Participation in Total Physical Activity	69.43	60.28	50.00	40.14
Low Participation in Free Play Activities	49.74	48.21	39.86	37.72
Low Participation in Organized Sports	68.39	57.59	48.19	32.87
Low Social Competence	56.48	49.55	38.41	32.87

Table 7b. Proportion of low participation in physical activity and low social competence among motor performance quartiles in females.

	Females (%)			
Motor Performance	**1st Quartile**	**2nd Quartile**	**3rd Quartile**	**4th Quartile**
Low Participation in Total Physical Activity	61.96	51.09	51.13	40.00
Low Participation in Free Play Activities	56.88	47.81	48.12	48.75
Low Participation in Organized Sports	63.41	55.84	48.87	35.00
Low Social Competence	53.26	46.72	30.83	36.88

By reviewing Table 7a and Table 7b above, we can see that more males had lower participation in total physical activity compared to females, except when compared in the third motor performance quartile, contradicting with previous literature. However, by looking at the subscores of the physical activity measurement, we are able to see where this relationship is varied. Lower participation in free play activities was always more prevalent in females compared to males except when compared in the second motor performance quartile. Lower participation in organized sports was more prevalent in males compared to females in the first and second motor performance quartiles however more prevalent in females compared to males in the third and fourth quartile.

In males, the proportion of lower participation in all physical activity measurements decreased as one moved into a higher motor performance quartile, which is consistent with previous literature (Cairney et al, 2010). In contrast, this relationship is not as clear in females, with an exception in organized sport participation. Total physical activity proportion did decrease from 1st to 4th quartile however the 2nd and 3rd quartile proportions were quite similar with the 3rd being unexpectedly higher than the 2nd. Free play activities participation did decrease from 1st to 2nd quartile, however it continued to increase into the 3rd and 4th quartile in females. This may be due to the more personal factors rather than motor performance playing a more dominant role displayed in organized sport participation. Low social competence proportions decreased in both genders from the 1st to 4th quartile except in females where the 4th quartile was slightly higher than the 3rd. Although these proportions are not very different, genders were separated in order to understand this moderating relationship in males and females separately.

Based on Pearson correlation matrices of individual relationships (Appendix C), there are no collinearity issues. The Pearson and Spearman correlation results were very similar, therefore Pearson correlation coefficients were reported. Table 8a and Table 8b display the overall correlation matrices with all three key components involved in males and females, respectively. These tables include the original PQ Organized Sport measurement. When the correlation matrix was run again with the square-rooted outcome measure, the coefficients only slightly changed for PQ Total score, PQ Free Play, motor performance and social competence to 0.7558, 0.86774, 0.27397 and 0.28109, respectively in males and 0.85694, 0.33533, 0.23299 and 0.28732, respectively in females. It can be seen again that based on correlation coefficients, there are no collinearity issues.

Table 8a. Pearson correlation matrix on physical activity, motor performance and social competence measures in males ($p<0.05$).

	PQ Total	**PQ Free Play**	**PQ Organized**	**Motor Performance**
PQ Free Play	0.75558	-	-	-
PQ Organized	0.90630	0.40793	-	-

Sports				
Motor Performance	0.23277	0.12105	0.24633	-
Social Competence	0.31096	0.26376	0.26323	0.20865

Table 8b. Pearson correlation matrix on physical activity, motor performance and social competence measures in females (p<0.05).

	PQ Total	**PQ Free Play**	**PQ Organized**	**Motor Performance**
PQ Free Play	0.71356	-	-	-
PQ Organized Sports	0.88631	0.30800	-	-
Motor Performance	0.22884	0.14486	0.21500	-
Social Competence	0.35010	0.30153	0.27611	0.22525

As previously addressed, the normality issue in PQ Organized Sports was not resolved however, the skewness of the distribution was greatly improved by square rooting the PQ Organized Sports measurement. Therefore, for a dependent variable in multiple regression and z score cut offs in logistic regression, the square rooted measure of PQ Organized Sports was used. By comparing the slopes computed in the simple linear regression models (Appendix D), it is recognized that the slopes are very similar when comparing males and females. However, based on statistically significant differences found between genders and previous literature (Azevedo et al, 2007; Tammelin et al, 2003; Trost et al, 1996; Trost et al, 1999), separating males and females to illustrate the moderating role of social competence would be beneficial due to the diverse social norms in males and females (Trost et al, 1999).

4.2.0 ANOVA Results

The purpose of an Analysis of Variance (ANOVA) procedure is to identify whether the mean values are equal between the different groups. In our analysis, we reviewed the mean differences of our PQ outcome measurements between motor performance quartiles (Table 9a; Table 9b). All models for PQ Total, PQ Free Play and PQ Organized Sports with F values of 18.11, 3.42 and 27.51, respectively in males and 15.30, 5.05 and 18.18, respectively in females. All p values were less than the significance level of 0.05. All comparative differences were based on Bonferroni post-hoc test.

Table 9a. Mean PQ Scores by Motor Performance Quartile in males

Motor Performance	1st Quartile (n=193)	2nd Quartile (n=224)	3rd Quartile (n=276)	4th Quartile (n=289)
PQ Total	15.20	16.08	17.95	19.61
PQ Free Play	11.30	11.41	11.89	12.16
PQ Organized Sports	3.90	4.67	6.05	7.45

Table 9b. Mean PQ Scores by Motor Performance Quartile in females

Motor Performance	1st Quartile (n=276)	2nd Quartile (n=274)	3rd Quartile (n=266)	4th Quartile (n=160)
PQ Total	14.97	16.88	17.43	19.26
PQ Free Play	10.72	11.57	11.49	11.80
PQ Organized Sports	4.25	5.31	5.94	7.46

In males, significant differences in PQ Total score, as well as PQ Organized Sports, were in all motor performance comparisons except when comparing 1st and 2nd quartile. Significant differences in PQ Free Play were only between 1st and 4th motor performance quartile. In females, significant differences in PQ Total score were in all comparisons except when comparing 2nd with 3rd motor performance quartile. PQ Free Play significant differences were when the 1st motor performance quartile was compared with any other quartile group. PQ Organized Sports had significant differences in all comparisons except in motor performance pairs of 1st vs. 2nd quartile and 2nd vs. 3rd quartile.

4.3.0 t Test Results

The purpose of a t test procedure is similar to an ANOVA procedure, but with only two comparison groups. This t test continued with the same function as the ANOVA procedure to identify the mean differences of PQ measurements, but with high and low social competence groups. The equal variances check was violated only in females when comparing PQ Total score and PQ Free Play means. All t values were significant for PQ Total, PQ Free Play and PQ Organized Sports with values of -8.51, -7.94 and -7.16, respectively in males and -9.69, -7.07 and -8.37, respectively in females. All corresponding p values were less than the significance level of 0.05.

Table 10a. Mean PQ Scores in High and Low Social Competence in males

Social Competence	**High (n=561)**	**Low (N=421)**
PQ Total	19.15*	15.23
PQ Free Play	12.47*	10.77
PQ Organized Sports	6.68*	4.46

**significantly higher PQ mean.*

Table 10b. Mean PQ Scores in High and Low Social Competence in females

Social Competence	**High (n=560)**	**Low (N=416)**
PQ Total	18.58*	14.60
PQ Free Play	11.98*	10.49
PQ Organized Sports	6.59*	4.11

**significantly higher PQ mean.*

Based on visually comparing the mean PQ measurements between high and low social competences in Table 10a and Table 10b, the high social competence group had significantly higher PQ mean values compared to the low social competence group in both genders.

4.4.0 Multiple Regression Models

Our first dependent variable is PQ Total score. This measurement shows all forms of physical activity participation including during school, during recess, after school, with friends and family members, as well as alone time. By having a higher PQ Total score, it is interpreted as higher participation in physical activity on their school time, as well as extracurricular time. Table 11a shows the results of the four models on males, with Table 11b displaying the results in females.

Table 11a. Parameter estimates on PQ Total score in males

	Model 1 (n=982)	Model 2 (n=982)	Model 3 (n=977)	Model 4 (n=620)
Intercept	13.22671*	3.92425*	2.32726	6.67601
R^2	0.0542	0.1262	0.1248	0.1336
Adj R^2	0.0532	0.1244	0.1212	0.1265
Motor Performance	0.05932*	0.04473*	0.04424*	0.04012*
Social Competence	-	0.52563*	0.51541*	0.59013*
Age	-	-	0.20366	-0.26697
BMI	-	-	-0.02873	-0.03571
Parental Education	-	-	-	0.12992

**significant parameter estimates (p<0.05)*

Table 11b. Parameter estimates on PQ Total score in females.

	Model 1 (n=976)	Model 2 (n=976)	Model 3 (n=971)	Model 4 (n=623)
Intercept	13.73115*	4.31985*	-0.87519	4.34138
R^2	0.0524	0.1463	0.1477	0.1345
Adj R^2	0.0514	0.1445	0.1442	0.1275
Motor Performance	0.05050*	0.03487*	0.03562*	0.02902*
Social Competence	-	0.53104*	0.52937*	0.51364*
Age	-	-	0.42286	0.18310
BMI	-	-	0.00669	-0.07018
Parental Education	-	-		0.01554

**significant parameter estimates (p<0.05)*

In both males and females, even after the incorporation of all confounding variables, both motor performance and social competence have a significant impact on the child’s total participation in physical activity. It can also be seen that when social competence is included, the parameter estimate of motor performance decreases, indicating a greater role of social competence compared to motor performance.

Therefore, motor performance and social competence both play a significant role on total participation in physical activity in both males and females. To statistically show a moderating effect, an interaction of social competence and motor performance was entered into the model. Although the interaction term was not significant, it did increase the adjusted R^2 of the model, indicating that social competence does play a role on the existing relationship, however it is not statistically significant (Kim, Kaye & Wright, 2001). The comparison of motor performance parameter estimates in the final two models displays a moderating effect of 9% in males and 17% in females from social competence on motor performance. Table 12a and Table 12b show the multiple regression models on PQ Free Play in males and females, respectively. The PQ Free Play measurement shows participation in personal choice activities where it is the child's decision to be active on their own time. This includes during recess and after school with friends and family. Similar to PQ Total, by having a higher PQ Free Play score, it is interpreted as higher participation in physical activity when the child chooses to be and where their capability to perform is less recognized.

Table 12a. Parameter estimates on PQ Free Play score in males.

	Model 1 (n=982)	Model 2 (n=982)	Model 3 (n=977)	Model 4 (n=620)
Intercept	10.72215*	6.80792*	1.03207	2.80264
R^2	0.0147	0.0741	0.0748	0.0944
Adj R^2	0.0136	0.0722	0.0710	0.0869
Motor Performance	0.01428*	0.00814*	0.00988*	0.00856
Social Competence	-	0.22117*	0.21300*	0.25534*
Age	-	-	0.45988	0.27371
BMI	-	-	0.01702	0.02654
Parental Education	-	-	-	-0.07227

**significant parameter estimates (p<0.05)*

Table 12b. Parameter estimates on PQ Free Play score in females.

	Model 1 (n=976)	Model 2 (n=976)	Model 3 (n=971)	Model 4 (n=623)
Intercept	10.37639*	6.25038*	5.98886	10.26303*
R^2	0.0210	0.0972	0.0990	0.0872
Adj R^2	0.0200	0.0953	0.0952	0.0797
Motor Performance	0.01556*	0.00871*	0.00954*	0.00535
Social Competence	-	0.23281*	0.23287*	0.22256*
Age	-	-	-0.00365	-0.20405

BMI	-	-	-0.01235	-0.03073
Parental Education	-	-		-0.12427

**significant parameter estimates (p<0.05)*

Compared to PQ Total score, PQ Free Play has a different relationship with our independent measurements when all confounding variables are included. In both males and females, when parental education is included in the final model, the significance of motor performance is removed. Therefore, when children have the same SES, comparable social competence and similar body composition within the same age group, their motor performance does not have a significant impact on their participation on free play activities. It can also be seen that when social competence is incorporated into the model, the parameter estimate of motor performance is reduce, indicating a greater role from social competence on participation in free play activities. By reviewing the adjusted R^2 values, it should be noted that adjusted R^2 slightly reduces when personal confounders are entered into the female model. This reflects that these variables may not be important for this relationship. However, the results were included to show their effect. In addition, when parental education was added, the adjusted R^2 was even further reduced, indicating its insignificant role on this relationship. Even though parental education removed the effect of motor performance on PQ Free Play, its inclusion in the model is not significant based on this reduction.

In the male model, the adjusted R^2 continually increased as more variables were included, as well as removing the effect of motor performance when parental education was included. This effect of parental education may be due to the fact that a more educated parent is aware of the health benefits from physical activity and will direct their children to be more active in free play where motor performance isn't as vital (Williams et al, 2002; Bailey, 2005; Parfitt & Eston, 2005). Also, due to their greater awareness on the health benefits, the parents' may be more physically active themselves, which has been shown to motivate their children into also being physically active (Kohl & Hobbs, 1998; Moore, Lombardi, White, Campbell, Oliveria & Ellison, 1991; Freedson & Everson, 1991). This effect only occurred in the male model, which may be influenced by the social worth that is highly recognized in school-aged children (Cairney et al, 2010). Again, the interaction terms to signify a moderating role were not significant, however the adjusted R^2 of the models did improve when the interaction term was added, specifying that social competence does play a role on the existing relationship. Table 13a and Table 13b illustrate the multiple regression models on PQ Organized Sports in males and females, respectively. The PQ Organized Sports measurement shows participation in more structured activities where the child's decision is not as dominant in these activities; a more authoritative figure, such as a parent or coach, decides whether they are participating in these activities or not. These activities include school sports teams, extracurricular teams, as well as intramural sports. Similar to the other PQ scores, by having a higher PQ Organized Sports score, it is interpreted as higher participation in physical activity in organized activities, where their capability to perform is more recognized.

Table 13a. Parameter estimates on PQ Organized Sports score in males.

	Model 1 (n=986)	Model 2 (n=986)	Model 3 (n=977)	Model 4 (n=620)
Intercept	1.22445*	-0.09489*	1.63231	2.18956
R^2	0.0751	0.1275	0.1283	0.1269
Adj R^2	0.0741	0.1257	0.1248	0.1197
Motor Performance	0.01160*	0.00953*	0.00901*	0.00791*
Social Competence	-	0.07455*	0.07340*	0.07629*
Age	-	-	-0.12168	-0.17767
BMI	-	-	-0.01065	-0.01325
Parental Education	-	-	-	0.05400*

**significant parameter estimates (p<0.05)*

Table 13b. Parameter estimates on PQ Organized Sports score in females.

	Model 1 (n=976)	Model 2 (n=976)	Model 3 (n=971)	Model 4 (n=623)
Intercept	1.52164*	0.27481	-0.04398	0.22174
R^2	0.0543	0.1124	0.1126	0.1041
Adj R^2	0.0533	0.1106	0.1090	0.0968
Motor Performance	0.00866*	0.00659*	0.00652*	0.00572*
Social Competence	-	0.07035*	0.07030*	0.06634*
Age	-	-	0.03013	0.01925
BMI	-	-	-0.00185	-0.00867
Parental Education	-	-	-	0.03897

**significant parameter estimates (p<0.05)*

Similar to PQ Total, motor performance and social competence remained significant indicators of participation in physical activity when all confounders were included, with this measure depicting the participation in organized sports. Similar to the previous models, the interaction terms were not statistically significant when included in the models, however they improved the adjusted R^2 in all cases, showing that social competence does play a role in this existing relationship. Furthermore, the addition of social competence reduced the parameter estimate of motor performance, indicating a more impactful role of social competence on participation in organized sports, parallel to PQ Total and PQ Free Play models. However, when parental education was included in the final males' model, it remained significant, unlike PQ Free Play.

4.5.0 Logistic Regression

Now that is has been established that motor performance and social competence independently play a role on physical activity participation, we will use our key measurements to illustrate the odds ratios of low participation in physical activity. We will use four sets of odds ratios to exemplify the moderating role of social competence on the existing relationship between motor performance and physical activity. Each set of odds ratios were compared with adjusted odds ratios with the previously discussed confounders which are age, BMI and SES. All odds ratios computed for confounders were not significant (Appendix F).

The first two sets of odds ratios will have motor performance and social competence as independent exposures. The purpose of these initial sets of odds ratios is to identify the individual exposures of our independent variables on physical activity participation. By displaying increased risk of low motor performance on lower participation in physical activity and increased risk of low social competence on lower participation in physical activity, this will display previous findings shown through literature (Cairney et al, 2010; Rovniak et al, 2002). Once we have established that our population displays the individual relationships discussed in literature, we can begin to show the moderating role that social competence plays. The third set will then classify our population into high or low motor performance, as well as high or low social competence. This set of odds ratios will show our moderating role of social competence at a preliminary glance. By showing the effect that social competence has in both high and low motor performance groups on physical activity participation, we can go beyond this point and become more precise as to which motor performance groups has the greatest risk of low participation in physical activity and how social competence affects this participation. The final set of odds ratios will extend the third set by using quartile groups for motor performance compared to a dichotomized measurement. These odds ratios will illustrate the moderating role of social competence by comparing the effect of high and low social competence on low participation in physical activity within each motor performance quartile.

4.5.1 Independent Odds Ratios on Low Participation in Physical Activity

In our first two sets of odds ratios, we have two independent exposures. One exposure is motor performance, where motor performance is in quartile groups with the 4th quartile group being the reference group ("high motor performance"). The second exposure is social competence, with z score cut off of less than 0 as low social competence and the reference group being high social competence (z score of equal to or greater than 0). Table 14 displays the odds ratios of low PQ Total score, unadjusted versus adjusted, in different motor performances.

Table 14. Odds ratios on low participation in total physical activity separated by gender and motor performance quartile.

Motor Performance	**MALES: Unadjusted**	**MALES: Adjusted***	**FEMALES: Unadjusted**	**FEMALES: Adjusted***
1st Quartile	2.850 (1.914 – 4.242)	2.972 (1.694 – 5.214)	2.117 (1.443 – 3.283)	1.910 (1.141 – 3.197)
2nd Quartile	1.998 (1.384 – 2.885)	1.811 (1.139 – 2.880)	1.454 (0.968– 2.184)	1.225 (0.758– 2.078)
3rd Quartile	1.441 (1.023 – 2.030)	1.368 (0.897– 2.089)	1.714 (1.138 – 2.581)	1.893 (1.134 – 3.161)
4th Quartile	1.00	1.00	1.00	1.00

**adjusted for age, BMI and SES.*

It is apparent that males are at risk of low participation in total physical activity when compared to the 4th motor performance quartile, prior to adjustments of confounders. However, once all confounders are taken into consideration, the 3rd quartile is no longer at risk of low participation levels. It can be said that when males in the 3rd motor performance are in the same age group, body composition and parents have similar education levels, they are no longer at risk of low participation in total physical activity when compared to the 4th motor performance quartile. It can also be seen that the risk of low participation in total physical activity is reduced if one has a higher motor performance quartile.

In contrast, females in the 2nd motor performance are at no increased odds of low participation in total physical activity compared to the 4th motor performance quartile, with comparable results after adjustments. This may be due to the similar levels of participation levels in females in the 2nd and 3rd motor performance quartiles, skewing our results. Unlike males, females risk of low participation in total physical activity in the 1st and 3rd motor performance quartile are similar to each other, indicating a not as significant motor performance role on total physical activity participation compared to male participation. Table 15 displays the odds ratios of low PQ Free Play, unadjusted versus adjusted, in different motor performances.

Table 15. Odds ratios on low participation in free play activities separated by gender and motor performance quartile.

Motor Performance	**MALES: Unadjusted**	**MALES: Adjusted***	**FEMALES: Unadjusted**	**FEMALES: Adjusted***
1st Quartile	1.340 (0.914 – 1.963)	1.380 (0.797 – 2.390)	1.255 (0.843 – 1.869)	1.051 (0.639 – 1.729)
2nd Quartile	1.341 (0.931 – 1.930)	1.463 (0.912 – 2.346)	0.902 (0.607 – 1.340)	0.749 (0.459 – 1.222)
3rd Quartile	1.042 (0.737 – 1.474)	1.125 (0.727 – 1.741)	1.014 (0.682 – 1.509)	1.059 (0.646 – 1.737)
4th Quartile	1.00	1.00	1.00	1.00

**adjusted for age, BMI and SES.*

Based on the motor performance odds ratios, it is clear that males and females are at no increased odds of low participation in free play activities when compared to the 4th motor performance quartile, even after adjusting for confounders. An explanation for this absent risk may be due to the fact that free play activities are based on the child's personal choice on participation; it doesn't matter how capable they are of being active, it is the child's own enjoyment that decides on whether they participate in free play activities or not, such as ice skating on the weekend or swimming at a neighborhood pool. Table 16 displays the odds ratios of low PQ Organized Sports, unadjusted versus adjusted, in different motor performances.

Table 16. Odds ratios on low participation in organized sports separated by gender and motor performance quartile.

Motor Performance	MALES: Unadjusted	MALES: Adjusted*	FEMALES: Unadjusted	FEMALES: Adjusted*
1st Quartile	3.841 (2.579– 5.721)	3.629 (2.077– 6.343)	2.950 (1.951 – 4.463)	3.256 (1.921 – 5.520)
2nd Quartile	2.509 (1.735 – 3.627)	2.395 (1.505 – 3.810)	2.240 (1.487 – 3.375)	2.330 (1.394 – 3.895)
3rd Quartile	1.857 (1.313 – 2.627)	1.665 (1.090 – 2.545)	1.896 (1.256 – 2.862)	2.466 (1.461– 4.162)
4th Quartile	1.00	1.00	1.00	1.00

**adjusted for age, BMI and SES.*

It is evident that both males and females are at risk of low participation in organized sports when compared to the 4th motor performance quartile, with this risk remaining after adjusting for confounders. Therefore, motor performance plays a large role in children's participation in organized sports. Similar to the risk of low participation in total physical activity in males, risk of low organized sport participation is reduced as one goes into a higher motor performance quartile in both genders. Table 17 displays the odds ratios of low participation in all physical activity measures, unadjusted versus adjusted, with low social competence.

Table 17. Odds ratios on low participation in each physical activity score in low social competence separated by gender.

	MALES: Unadjusted	MALES: Adjusted*	FEMALES: Unadjusted	FEMALES: Adjusted*
Total	2.710 (2.068 – 3.553)	2.818 (2.010 – 3.951)	2.705 (2.066 – 3.543)	2.559 (1.826 – 3.588)
Free Play	2.485 (1.907 – 3.237)	2.878 (2.049 – 4.042)	1.915 (1.473 – 2.489)	1.840 (1.325 – 2.556)
Organized Sports	2.259 (1.727 – 2.954)	2.203 (1.575 – 3.082)	2.132 (1.632 – 2.786)	2.225 (1.588 – 3.117)

**adjusted for age, BMI and SES.*

In all physical activity scores for males and females, low social competence leads to an increased risk of low participation in physical activity when compared to children of the same age, body composition and SES with high social competence. This is a significant finding as this is the central concept of this analysis. By illustrating that children at a lower social competence are at a significantly greater risk of low participation in any physical activity, this can be distributed through different motor performance scenarios to see its moderating effect on participation levels.

4.5.2 Dichotomized Exposures for Odds Ratios on Low Participation in Physical Activity

The third set of odds ratios takes our motor performance exposure and dichotomizes the quartiles into two groups: the 1st and 2nd motor performance quartile is 'low motor performance' with the 3rd and 4th quartiles being 'high motor performance'. These motor performance groups are then further combined with the social competence groups previously used in the second set of odds ratios. This leaves us with four groups: (1) low motor performance (MP) and low social competence (SC), (2) high MP and low SC, (3) low MP and high SC, and finally (4) high MP and high SC as our reference group. The purpose of this set of odds ratios is to show a simplified version of the moderating role of social competence between motor performance and physical activity. It has been previously shown that both motor performance and social competence significantly impact the odds of low participation levels, therefore these odds ratios will show the role that higher social competence plays on physical activity levels at different motor performance levels. Table 18 displays the odds ratios of low PQ Total score, unadjusted versus adjusted, with the three discussed MP and SC groups.

Table 18. Dichotomized exposures for odds ratios on low participation in total physical activity

	MALES: Unadjusted	**MALES: Adjusted***	**FEMALES: Unadjusted**	**FEMALES: Adjusted***
Low MP/ Low SC	5.473 (3.759 – 7.967)	5.294 (3.234 – 8.677)	3.359 (2.374 – 4.752)	2.597 (1.670 – 4.039)

Low MP/ High SC	2.627 (1.844– 2.743)	2.920 (1.902 – 4.483)	3.377 (2.209 – 5.163)	3.642 (2.109 – 6.290)
High MP/ Low SC	1.865 (1.312– 2.650)	1.855 (1.168 – 2.947)	1.470 (1.049 – 2.060)	1.314 (0.857 – 2.014)
High MP/ High SC	1.00	1.00	1.00	1.00

**adjusted for age, BMI and SES.*

When males are with low MP and low SC, they are at significantly greater odds of having low participation in total physical activity, even after adjusting for confounders and with this risk being less severe in females. However, when males are in the same motor performance group but with higher social competence, their odds are greatly reduced when compared to those with lower social competence. Although they are still at greater odds of having lower participation in total physical activity compared to those with high MP and high SC, they are not as much at risk anymore. Nevertheless, females are still at greater odds when they have higher social competence in the low motor performance group. It is important to note that when low MP and low SC group is compared with the low MP and high SC group in females, their odds ratios are very similar, indicating a minor change when social competence is improved. Therefore, for females, motor performance predicts odds of lower participation in total physical activity more than social competence. Finally, when compared to males with high MP and high SC, males with high MP but low SC are still at increased odds of low participation in total physical activity; however the effect is greatly reduced compared to those with low MP. Females with high MP and low SC have a slight increased odds of low participation in total physical activity. However, after adjusting for confounders, the risk is removed. It can therefore be said that for females with the same motor performance, age group, body composition and parental education, having lower social competence does not increase your odds of lower participation in total physical activity. Table 19 displays the odds ratios of low PQ Free Play, unadjusted versus adjusted, with the MP and SC groups.

Table 19. Dichotomized exposures for odds ratios on low participation in free play activities

	MALES: Unadjusted	**MALES: Adjusted***	**FEMALES: Unadjusted**	**FEMALES: Adjusted***
Low MP/ Low SC	3.194 (2.253 – 4.528)	3.748 (2.327– 6.037)	2.030 (1.450 – 2.843)	1.552 (1.008 – 2.387)
Low MP/ High SC	2.827 (1.978– 4.040)	3.272 (2.107– 5.080)	2.247 (1.487– 3.397)	2.236 (1.319 – 3.788)
High MP/ Low SC	1.501 (1.043– 2.159)	1.572 (0.962– 2.569)	1.162 (0.832 – 1.624)	0.965 (0.634– 1.469)
High MP/ High SC	1.00	1.00	1.00	1.00

**adjusted for age, BMI and SES.*

Just like PQ Total, when males have low MP and low SC, they are at significantly greater odds of having low participation in free play activities, even after adjusting for confounders, with this risk being smaller in females. This increased risk is also similar for both males and females in the same motor performance group but with higher social competence, with this risk being slightly reduced in males. This indicates that even males with low MP, by having a higher SC reduces the risk of low participation in free play activities. When it comes to children in the high MP and low SC group, there is only an increased odds of low participation in free play activities in males, prior to adjusting for confounders. Once confounders are taken into account, this risk is removed. In other words, males of the same motor performance, age group, body composition and parental education, low social competence will not increase their odds of low participation in free play activities. Females in the high MP and low SC group are at no increased odds of low participation in free play activities compared to females in the high MP and high SC group, prior to and after adjusting for confounders. Therefore, it can be said that children with low motor performance are at a significantly greater odds of low participation in free play activities. These odds are reduced by high social competence, and completely removed for children with higher motor performance, independent of their social competence. Table 20 displays the odds ratios of low PQ Organized Sports, unadjusted versus adjusted, with the MP and SC groups.

Table 20. Dichotomized exposures for odds ratios on low participation in organized sports

	MALES: Unadjusted	MALES: Adjusted*	FEMALES: Unadjusted	FEMALES: Adjusted*
Low MP/ Low SC	5.225 (3.617– 7.547)	4.938 (3.028– 8.055)	3.572 (2.521 – 5.062)	3.384 (2.162– 5.299)
Low MP/ High SC	2.143 (1.507– 3.047)	2.132 (1.395– 3.259)	2.529 (1.672– 3.823)	2.999 (1.763– 5.103)
High MP/ Low SC	2.061 (1.447– 2.937)	1.984 (1.249 – 3.150)	1.942 (1.385– 2.724)	1.939 (1.263 – 2.976)
High MP/ High SC	1.00	1.00	1.00	1.00

**adjusted for age, BMI and SES.*

The changes in odds ratios based on motor performance and social competence are very similar in males and females when comparing their odds of low participation in organized sports. For children in low MP and low SC, their odds of low participation in organized sports are very high when compared to children with high MP and high SC. This is expected as children with low motor performance are known to have lower participation levels in sports, as well as children with low social competence. With these two exposures together, their odds of low participation in organized sports are much greater. However, once either motor performance or social competence are improved to higher levels, the odds of low participation in organized sports greatly reduces when compared to children with high MP and high SC. More importantly, by improving a child's social competence, their risk of low participation in organized sports is reduced; the key focus for this investigation. This reduction was also shown in total physical activity participation, but not in free play activities. By illustrating this moderating effect that social competence plays in physically active environments, we can further display this relationship by expressing the motor performance in a more accurate measure in quartile form.

4.5.3 Motor Performance Quartiles for Odds Ratios on Low Participation in Physical Activity

The final set of odds ratios takes our motor performance exposure and separates them into the quartiles with the 4th quartile being 'high motor performance'. These motor performance quartiles are then further combined with the social competence groups previously used in the second and third sets of odds ratios. This leaves us with eight groups: (1) 1st MP quartile and low SC, (2) 2nd MP quartile and low SC, (3) 3rd MP quartile and low SC, (4) 4th MP quartile and low SC, (5) 1st MP quartile and high SC, (6) 2nd MP quartile and high SC, (7) 3rd MP quartile and high SC and our reference group of (8) 4th MP quartile and high SC. The purpose of this set of odds ratios is to expand on the previous odds ratios in a more specified environment that these children may be exposed to in order to again express the moderating role of social competence. From the previous odds ratios, it was shown that the relationship between motor performance and social competence on physical activity participation was clear in some cases, however, not as comprehensible in others. Therefore, these odds ratios will demonstrate how a quartile exposure of motor performance will further explain the relationship between motor performance, social competence and physical activity participation. Table 21 displays the odds ratios of low PQ Total score, unadjusted versus adjusted, with the seven stated groups.

Table 21. MP Quartiles with SC for odds ratios on low participation in total physical activity.

	MALES: Unadjusted	**MALES: Adjusted***	**FEMALES: Unadjusted**	**FEMALES: Adjusted***
1st MP/ Low SC	6.516 (3.812 – 11.141)	8.400 (3.896 – 18.108)	5.215 (3.010 – 9.035)	3.942 (1.991 – 7.806)
2nd MP/ Low SC	5.749 (3.414 – 9.682)	4.236 (2.213 – 8.107)	3.476 (2.005 – 6.027)	3.181 (1.633 – 6.197)
3rd MP/ Low SC	3.934 (2.381 – 6.500)	4.160 (2.263 – 7.647)	6.684 (3.470 – 12.875)	8.051 (3.488 – 18.583)
4th MP/ Low SC	2.155 (1.306 – 3.554)	2.246 (1.225 – 4.116)	2.556 (1.318 – 4.954)	2.755 (1.208 – 6.283)

1st MP/ High SC	2.852 (1.683 – 4.832)	2.505 (1.193 – 5.259)	2.330 (1.354 – 4.011)	2.369 (1.222 – 4.592)
2nd MP/ High SC	1.653 (1.029 – 2.657)	1.782 (0.982 – 3.234)	1.547 (0.908 – 2.636)	1.332 (0.690 – 2.572)
3rd MP/ High SC	1.262 (0.823 – 1.935)	1.121 (0.650 – 1.933)	1.451 (0.869 – 2.421)	1.621 (0.857 – 3.066)
4th MP/ High SC	1.00	1.00	1.00	1.00

**adjusted for age, BMI and SES.*

Again, all odds ratios are relative to children in the high motor performance (4th quartile) and high social competence (zero risk). It can be seen that both males and females, children in the 1st (lowest) motor performance quartile with low social competence have the greatest odds of low participation in total physical activity, with males having greater odds (8.400 and 3.942, respectively). In males, these odds are slightly reduced as the child moves up to the next motor performance quartile. In females, this relationship is not as clear with the 3rd motor performance quartile being at greater odds than the 1st and 2nd quartile for low participation in total physical activity. However, their odds ratios are within one other's confidence intervals after adjusting for confounders, therefore this difference is not significant. When children are considered as socially competent, the odds of low participation in total physical activity are greatly reduced when comparing between motor performances quartiles. Most importantly, once a child enters the 2nd motor performance quartile with high social competence, their odds of low participation in total physical activity are removed after adjusting for confounders. In other words, by having a higher social competence, children with poor motor performance are still able to meet adequate levels of participation in total physical activity. This effect is shown in both males and females with similar magnitudes. Table 22 displays the odds ratios of low PQ Free Play, unadjusted versus adjusted.

Table 22. MP Quartiles with SC for odds ratios on low participation in free play activities.

	MALES: Unadjusted	MALES: Adjusted*	FEMALES: Unadjusted	FEMALES: Adjusted*
1st MP/ Low SC	3.053 (1.874 – 4.976)	5.320 (2.624 – 10.786)	2.273 (1.354 – 3.816)	1.735 (0.908 – 3.315)
2nd MP/ Low SC	3.524 (2.161 – 5.746)	3.691 (1.914 – 7.116)	1.410 (0.835 – 2.382)	1.072 (0.570 – 2.016)
3rd MP/ Low SC	2.903 (1.776 – 4.747)	3.600 (1.938 – 6.687)	2.400 (1.315 – 4.381)	2.651 (1.239 – 5.672)
4th MP/ Low SC	2.906 (1.747 – 4.832)	4.035 (2.135 – 7.626)	1.579 (0.827 – 3.015)	1.323 (0.597 – 2.932)
1st MP/ High SC	1.716 (1.008 – 2.923)	1.298 (0.567 – 2.974)	1.152 (0.683 – 1.942)	0.924 (0.492 – 1.735)
2nd MP/ High SC	1.421 (0.870 – 2.322)	2.176 (1.154 – 4.100)	0.945 (0.567 – 1.575)	0.763 (0.409 – 1.420)
3rd MP/ High SC	1.059 (0.676 – 1.660)	1.354 (0.749 – 2.448)	0.837 (0.513 – 1.368)	0.788 (0.430 – 1.442)
4th MP/ High SC	1.00	1.00	1.00	1.00

**adjusted for age, BMI and SES.*

In males, a similar pattern occurs similar to total physical activity, with children in the 1st motor performance quartile and low social competence being at the greatest odds of having low participation in free play activities when compared to our reference group. Again, the odds of low participation are reduced when a child enters a higher motor performance quartile but remains in the low social competence group. However, the odds ratios in 4th motor performance quartile are higher than in the 3rd motor performance quartile, but this difference is not significant based on the confidence intervals. In females, the odds of low participation in free play activities are all not significant after adjusting for confounders, except when females are in the 3rd motor performance quartile group with low social competence. This outcome may be due to the females' personal choice to be active on their own time.

For socially competent males, the odds of low participation in free play activities are eliminated, except when they are in the 2nd motor performance quartile after adjusting for confounders. In other words, socially competent males with the same age, body composition, and SES are nearly twice as likely to have low participation in free play activities in the 2nd motor performance quartile compared to males in the 4th quartile. Therefore, although higher social competence does not remove the odds of having low participation, it greatly reduces their odds of 3.691 when these males of the 2nd quartile had low social competence to 2.176 when social competence was adequate. After controlling for confounders, the only odds ratios that was significant for females was those in the 3rd motor performance quartile with low social competence. However, socially competent females of the same motor performance quartile were not at greater odds. This illustrates the impact that social competence has on females who are at greater risk of low participation in free play activities, with lower social competence being a detriment on their participation in the 3rd motor performance quartile. Table 23 displays the odds ratios of low PQ Organized Sports, unadjusted versus adjusted.

Table 23. MP Quartiles with SC for odds ratios on low participation in organized sports

	MALES: Unadjusted	**MALES: Adjusted***	**FEMALES: Unadjusted**	**FEMALES: Adjusted***
1st MP/ Low SC	7.129 (4.195 – 12.113)	6.723 (3.211 – 14.077)	5.364 (3.087 – 9.321)	6.200 (3.028 – 12.695)
2nd MP/ Low SC	6.084 (3.635 – 10.181)	4.730 (2.452 – 9.121)	4.219 (2.412 – 7.379)	5.721 (2.827 – 11.576)
3rd MP/ Low SC	4.066 (2.465 – 6.708)	3.713 (2.033 – 6.781)	5.396 (2.860 – 10.182)	8.378 (3.678 – 19.080)
4th MP/ Low SC	1.716 (1.027 – 2.868)	1.418 (0.765 – 2.628)	1.865 (0.956 – 3.637)	2.888 (1.237 – 6.742)
1st MP/ High SC	3.808 (2.226 – 6.514)	3.014 (1.426 – 6.371)	3.085 (1.779 – 5.352)	4.450 (2.218 – 8.930)
2nd MP/ High SC	1.956 (1.205– 3.173)	1.908 (1.049– 3.471)	2.240 (1.311– 3.830)	2.602 (1.313 – 5.154)
3rd MP/ High SC	1.603 (1.035 – 2.482)	1.222 (0.707 – 2.112)	1.556 (0.926 – 2.615)	2.400 (1.227 – 4.693)

4th MP/ High SC	1.00	1.00	1.00	1.00

**adjusted for age, BMI and SES.*

Similar to total physical activity participation, it is clear that for both males and females, children in the 1st motor performance quartile and low social competence are at increased odds for low participation in organized sports when compared to the reference group, with males having similar odds as females (6.723 and 6.200, respectively) after adjusting for confounders. In males, these odds are slightly reduced as the child moves up the motor performance quartiles, with the odds being eliminated when males are in the 4th motor performance quartile with low social competence. In females, this relationship is not as clear with the 3rd motor performance quartile being at greater odds than the 1st and 2nd quartiles for low participation in organized sports. However, these odds ratios are within each other's confidence intervals after adjusting for confounders, therefore this difference is not significant. When children are considered socially competent, the odds of low participation in organized sports are greatly diminished regardless of motor performances quartiles. In both genders, the odds of low participation in organized sports are reduced to a great extent when they have higher social competence, with the odds of low participation being nonexistent when males are in the 3rd motor performance quartile.

Chapter 5: Discussion

5.1.0 Discussion

Through the use of ANOVA, t tests, multiple regression models and odds ratios, it has been made clear that social competence has an important role in regard to motor performance and physical activity. The ANOVA and t test results demonstrate that the higher your motor performance is and the more socially competent you are, participation in physical activity was higher. Through the use of multiple regression models, it is clear that motor performance and social competence are independent contributors to physical activity participation in both males and females, with social competence having a greater moderating effect in females of 17%, compared to males with 9%. This is likely due to the fact that motor performance is a more prominent factor for physical activity participation in males. This leaves males less room for social competence to ameliorate the risk of low physical activity participation due to motor performance's profound effect on their participation. Social competence has more room to play its positive role on physical activity participation in females since motor performance is not as essential in this gender's physical activity participation. Parental education was more important in the male model of free play activities as the adjusted R^2 increased when parental education was added, an event that did not occur in the female model. This reflects the role that parents' play in creating the social importance of being physically active, as a more educated parent would be more aware of the benefits and social worth of physical activity and therefore will promote physical activity more for their children. This is particularly beneficial for young males (Williams et al, 2002; Bailey, 2005; Parfitt & Eston, 2005; Trost et al, 1999).

Kohl & Hobbs (1998) established that children with lower motor performance are less likely to participate in physical activity. Nevertheless, with a more educated parent, the child is more motivated to becoming physically active due to the parenting styles influenced by their knowledge on the health benefits of physical activity, along with greater access to resources such as a safe neighborhood (CDC, 2011a; Trost et al, 2003; Estabrooks, Lee & Gyurcsik, 2003). Therefore, when referring to free play activities, motor performance is not as statistically significant when the child has a supportive parent. Unlike all other multiple regression models, when parental education was added to the male organized sports model, it remained significant. This can be related to the cost of extracurricular activities provided by the parents. If a child has a lower SES, this may limit opportunities for them to play in organized sports.

In this investigation, the motor performance and physical activity relationship was reflective in both total physical activity score and organized sports, yet there no increased odds of low participation in free play activities in lower motor performance quartiles in both genders. This may be due to fact that many studies using the PQ Free Play measure compare it based on DCD status rather than motor performance quartiles (Cairney et al, 2006a; Cairney et al, 2010). It was then expected that in children with the same motor performance, children with lower perceived social competence are less likely to achieve an adequate level of physical activity participation compared to those who perceive themselves as socially competent. Therefore, with the use of multiple regression and logistic regression, being socially competent was uncovered as a facilitator of physical activity in younger years, where we learn to adapt our healthy lifestyle choices. However, its impact on physical activity participation was not as strong in some cases. In particular, females had no increased odds of low participation in free play activities in any motor performance quartile, excluding the third quartile when referring to the final set of odds ratios. This may be due to personal factors including emotional or physical aspects of these children such as the child's perception of their motor capabilities to play with other children but to remain focused on the purpose of this study, other aspects of health were not taken into consideration.

It was demonstrated that children with lower motor performance also had increased odds of low participation in organized sports. This variable includes school teams, where coaches determine who is on the team; the child's personal choice to play on the sports team is only one of many factors in these environments. If a child does poorly in a try-out for a school team, this may transfer into their perception on participating on an intramural team where their confidence is reduced to join a team with other children. Therefore, when it comes to organized sport participation, motor performance is very important when it comes to a child's ability to play. This is because children with higher motor performances are more likely to make the team and subsequently to play more often during a game, based on their motor skills. In addition, by having a higher social competence, this does reduce the odds of low participation in children in the lower motor performance quartiles, although this does not eliminate the odds. On the other hand, the majority of final set of odds ratios remained significant after adjusting for confounders of age, BMI and SES, indicating the influential role of social competence on physical activity participation.

It has been well established that motor performance is highly associated with physical activity levels (Cairney et al, 2010), as well as a predictor of child's social competence in the classroom setting, where children are less socially desirable and have fewer friends compared to peers (Cantell et al, 1994). There have been minimal findings on the association between social competence and physical activity participation in children, with Jago et al (2011) recognizing that more social interactions enhance the participation of physical activity in childhood. Providing children with motor limitations a supportive social network could facilitate regular involvement in physical activity, reducing the burden on their health resulting from inactivity. Due to the limited awareness on the moderating role of social competence on the existing relationship between motor performance and physical activity, the main objective of this study was to fill in this research gap and highlight the importance of social competence in school-aged children.

The concept of why social competence has this effect on the relationship between motor performance and physical activity is imperative for this investigation. First off, lower motor performance has been associated with lower social competence; however, in our study population, the range of social competence scores were comparable between motor performance quartiles so this shows a possibility of adequate social competence in the lower motor performance quartiles, where a moderating role is capable of existing. In regards to physical activity, Rovniak et al (2002) recognized that a social support system, with its foundation being from high social competence, improves the child's ability to become or remain active. By having more active friends and family members, children are more likely to adapt healthy lifestyle choices, including physical activity participation

(Jago et al, 2011). However, due to the dissimilar social norms of males and females on being active (Donnelly & Hay, 1996; Trost et al, 1999), this support system may cause a different effect, with social competence expecting to alter boys' physical activity more than girls, particularly in organized sports. Compared to boys, girls have a wider range of activities where they can be socially competent including the dramatic arts, mathematics, or singing. However, the social expectation of boys is primarily in the physical activity spectrum, where boys who make the school's team and participate in intramural sports are more socially accepted with peers, aiding in the development of their social competence. When children are rejected from participating in physical activity with peers, the support system for a female would lead to greater support compared to males. Males' support system would pertain to more pressures on success in another approach for being active but a females' support system would act as a reassurance for being socially competent through other activities previously mentioned. Males are also more susceptible to the social expectation on being physically active than females, where failing to participate on a sports team leads to more judgment and negative social outcomes. According to computed odds ratios based on motor performance quartile and social competence (Table 23), social competence did have a greater impact on male participation in organized sports when compared to females, reflecting our anticipated results.

5.2.0 Study Limitations

All findings of this study should be viewed in terms of these limitations. Since this was a cross-sectional study design, there is inability to conclude a causation as there is no tracking of changes overtime. If a child modifies their motor performance or social competence overtime, will this change their odds of low participation in physical activity? Will social competence have as high of an effect in children in higher or lower grades? Nevertheless, this relationship has not been established in this age group, let alone any age group, and by recognizing that this interrelationship exists, further research can compare between grades to determine whether this relationship continues throughout the school-aged years.

Another limitation is the lack of information on ethnicity and pubertal stage, both recognized as confounders in previous literature (Estabrooks et al, 2003; Kohl & Hobbs, 1998). It is important for future research to address this limitation and understand the variation between pubertal stages and ethnicities.

Physical activity and social competence scores were self-reported where self-report bias may exist where children may alter their response to a more 'desirable' outcome. However, both of these questionnaires have been validated against other accepted measurement tools and are both reliable and valid methods in determining participation levels in physical activity and social competence in childhood (Hay, 1992; Harter, 1982). All children knew these responses would remain confidential; all responses were made independently of other children in the classroom, and trained research assistants moderated the classroom to ensure children were not sharing answers..

Finally, the dichotomization or categorization of all key components in our study eliminates the continuous nature of our variables. However, motor performance quartiles are commonly used for this measurement, and z scores maintain the continuous nature of our variables by using measures of central tendency to categorize the study population.

5.3.0 Conclusion

Social competence is recognized as a 'central organized construct of development' in many aspects including education, communication and occupation (Guralnick, 1990). Therefore, highlighting the importance of social competence interventions in school-aged children is crucial. Incredible Years® Parent Program is a great example of how these interventions should be conducted. This is a group based intervention method that aims to support and improve the social and emotional competence in childhood (Webster-Stratton, Gaspar & Seabra-Santos, 2012). It is a 22-week program that has been integrated into many cultures, signifying its transportability to other race/ethnic groups. It can be conducted as weekly or bi-weekly two-hour sessions with four to six children per group. These sessions use seven components of social competence (Webster-Stratton et al, 2012), including introduction and rules (where the child learns the structure and purpose of the intervention), empathy and emotion, problem solving, anger control, friendship skills, communication skills and school skills (Webster-Stratton & Reid, 2003). Interventions need to focus on personal, family-related and peer-related factors which all impact a different aspect of social competence.

Personal factors that need to be taken into account are emotional regulation, which may be altered based on motor performance and social exclusion related to motor performance (Guralnick, 1990). Children with lower social competence may have a higher temper, altered social cues and furthermore, an altered response, causing a downward spiral of inappropriate events (Beauchaine, Hinshaw, & Pang, 2010). All children react in different ways that need to be recognized prior to intervention. Family-related factors have recently been recognized as having a likelihood of preventing initial peer social competence issues. However, family intervention alone cannot be used to overcome poor social competence at this young age (Guralnick, 1990). Risk factors related to family is a ‘negative reinforcement pattern’, where there are high requests and demands on the child. This pattern has a high potential for poor social support system where healthy lifestyles are adapted from (Patterson & Fisher, 2002). Although both personal and family-related factors cannot be ignored when dealing with social competence, the most predominant factor of a school-aged child’s social competence is their peer interactions.

Peer-to-peer exchanges are a vital component in the development of social competence. The key factors of the peer-related component are appropriateness, including the context, culture and prior social experiences, and acceptance, the child’s need to be wanted in the classroom (Taylor & Asher, 1984). It has been shown that significant advantages occur in social development through group play, in both socially competent and incompetent children. Interventions aim for observational learning, where the peer-to-peer interactions are recognized and then replicated by the children themselves. Interventions on socially incompetent children are much more effective when these children are exposed to more socially competent peers, where proper social actions are performed for observation (Guralnick, 1990). This is an easy modification for school-aged children by not separating children into social groups, but randomizing as a whole. One risk factor that needs to be recognized when implementing social competence interventions is how socially incompetent children will manage their social behaviours around other socially incompetent peers (Webster-Stratton et al, 2012). Effective intervention needs to recognize the multiple risk factors including personal perceptions, family influences and peer interactions. One common barrier that children face in being physically active is parental resources (CDC, 2011a). Many low income families are unable to financially support their child with enrolment of various extracurricular activities including sports teams or clubs. Niagara Region Community Services oversees a program named ProKids® that supports the participation of children in sports, recreational or cultural activities who are in low income families (Niagara Region, 2013). The eligibility criteria includes Niagara resident, have children between the ages of 0 and 18, and have an annual taxable income below $40, 000. ProKids® provides annual payments to open more physical activity opportunities for underprivileged children, exposing them to more social environments with other children to build their social competence (Niagara Region, 2013). With this resource, early intervention can prevent a developmental curve leading to antisocial or unacceptable social behaviour in later years where intervention is not as successful (Webster-Stratton et al, 2012).

With implementation of social competence interventions in school-aged years, this can be expanded into physical education class where both free play activities and organized sports are applied. It has been shown through implementing physical education class into schools, children's' level of MVPA increased from 37.4% to 51.4% (Luepker et al, 1996). Intervention components can be related to more physical activity opportunities where children build an active support system to gain confidence and comfortability in being active with peers, as well as individual activity time following school hours. These opportunities also provide experiences where children can gain new friendships, which have been shown to positively influence one's social interactions (Glick & Rose, 2011); an aspect that directly improves one's perceived social competence (Cole et al, 2001). In comparison to females, a male's physical activity levels are more socially important. Males who are more physically active with peers are more socially accepted in the classroom, positively affecting their perceived social competence (Cairney et al, 2006a; Shin et al, 2011; Bailey, 2005; Parfitt & Eston, 2005). However, both genders are able to improve their social competence through the use of friendships, social interactions, and group activities (Glick & Rose, 2011).

In summary, social competence is a vital component in early childhood development and yet is under investigated. Lower social competence is an indication of lower social skills and interactions between peers, which are associated with elevated social anxiety and raised stress levels (Ali-Ali, Pratap, Singh & Smekal, 2011; Seeman, Singer, Ryff, Love & Levy-Storms, 2002). It is important for Public Health to recognize how essential social competence is at a young age and the role it plays in the adoption of healthy lifestyles (Shin et al, 2011). Based on the findings, higher social competence leads to higher participation in physical activity in all motor performance quartiles, emphasizing the role that social competence has on physical activity participation and healthy active living, despite the child’s motor performance.

References

Aber, J. L., Jones, S. M., Brown, J. L., Chaudry, N., & Samples, F. (1998). Resolving conflict creatively: evaluating the developmental effects of a school-based violence prevention program in neighborhood and classroom context. *Development and Psychopathology*, *10*, 187– 213.

Ajzen, I., & Fishbein, M. (1980). Understanding attitudes and predicting social behavior. Englewood-Cliffs, NJ: Prentice-Hall.

Ali-Ali, M.M., Pratap Singh, A. & Smekal, V. (2011). Social anxiety in relation to social skills, aggression, and stress among male and female commercial institute students. *Education*, *132 (2),* 351-361.

Anderson, S. & Messick, S. (1974). Social competency in young children. *Developmental Psychology*, *10(2),* 282-293.

Anis, A.H., Zhang, W., Bansback, N., Guh, D.P., Amarsi, Z. & Birmingham, C.L. (2010). Obesity and overweight in Canada: an updated cost-of-illness study. *Obesity Reviews*, *11*, 31-40. DOI: 10.1111/j.1467-789X.2009.00579.x.

Azevedo, M.R., Araújo, C.L., Cozzensa da Silva, M. & Hallal, P.C. (2007). Tracking of physical activity from adolescence to adulthood: a population-based study. *Revista de Saúde Pública, 41(1),* 69-75.

Baerg, S., Cairney, J., Hay, J., Rempel, L., Mahlberg, N. & Faught, B.E. (2011). Evaluating physical activity using accelerometry in children at risk of developmental coordination disorder in the presence of attention deficit hyperactivity disorder. *Research in Developmental Disabilities, 32(4),* 1343-1350.

Bailey, R. (2005). Evaluating the relationship between physical education, sport and social inclusion. *Educational Review, 57(1),* 71-90.

Baranowski, T., Thompson, W.O., DuRant, R.H., Baranowski, J. & Puhl, J. (1993). Observations on physical activity in physical locations: Age, gender, ethnicity, and month effects. *Research Quarterly for Exercise and Sport, 64(2),* 127-133.

Barnett, L.M., van Beurden, E., Morgan, P.J., Brooks, L.O. & Beard, J.R. (2008). Does childhood motor skill proficiency predict adolescent fitness? *Medicine & Science in Sports & Exercise, 40(12),* 2137-2144. DOI: 0.1249/MSS.0b013e31818160d3

Barnett, L.M., van Beurden, E., Morgan, P.J., Brooks, L.O. & Beard, J.R. (2009). Childhood motor skill proficiency as a predictor of adolescent physical activity. *Journal of Adolescent Health, 44,* 252-259. DOI: 10.1016/j.jadohealth.2008.07.004

Barnhart, R.C., Davenport, M.J., Epps, S.B. & Norsquist, V.M. (2003). Developmental coordination disorder. *Physical Therapy, 83,* 722-731.

Bar-Or, O. & Rowland, T.W. (2004) Habitual activity and energy expenditure in the healthy child. In Robertson, L.D. (Eds.), Pediatric Exercise Medicine (pp.61-62). Champaign, IL: Sheridan Books.

Bassett, D.R.J., Ainsworth, B.E., Leggett, S.R., Mathien, C.A., Main, J.A., Hunter, D.C., et al. (1996). Accuracy of five electronic pedometers for measuring distance Q4 walked. *Medicine & Science in Sports & Exercise, 28(8),* 1071–1077.

Beauchaine, T. P., Hinshaw, S. P., & Pang, K. L. (2010). Comorbidity of attention - deficit/hyperactivity disorder and early-onset conduct disorder: Biological, environmental, and developmental mechanisms. *Clinical Psychology: Science and Practice, 17*, 327-336.

Berenson, G.S., Srinivasan, S.R., Bao, W., Newman III, W.P., Tracy, R.E. & Wattigney, W.A. (1998). Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. *New England Journal of Medicine, 338*, 1650-1656.

Boreham, C. & Riddoch, C. (2001). The physical activity, fitness and health of children. *Journal of Sports Sciences, 19*, 915-929.

Boreham, C.A., Twisk, J., Murray, L., Gallagher, A. & Savage, M. (2003). Relationships between aerobic fitness, physical activity and arterial compliance in young adults. *Medicine & Science in Sports & Exercise, 35*, S72.

Broadhead, W.E., Kaplan, B.H., James, S.A., Wagner, E.H., Schoenbach, V.J., Grimson, R., et al (1983). The epidemiological evidence for a relationship between social support and health. *American Journal of Epidemiology, 117(5)*, 521-537.

Buhrmester, D., & Furman, W. (1986). The changing function of friends in childhood. A eo-Sullivanian perspective. In V. Derlega & B. Winstead (Eds.). Friendship and social interaction (pp. 41-62). N.Y.: Springer-Verlag.

Cairney, J., Hay, J., Faught, B.E., Corna, L.M. & Flouris, A.D. (2006a). Developmental coordination disorder, age, and play: A test of the divergence in activity-deficit with age hypothesis. *Adapted Physical Activity Quarterly, 23*, 261-276.

Cairney, J., Hay, J.A., Faught, B.E., Flouris, A. & Klentrou P. (2007a). Developmental coordination disorder and cardiorespiratory fitness in children. *Pediatric Exercise Science, 19(1)*, 20-28.

Cairney, J., Hay, J.A., Faught, B.E. & Hawes, R. (2005b). Developmental coordination disorder and overweight and obesity in children aged 9-14 y. *International Journal of Obesity, 29*, 389-372. DOI: 10.1038/sj.ijo.0802893.

Cairney, J., Hay, J.A., Faught, B.E., Wade, T.J., Corna, L. & Flouris, A. (2005a). Developmental coordination disorder, generalized self-efficacy toward physical activity, and participation in organized and free play activities. *Journal of Pediatrics, 147*, 515-520.

Cairney, J., Hay, J., Mandigo, J., Wade, T., Faught, B.E. & Flouris, A. (2007b). Developmental coordination disorder and reported enjoyment of physical education in children. *European Physical Education Review*, 13(1), 81-89. DOI: 10.1177/1356336X07072678.

Cairney, J., Hay, J., Veldhuizen, S. & Faught, B.E. (2010). Trajectories of cardiorespiratory fitness with and without developmental coordination disorder: a longitudinal analysis. *British Journal of Sports Medicine, 45,* 1196-1201. DOI: 10.1136/1196bjsm.2009.069880

Cairney, J., Hay, J., Veldhuizen, S., Missiuna, C. & Faught, B.E. (2009a). Comparing probable case identification of developmental coordination disorder using the short form of the Bruininks-Oseretsky Test of Motor Proficiency and the Movement ABC. *Child: Care, Health and Development, 35 (3),* 402-408. DOI:10.1111/j.1365-2214.2009.00957.x

Cairney, J., Hay, J.A., Veldhuizen, S., Missiuna, C. & Faught, B.E. (2009b). Developmental coordination disorder, sex, and activity deficit over time: a longitudinal analysis of participation trajectories in children with and without coordination difficulties. *Developmental Medicine and Child Neurology, 52*, e-67-e72. DOI: 10.1111/j.1469-8749.2009.03520.x

Cairney, J., Hay, J.A., Wade, T.J., Faught, B.E. & Flouris, A. (2006b). Developmental coordination disorder and aerobic fitness: Is it all in their heads or is measurement still the problem? *American Journal of Human Biology, 18*, 66-70. DOI: 10.1002/ajhb.20470.

Cantell, M.H., Smyth, M.M., & Ahonen, T.P. (1994) Clumsiness in adolescence: Educational, motor and social outcomes of motor delay detected at 5 years. *Adapted Physical Activity Quarterly, 11*, 115-129.

Cardiovascular diseases (CVD) (2012). In World Health Organization. Retrieved from: http://www.who.int/cardiovascular_diseases/en/

Catalano, R.F., Mazza, J.J., Harachi, T.W., Abbott, R.D., Haggerty, K.P. & Fleming, C.B. (2003). Raising healthy children through enhancing social development in elementary school: Results after 1.5 years. *Journal of School Psychology, 41*, 143-164. DOI :10.1016/S0022-4405(03)00031-1

Cole, D.A., Jacquez, F.M., & Maschman, T.L. (2001). Social origins of depressive cognitions: A longitudinal study of self-perceived competence in children. *Cognitive Therapy and Research, 25(4)*, 377-395.

Coleman, R., Piek, J.P. & Livesey, D.J. (2001) A longitudinal study of motor ability and kinaesthetic acuity in young children at risk of developmental coordination disorder. *Human Movement Science, 20(1–2),* 95–110.

Cote, S., Zoccolillo, M., Tremblay, R. E., Nagin, D., & Vitaro, F. (2001). Predicting girls' conduct disorder in adolescence from childhood trajectories of disruptive behaviors. Journal of the American Academy of Child and Adolescent Psychiatry, 40, 678–684.

Cousins, M. & Smyth, M.M. (2003). Developmental coordination impairments in adulthood. *Human Movement Science, 22*, 433-459. DOI: 10.1016/j.humov.2003.09.003

Crawford, S.G., Wilson, B.N. & Dewey, D. (2001). Identifying developmental coordination disorder: Consistency between tests. *Physical & Occupational Therapy in Pediatrics, 20(2-3),* 29-50.

Daniels, S.R., Greer, F.R. & Committee of Nutrition (2008). Lipid screening and cardiovascular health in childhood. *Pediatrics, 122,* 198-208. DOI: 10.1542/peds.2008-1349

Davis-Kean, P.E. (2005). The influence of parent education and family income on child achievement: The indirect role of parental expectations and home environment. *Journal of Family Psychology, 19(2),* 294-304. DOI: 10.1037/0893-3200.19.2.294

Dewey, D., Kaplan, B.J., Crawford, S.G. & Wilson, B.M. (2002). Developmental coordination disorder: Associated problems in attention, learning, and psychosocial adjustment. *Human Movement Science, 21*, 905-918. DOI: 10.1016/S0167-9457(02)00163-X.

Dodge, K.A., Pettit, G.S., McClaskey, C.L., Brown, M.M. & Gottman, J.M. (1986). Social competence in children. *Monographs of the Society for Research in Child Development*, *51(2),* i+iii+v-vi+1-86.

Donnelly, P. & Hay, J. (1996) Sorting out the boys from the girls: teacher and student perception of student physical ability. *Avante, 2 (1),* 36-52.

Early Childhood Development (2012). In World Health Organization. Retrieved from http://www.who.int/mediacentre/factsheets/fs332/en/.

Eckel, R.H. & Krauss, R.M. (1998). American Heart Association call to action: Obesity as a major risk factor for coronary heart disease. *Circulation, 97*, 2099-2100. DOI: 10.1161/01.CIR.97.21.2099.

Epstein, L.H., Valoski, A.M., Vara, L.S., McCurley, J., Wisniewski, L., Kalarchian, M.A., et al (1995). Effects of decreasing sedentary behaviour and increasing activity on weight change in obese children. *Health Psychology, 14*, 109-115.

Estabrooks, P.A., Lee, R.E. & Gyurcsik, N.C. (2003). Resources for physical activity participation: Does availability and accessibility differ by neighbourhood socioeconomic status? *Annals of Behavioural Medicine*, *25(2),* 100-104.

Evans, J., & Roberts, G.C. (1987). Physical competence and the development of children's peer relations. *Quest*, *39*, 23-35.

Factors Influencing Health (2012). In Canadian Institute for Health Information. Retrieved from http://www.cihi.ca/CIHI-extportal/internet/EN/Theme/factors+influencing+health/cihi010677. Accessed [May 29, 2012].

Faircloth, B.S. & Hamm, J.V. (2011), The dynamic reality of adolescent peer network and sense of belonging. *Merrill-Palmer Quarterly, 57(1),* 48-72.

Flegel, J. & Kolobe, T.H.A. (2002). Predictive validity of the test of infant motor performance as measured by the Bruininks-Oseretsky Test of Motor Proficiency at school age. *Physical Therapy, 82*, 762-771.

Foulkes, M.A. & Davis, C.E..(1981) An index of tracking for longitudinal data. *Biometrics, 37,*439–46.

Freedson, P.S. & Everson, S. (1991). Familial aggregation in physical activity. *Research Quarterly for Exercise and Sport, 62(4),* 384-389.

Fuentes, R.M., Notkola, I.L., Shemeikka, S., Tuomilehto, J. & Nissinen A. (2003). Tracking of body mass index during childhood: A 15-year prospective population-based family study in eastern Finland. *International Journal of Obesity*, *27*, 716-721. DOI: 10.1038/sj.ijo.0802271.

Garmezy, N., Masten, A.S. & Tellegen, A. (1984) The study of stress and competence in children: A building block for Developmental Psychopathology. *Child Development*, *55*, 97-111. URL: http://www.jstor.org/stable/1129837

Glick, G.C. & Rose, A.J. (2011). Prospective associations between friendship adjustment and social strategies: Friendship as a context for building social skills. *Developmental Psychology, 47(4),* 1117-1132. DOI: 10.1037/a0023277

Gordon-Larsen, P., Nelson, M.C. & Popkin, B.M. (2004). Longitudinal physical activity and sedentary behaviour trends. *American Journal of Preventive Medicine, 27(4)*, 277-283. DOI: 10.1016/j.amepre.2004.07.006.

Green, D., Lingam, R., Mattocks, C., Riddoch, C., Ness, A. & Emond, A. (2011). The risk of reduced physical activity in children with probable developmental coordination disorder: A prospective longitudinal study. *Research in Developmental Disabilities, 32,* 1332-1342. DOI: 10.1016/j.ridd.2011.01.040.

Greenberg, M.T. & Kusché, C.A. (1998). Preventive intervention for school-age deaf children: The PATHS curriculum. *Journal of Deaf Studies and Deaf Education, 3(1),* 49-63.

Gunnell, D.J., Frankel, S.J., Nanchahal, K., Peter, T.J. & Smith, G.D. (1998) Childhood obesity and adult cardiovascular mortality: a 57-y follow up study based on the Boyd Orr cohort. *American Journal of Clinical Nutrition, 67,* 1111-1118.

Guo, S.S. & Chumlea, W.C. (1999). Tracking of body mass index in children in relation to overweight in adulthood. American Journal of Clinical Nutrition, 70, 145S-148S.

Guralnick, M.J. (1990). Social Competence and Early Intervention. *Journal of Early Intervention, 14 (1),* 3-14.

Gutin, B., Yin, Z., Humphries, M.C. & Barbeau, P. (2005). Relations of moderate and vigorous physical activity to fitness and fatness in adolescents. *American Journal of Clinical Nutrition, 81,* 746-750.

Halberstadt, A.G., Denham, S.E. & Dunsmore, J.C. (2001). Affective Social Competence. *Social Development, 10(1)*, 79-119.

Hands, B. P., Larkin, D., Parker, H., Straker, L., & Perry, M. (2008). The relationship between physical activity, motor competence and health-related fitness in 14-year-old adolescents. *Scandinavian Journal of Medicine and Science in Sports, 19(5),* 655–663. DOI: 10.1111/j.1600-0838.2008.00847.x.

Harter, S. (1982). The Perceived Competence Scale for Children. *Child Development, 53(1),* 87-97.

Harter, S. (1988). Manual for the Self-Perception Profile for Adolescents. Denver: University of Denver.

Haubenstricker, J. & Seefeldt, V. (1986). Acquisition of motor skills during childhood. In Reston, V. (Eds.) Physical Activity and Well-Being (pp. 41-92). Reston, VA: AAHPERD.

Hay, J. A. (1992). Adequacy in and Predilection for Activity. *Clinical Journal of Sport Medicine*, 2(3), 192-201.

Hay J. & Missiuna, C. (1998) Motor proficiency in children reporting low levels of participation in physical activity. *Canadian Journal of Occupational Therapy, 65,* 64–71.

Haywood, K. (1986) Motor milestones: The pathway to voluntary movements. In Patterson Wright, J., Schwarzentraub, M., Fritz, K.G. & Gleeson, N. (Eds.), Life span motor development (pp.101-106). Champaign, IL: Human Kinetics Publishers.

Henderson, S.E. & Sugden, D.A. (1992). Movement Assessment Battery for Children. Sidcup, Kent: The Psychological Corporation.

Howes, C. (1983). Patterns of friendship. *Child Development, 54,* 1041–1053. DOI:10.2307/1129908

Hunter, G.R., Weinsier, R.L., Bamman, M.M. & Larson, D.E. (1998). A role for high intensity exercise on energy balance and weight control. *International Journal of Obesity and Related Metabolic Disorders, 22(6),* 489-493.

Ikeda, J.P., Crawford, P.B. & Woodward-Lopez, G. (2006). BMI screening in schools: helpful or harmful. *Health Education Research, 21 (6),* 761-769.

Jaffe, M., Tirosh, E., Cohen, A. & Taub, Y. (1988). Relationship between joint hypermobility and motor development in early life. *Archives of Disease in Childhood, 63,* 153-161.

Jago, R., Macdonald-Wallis, K., Thompson, J.L., Page, A.S., Brockman, R. & Fox, K.R. (2011). Better with a buddy: Influence of best friends on children's physical activity. *Official Journal of the American College of Sports Medicine, 43(2),* 259-265. DOI: 10.1249/MSS.0b013e3181edefaa.

Jansen, A.C.M., van Aalst-Cohen, E.S., Tanck, M.W., Trip, M.D., Lansberg, P.J., Liem, A.H., et al (2004). The contribution of classical risk factors to cardiovascular disease in familial hypercholesterolemia: data in 2400 patients. *Journal of Internal Medicine, 256,* 482-490.

Janz, K.F., Dawson, J.D. & Mahoney, L.T. (2000) Tracking physical fitness and physical activity from childhood to adolescence: the Muscatine study. *Medicine & Science in Sports & Exercise, 32(7),* 1250-1257.

Kavey, R.W., Allada, V., Daniels, S.R., Hayman, L.L., McCrindle, B.W., Newburger, J.W., et al (2006). Cardiovascular risk reduction in high-risk pediatric patients: A scientific statement from the American Heart Association expert panel on population and prevention science; the Councils on Cardiovascular Disease in the Young, Epidemiology and Prevention, Nutrition, Physical Activity and Metabolism, High Blood Pressure Research, Cardiovascular Nursing, and the Kidney in Heart Disease; and the Interdisciplinary Working Group on Quality of Care and Outcomes Research: Endorsed by the American Academy of Pediatrics. *Circulation, 114*, 2710-2738. DOI: 10.1161/CIRCULATIONAHA.106.179568.

Kemper, H.C.G, Vente, D.E., van Mechelen, W. & Twisk, J.W.R. (2001). Adolescent motor skill and performance: Is physical activity in adolescence related to adult physical fitness? *American Journal of Human Biology, 13,* 180-189.

Kim, J., Kaye, J. & Wright, L.K. (2001). Moderating and mediating effects in causal models. *Issues in Mental Health Nursing, 22*, 63-75.

Klesges, R.C., Eck, L.H., Hanson, C.L., Haddock, C.K. & Klesges, L.M. (1990). Effects of obesity, social interactions and physical environment on physical activity in preschool. *Health Psychology, 9(4),* 435-449.

Kohl III, H.W. & Hobbs, K.E. (1998) Development of physical activity behaviours among children and adolescents. *Pediatrics, 101,* 549-554.

Lamborn, S.D., Mounts, N.S., Steinberg, L. & Dornbusch, S.M. (1991). Patterns of Competence and Adjustment among Adolescents from Authoritative, Authoritarian, Indulgent, and Neglectful Families. *Child Development, 62 (5),* 1049-1065.

Lee, A., Hankin, B.L. & Mermelstein, R.J. (2010). Perceived social competence, negative social interactions and negative cognitive style predict depressive symptoms during adolescence. *Journal of Clinical Child & Adolescent Psychology, 39(5),* 603-615. DOI: 10.1080/15374416.2010.501284

Lingam, R., Golding, J., Johnmans, M.J., Hunt, L.P., Ellis, M. & Emond, A., (2010). The association between developmental coordination disorder and other developmental traits. *Pediatrics, 126,* e1109-e1118. DOI: 10.1542/peds.2009-2789.

Lingam, R., Hunt, L., Golding, J., Jongmans, M. & Emond, A. (2009). Prevalence of developmental coordination disorder using the DSM-IV at 7 years of age: A UK Population-based study. *Pediatrics, 123*, e693-e700. DOI: 10.1542/peds.2008-1770.

Liu, J., Wade, T., Faught, B.E. & Hay, J. (2008). Physical inactivity in Canada: Results from the Canadian Community Health Survey Cycle 2.2 (2004-2005). *Public Health, 122,* 1384-1386. DOI: 10.1016/j.puhe.2008.05.007.

Lopes, V.P., Rodrigues, L.P., Maia, J.A. & Malina, R.R. (2009). Motor coordination as predictor of physical activity in childhood. *Scandinavian Journal of Medicine and Science in Sports, 21(5),* 663-669.

Losse, A., Henderson, S.E., Elliman, D., Hall, D., Knight, E & Jongmans, M. (1991). Clumsiness in children: do they grow out of it? A 10-year follow-up study. *Developmental Medicine and Child Neurology, 33*, 55– 68.

Luepker, R.V., Perry, C.L., McKinlay, S.M., Nader, P.R., Parcel, G.S., Stone, E.J., et al. (1996). Outcomes of a field trial to improve children's dietary patterns and physical activity. The child and adolescent trial for cardiovascular health. *American Medical Association, 275,* 768–776.

Macera, C.A., Ham, S.A., Yore, M.M., Jones, D.A., Ainsworth, B.E., Kimsey, C.D., et al (2005). Prevalence of physical activity in the United States: Behavioral Risk Factor Surveillance System, 2001. *Preventing Chronic Disease, 2(2),* 1-10. URL: http://www.cdc.gov/pcd/issues/2005/apr/04_0114.htm. Accessed [May 23, 2012]

Malina, R.M. (2001). Physical activity and fitness: Pathways from childhood to adulthood. *American Journal of Human Biology, 13,* 162-172.

McEwen, B.S. (2008). Central effects of stress hormones in health and disease: understanding the protective and damaging effects of stress and stress mediators. *European Journal of Pharmacology, 583 (2-3)*, 174-185.

McGuire, K. D., & Weisz, J. R. (1982). Social cognition and behavioral correlates of preadolescent chumship. *Child Development, 53*, 1478–1484.

Meece, D. & Mize, J. (2010). Multiple aspects of preschool children's social cognition: relations with peer acceptance and peer interaction style. *Early Child Development and Care, 180(5)*, 585-604. DOI: 10.1080/03004430802181452.

Mitchell, J.A., Mattocks, C., Ness, A.R., Leary, S.D., Pate, R.R., Dowda, M., et al (2009). Sedentary behaviour and obesity in a large cohort of children. *Obesity, 17*, 1596-1602. DOI: 10.1038/oby.2009.42.

Miyahara, M. & Clarkson, J. (2005). Concurrent validity of selected movement skill items in the New Zealand Ministry of Education's Health and Physical Education Assessment. *Australian Journal of Educational & Developmental Psychology, 5*, 32-39.

Mokdad, A.H., Marks, J.S., Stroup D.F. & Gerberding, J.L. (2004). Actual causes of death in the United States, 2000. *American Medical Association, 291(1),* 1238-1245.

Monteiro, C.A., Conde, W.L., Matsudo, S.M., Matsudo, V.R., Bonsenor, I.M. & Lotufo, P.A.(2003). A descriptive epidemiology of leisure-time physical activity in Brazil, 1996-1997. *Rev Panam Salud Publica, 14,* 246-254.

Moore, L.L., Lombardi, D.A., White, M.J., Campbell, J.L., Oliveria, S.A., & Ellison, R.C. (1991). Influence of parents' physical activity levels on activity levels of young children. *Journal of Pediatrics, 118,* 215-219.

Mora, S., Cook, N., Buring, J.E., Ridker, P.M. & Lee, I. (2007). Physical activity and reduced risk of cardiovascular events: Potential mediating mechanisms. *Circulation, 116,* 2110-2118. DOI: 10.1161/CIRCULATIONAHA.107.729939.

Newman, D.L., Sontag, L.M. & Salvato, R. (2006). Psychosocial aspects of body mass and body image among rural American Indian adolescents. *Journal of Youth and Adolescents, 35,* 281-291. DOI: 10.1007/s10964-005-9011-8.

Non-medical determinants of health (2002). In Statistics Canada. Retrieved from http://www.statcan.gc.ca/pub/82-221-x/2012001/def/def2-eng.htm. Accessed [May 21, 2012].

Okely, A.D., Booth, M.L. & Patterson, J.W. (2001). Relationship of physical activity to fundamental movement skills among adolescents. *Medicine & Science in Sports & Exercise, 33(11),* 1899-1904.

Osika, W., Montgomery, S.M (2008). Physical control and coordination in childhood and adult obesity among members of a longitudinal birth cohort. *British Medical Journal, 337*, a699. DOI: 10.1136/bmj.a699.

Palmen, H., Vermande, M.M., Deković, M. & van Aken, M.A.G. (2011). Competence, problem behaviour, and the effects of having no friends, aggressive friends, or nonaggressive friends. *Merrill-Palmer Quarterly, 57(2),* 186-213.

Parfitt, G. & Eston, R.G. (2005). The relationship between children's habitual activity levels and psychological well-being. *Acta Pediatrica, 94*, 1791-1797. DOI: 10.1080/08035250500268266.

Patterson, G.R., & Fisher, P.A. (2002). Recent developments in our understanding of parenting: Bidirectional effects, causal models, and search for parsimony. In M.H. Bornstein (Ed.), *Handbook of Parenting: Practical Issues in Parenting, Vol 5,* (pp. 59-88). Mahwah, NJ: Erlbaum.

Patterson, P., Wiksten, D.L. & Ray, L. (1996). The validity and reliability of the back saver sit-and-reach test in middle school girls and boys. *Research Quarterly of Exercise & Sports, 67*, 488.

Petrolini, N., Iughetti, L. & Bernasconi, S. (1995). Difficulty in visual motor coordination as a possible cause of sedentary behaviour in obese children. *International Journal of Obesity and Related Metabolic Disorders, 19*, 928.

Physical Activity for Everyone: Overcoming Barriers to Physical Activity. (2011a). In Centre of Disease Control and Prevention. Retrieved from http://www.cdc.gov/physicalactivity/everyone/getactive/barriers.html. Accessed [May 28, 2012].

Physical Activity for Levels of High School Students – United States, 2010. (2011b). In Centre of Disease Control and Prevention. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6023a1.htm?s_cid=mm6023a1_w . Accessed [May 26, 2012].

Piek, J.P., Drowcan, M., Barrett, N.C. & Coleman R. (2000). Determinants of self-worth in children with and without developmental coordination disorder. *International Journal of Disability, Development and Education, 47*, 259-272.

Puyau, M.R., Adolph, A.L., Vohra, F.A. & Butte, N.F. (2002). Validation and calibration of physical activity monitors in children. *Obesity Research, 10(3),* 150-157.

Raitakari, O.T., Juonala, M., Kähönen, M., Taittonen, L., Laitinen, T., Mäki-Torkko, N., et al (2003). Cardiovascular risk factors in childhood and carotid artery intima-media thickness in adulthood: The cardiovascular risk in Young Finns study. *American Medical Association, 290(17),* 2277-2283.

Reid, D. (1987). Occupational therapists' assessment practices with handicapped children in Ontario. Canadian Journal of Occupational Therapy, 54, 181–188.

Reynolds, K.D., Killen, J.D., Bryson, S.W., Maron, D.J., Taylor, C.B., Maccoby, N. et al (1990). Psychosocial predictors of physical activity in adolescents. *Preventive Medicine, 19(5),* 541-551.

Rivilis, I., Hay, J., Cairney, J., Klentrou, P., Liu, J. & Faught, B.E. (2011). Physical activity and fitness in children with developmental coordination disorder: A systematic review. *Research in Developmental Disabilities, 32,* 894-910. DOI: 10.1016/j.ridd.2011.01.017.

Rivilis, I., Liu, J., Cairney, J., Hay, J., Klentrou, P. & Faught, B.E. (2012). A prospective cohort study comparing workload in children with and without developmental coordination disorder. *Research in Developmental Disabilities, 33*, 442-448. DOI: 10.1016/j.ridd.2011.09.027

Rolland-Cachera, M., Deheeger, M., Bellisle, F., Sempé, M., Guilloud-Bataille, M., & Patois, E. (1983). Adiposity rebound in children: a simple indicator for predicting obesity. *American Journal of Clinical Nutrition, 29*, 129-135.

Rose, B., Larkin, D. & Berger, B. (1997). Coordination and gender influences on perceived competence in children. *Adapted Physical Activity Quarterly, 14,* 210-221.

Ross, J.G. (1987) National Children and Youth Fitness Study II 1987. *Journal of Physical Education, Recreation and Dance, 58(9),* 49-96.

Ross, J.G., Dotson, C.O., Gilbert, G.G. & Katz, S.J. (1985). What are kids doing in school physical education? *Journal of Physical Education, Recreation and Dance, 56*, 31–34.

Rovniak, L.S., Anderson, E.S., Winett, R.A. & Stephens, R.S. (2002). Social cognitive determinants of physical activity in young adults: A prospective structural equation analysis. *Annals of Behavioural Medicine, 24(2)*, 149-156.

Rowland, T.W., Rambusch, J.M., Staab, J.S., Unnithan, V.B. & Siconolfi, S.F. (1993). Accuracy of physical working capacity (PWC170) in estimating aerobic fitness in children. *Journal of Sports Medicine and Physical Fitness, 33*. 184-188.

Sallis, J.F., McKenzie, T.L. & Alcaraz, J.E. (1993). Habitual physical activity and health-related physical fitness in fourth-grade children. *American Journal of Diseases of Children, 147*, 890-896.

Salo, P., Viikari, J., Hämäläinen, M., Lapinleimu, H., Routi, T., Rönnemaa, T., et al (1999). Serum cholesterol ester fatty acids in 7- and 13-month-old children in a prospective randomized trial of a low-saturated fat, low-cholesterol diet: the STRIP baby project. *Acta Paediatrica, 88*, 505-512.

Schoemaker, M.M. & Kalverboer, A.F. (1994). Social and affective problems of children who are clumsy: How early do they begin? *Adapted Physical Activity Quarterly, 11*, 130-140.

Seeman, T.E., Singer, B.G., Ryff, C.D., Dienberg Love, C. & Levy-Storms, L. (2002). Social relationships, gender, and allostatic load across two age cohorts. *Psychosomatic Medicine, 64*, 395-406.

Semrud-Clikeman, M. (2007). Social Competence in Children. In Springer Science + Business Media, LCC (Eds.) Social Competence in Children. (pp. 1-10). New York, NY: Springer Science + Business Media, LCC.

Shin, N., Vaughn, B.E., Kim, M., Kryzsik, L., Bost, K.K., McBride, B., et al (2011). Longitudinal analyses of a heirarchical model of peer social competence for preschool children: Structural fidelity and external correlates. *Merrill-Palmer Quarterly, 57(1)*, 73-103.

Shrier, I., Feldman, D., Klvana, J., Rossignol, M. & Abenhaim, L. (1998). Concurrent validity of abdominal endurance and abdominal strength testing in adolescents. *Medicine & Science in Sports & Exercise, 30,* S214.

Silman, A., Cairney, J., Hay, J., Klentrou, P. & Faught, B.E., (2011) Role of physical activity and perceived adequacy on peak aerobic power in children with developmental coordination disorder. *Human Movement Science, 30*, 672-681. DOI: 10.1016/j.humov.2010.08.005.

Singer, M.R., Moore, L.L., Garrahie, E.J. & Ellison, R.C. (1995). The tracking of nutrient intake in young children: The Framingham Children's Study. *American Journal of Public Health*, *85*, 1673-1677.

Skinner, R.A. & Piek, J.P. (2001). Psychosocial implications of poor motor coordination in children and adolescents. *Human Movement Science, 20*, 73-94.

Skuse, D.H., Mandy, W.P. & Scourfield, J. (2005). Measuring autistic traits: heritability, reliability and validity of the Social and Communication Disorders Checklist. *British Journal of Psychiatry*, *187*, 568-572.

Sports, Recreation, and Culture Programs. (2013). In Niagara Region Child Care/Assistance. Retrieved from http://www.niagararegion.ca/living/childcare/financial-assistance/recreation-culture-programs.aspx. Accessed [February 9, 2013].

Tammelin, T., Näyhä, S., Hills, A.P. & Järvelin, M. (2003). Adolescent participation in sports and adult physical activity. *American Journal of Preventive Medicine, 24(1)*, 22-28.

Tappe, M.K., Duda, J.L. & Ehrnwald, P.M. (1989). Perceived barriers to exercise among adolescents. *Journal of School Health, 59(4),* 153-155.

Taylor, A.R. & Asher, S.R. (1984). Children's goals and social competence: Individual differences in a game-playing context. In T.Field, J.L. Roopnarinem & M. Segal (Eds.), *Friendships in normal and handicapped children* (pp. 53-78). Norwood, NJ: Ablex Publishing Co.

Telama, R., Leskinen, E. & Yang, X. (1996) Stability of habitual physical activity and sport participation: a longitudinal tracking study. *Scandinavian Journal of Medicine and Science in Sports, 6,* 371-378.

Telama, R., Yang, X., Laakso, L. & Viikari, J. (1997), Physical activity in childhood and adolescence as predictor of physical activity in young adulthood. *American Journal of Preventive Medicine, 13*, 317–23.

Thibault, H., Contrand, B., Saubausse, E., Baine, M. & Maurice-Tison, S. (2010). Risk factors for overweight and obesity in French adolescents: Physical activity, sedentary behaviour and parental characteristics. *Nutrition, 26,* 192-200. DOI: 10.1016/j.nut.2009.03.015.

Tirosh, E., Jaffe, M., Marmur, R., Taub, Y. & Rosenberg, Z. (1991). Prognosis of motor development and joint hypermobility. *Archives of Disease in Childhood, 66*, 931-933.

Tremblay, R. E., Pihl, R. O., Vitaro, F., & Dobkin, P. L. (1994). Predicting early onset of male antisocial behavior from preschool behavior. *Archives of General Psychiatry, 51*, 732– 739.

Tremblay, M.S., Warburton, D.E.R., Janssen, I., Paterson, D.H., Latimer, A.E., Rhodes, R.E., et al (2011). New Canadian physical activity guidelines. *Applied Physiology, Nutrition and Metabolism, 36*, 36-46. DOI: 10.1139/H11-009.

Trost, S.G., Kerr, L.M., Ward, D.S. & Pate, R.R. (2001). Physical activity and determinants of physical activity in obese and non-obese children. *International Journal of Obesity, 25,* 822-829.

Trost, S.G., Pate, R.R., Dowda, M., Saunders, R., Ward, D.S. & Felton, G. (1996). Gender differences in physical activity and determinants of physical activity in rural fifth grade children. *Journal of School Health, 66(4),* 145-150.

Trost, S.G., Pate, R.R., Ward, D.S., Saunders, R., & Riner, W. (1999). Correlates of Objectively Measured Physical Activity in Preadolescent Youth. *American Journal of Preventative Medicine*, 17(2), 120 - 126.

Trost, S.G., Sallis, J.F., Pate, R.R., Freedson, P.S., Taylor, W.C. & Dowda, M. (2003). Evaluating a model of parental influence on youth physical activity. *American Journal of Preventive Medicine, 25(4),* 277-282. DOI: 10.1016/S0749-3797(03)00217-4.

Tsimeas, P.D., Tsiokanos, A.L., Koutedakis, Y., Tsigilis, N. & Kellis, S. (2005). Does living in urban or rural settings affect aspects of physical fitness in children? An allometric approach. *British Journal of Sports Medicine, 39*, 671-674.

Tudor-Locke, C., Williams, J.E., Reis, J.P. & Pluto, D. (2002) Utility of pedometers for assessing physical activity: convergent validity. *Sports Medicine, 32(12),* 795–808.

Tudor-Locke, C., Williams, J.E., Reis, J.P. & Pluto, D. (2004) Utility of pedometers for assessing physical activity: construct validity. *Sports Medicine, 34(5),* 281–291.

Ulmer, H., Kelleher, C., Diem, G. & Concin, H. (2003). Long-term tracking of cardiovascular risk factors among men and women in a large population-based health system. *European Heart Journal, 24*, 1004-1013. DOI: 10.1016/50195-668X(03)00170-2.

Urbina, E.M., Brinton, T.J., Elkasabany, A. & Berenson, G.S. (2002). Brachial artery distensibility and relation to cardiovascular risk factors in healthy young adults (The Bogalusa Heart Study). *American Journal of Cardiology, 89,* 946-951.

Wall, A.E. (2004). The developmental skill-learning gap hypothesis: Implications for children with movement difficulties. *Adapted Physical Activity Quarterly, 21*, 197-218.

Webber, L.S., Osganian, V., Luepker, R.V., Feldman, H.A., Stone, E.J., Elder, J.P., Perry C.L., et al (1995). Cardiovascular risk factors among third grade children in four regions of the United States. The CATCH Study: Child and Adolescent Trial for Cardiovascular Health. *American Journal of Epidemiology*, *141(5),* 428–439.

Webster-Stratton, C., Gaspar, M.F. & Seabra-Santos, M.J. (2012). Incredible Years® Parent, Teachers and Children's Series: Transportability to Portugal of Early Intervention Programs for Preventing Conduct Problems and Promoting Social and Emotional Competence. *Psychosocial Interventions, 21 (2),* 157-169.

Webster-Stratton, C., & Reid, M.J. (2003). Treating conduct problems and strengthening social emotional competence in young children (aged 4-8 years): The Dina Dinosaur treatment program. *Journal of Emotional and Behavioral Disorders, 11,* 130-143.

Williams, C.L., Hayman, L.L., Daniels, S.R., Robinson, T.N., Steinberger, J., Paridon, S., et al (2002). Cardiovascular health in childhood: A statement for Health Professionals from the Committee on Atherosclerosis, Hypertension, and Obesity in the Young (AHOY) of the Council on Cardiovascular Disease in the Young, American Heart Association. *Circulation, 106*, 143-160. DOI:10.1161/01.CIR.0000019555.61092.9E.

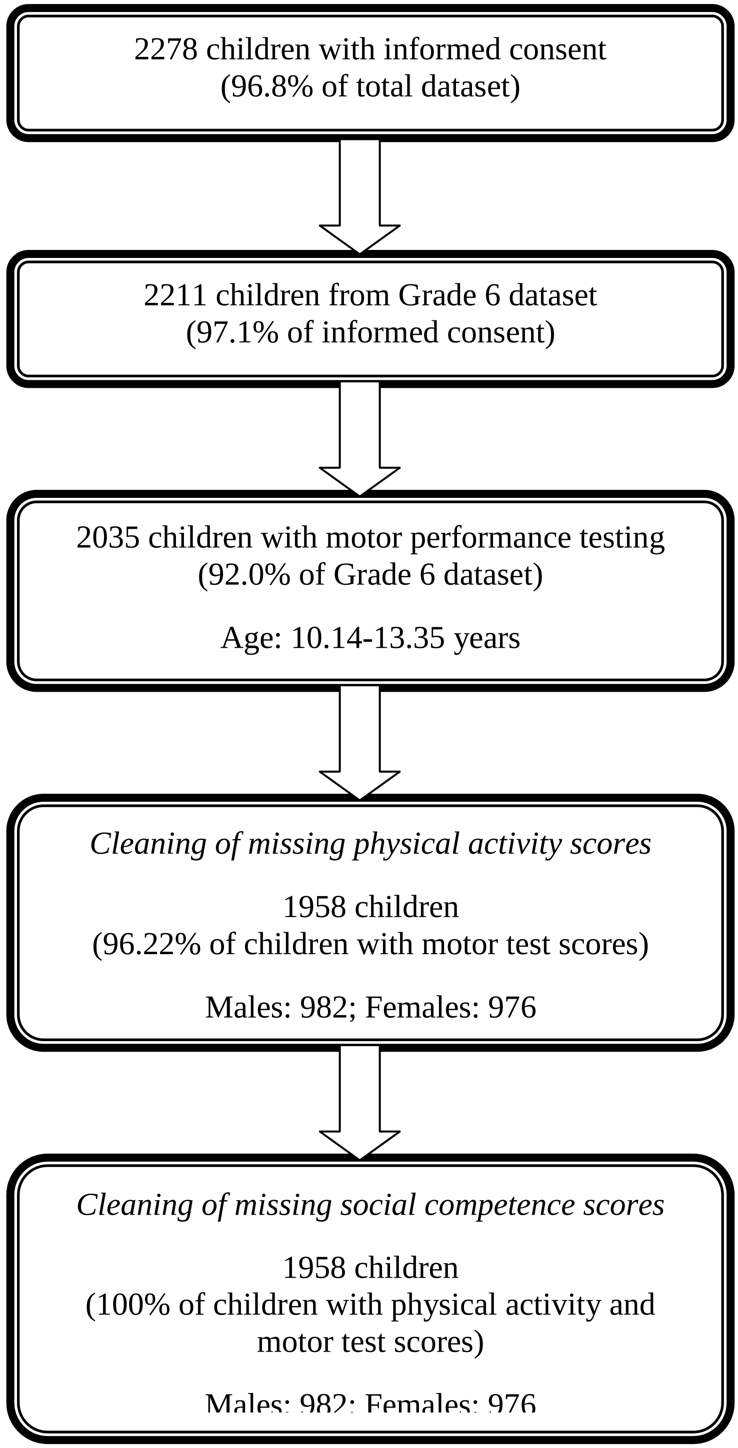
Wojslawowicz Bowker, J.C., Rubin, K.H., Burgess, K.B., Booth-LaForce, C. & Rose-Krasnor, L. (2006). Behavioural characteristics associated with stable and fluid best friendship patterns in middle childhood. *Merrill-Palmer Quarterly, 52(4),* 671-693.

Wong, S.L. & Leatherdale, S.T. (2009). Association between sedentary behaviour, physical activity, and obesity: Inactivity among active kids. *Preventing Chronic Disease*, *6(1)*, 1-13. URL: http://www.cdc.gov/pcd/issues/2009/jan/07_0242.htm. Accessed [May 24, 2012]

Wrotniak, B.H., Epstin, L.G., Dorn, J.H., Jones K.E. & Kondilis, V.A. (2006). The relationship between motor proficiency and physical activity in children. *Pediatrics, 118*, e1758-e1765. DOI: 10.1542/peds.2006-0742.

Wuensch, K.L. (2011). Continuous moderator variables in multiple regression analysis [text file]. URL http://core.ecu.edu/psyc/wuenschk/MV/MultReg/Moderator.docx.

Appendix A – Cleaning Flow Chart



Appendix B – Descriptive Tables

Table B1. Means (Standard Deviation) of key variables by BOTMP-SF Quartile in Males

	Q1 (n=193)	Q2 (n=224)	Q3 (n=276)	Q4 (n=289)
PQ $_{Total}$	15.20 (6.72)	16.08 (6.77)	17.95 (7.38)	19.61 (7.65)
PQ $_{Free\ Play}$	11.30 (3.60)	11.41 (3.48)	11.89 (3.38)	12.16 (3.23)
PQ $_{Organized\ Sports}$	3.90 (4.48)	4.67 (4.70)	6.05 (5.35)	7.45 (5.63)
Social Competence	18.44 (4.09)	19.24 (3.98)	20.01 (3.73)	20.54 (3.44)

Table B2. Means (Standard Deviation) of key variables by BOTMP-SF Quartile in Females

	Q1 (n=276)	Q2 (n=274)	Q3 (n=266)	Q4 (n=160)
PQ $_{Total}$	14.97 (5.98)	16.88 (6.79)	17.43 (6.98)	19.26 (6.56)
PQ $_{Free\ Play}$	10.72 (3.31)	11.57 (3.25)	11.49 (3.32)	11.80 (3.06)
PQ $_{Organized\ Sports}$	4.25 (4.05)	5.31 (5.16)	5.94 (5.04)	4.46 (5.20)
Social Competence	18.46 (4.43)	19.49 (3.80)	20.27 (3.65)	20.39 (3.58)

Table B3. Means (Standard Deviation) of key variables in Social Competence Groups by Gender

	Males (n=982)		Females (n=976)	
	High Social Competence (n=561)	Low Social Competence (n=421)	High Social Competence (n=560)	Low Social Competence (n=416)
PQ $_{Total}$	19.15 (7.39)	15.23 (6.77)	18.58 (6.73)	14.60 (6.02)
PQ $_{Free\ Play}$	12.47 (3.28)	10.77 (3.36)	11.98 (3.01)	10.49 (3.43)
PQ $_{Organized\ Sports}$	6.68 (5.54)	4.46 (4.68)	6.59 (5.30)	4.11 (4.04)
Motor Performance	76.09 (26.34)	65.49 (31.19)	67.10 (28.76)	56.05 (31.62)

Appendix C – Skewness Values and Correlation Tables

Table C1. Skewness values of physical activity, motor performance and social competence in males.

Variables	N	Mean	Standard Deviation	Skewness
PQ $_{Total}$	982	17.47	7.39	0.6591
PQ $_{Free\ Play}$	982	11.74	3.42	-0.3710
PQ $_{Organized\ Sports}$	982	5.73	5.30	1.2914
BOTMP Percentile Rank	982	71.55	28.98	-1.0120
Social Competence	982	19.68	3.86	-0.9612

Table C2. Pearson correlation matrix of physical activity and motor performance in males (p value <.0001)

	PQ $_{Total}$	**PQ $_{Free\ Play}$**	**PQ $_{Organized\ Sports}$**
PQ $_{Free\ Play}$	0.75558	-	-
PQ $_{Organized\ Sports}$	0.90630	0.40793	-
BOTMP Percentile Rank	0.23277	0.12105	0.24633

Table C3. Pearson correlation matrix of physical activity and social competence in males (p value <.0001)

	PQ $_{Total}$	**PQ $_{Free\ Play}$**	**PQ $_{Organized\ Sports}$**
PQ $_{Free\ Play}$	0.75558	-	-
PQ $_{Organized\ Sports}$	0.90630	0.40793	-
Social Competence	0.31096	0.26376	0.26323

Table C4. Pearson correlation matrix of motor performance and social competence in males. (p value <.0001)

	Social Competence
BOTMP Percentile Rank	0.20865

Table C5. Skewness values of physical activity, motor performance and social competence in females.

Variables	N	Mean	Standard Deviation	Skewness
PQ **Total**	976	16.88	6.73	0.6264
PQ **Free Play**	976	11.35	3.28	-0.2785
PQ **Organized Sports**	976	5.53	4.96	1.3004
BOTMP Percentile Rank	976	62.39	30.49	-0.5728
Social Competence	976	19.56	3.99	-1.1327

Table C6. Pearson correlation matrix of physical activity and motor performance in females (p value <.0001)

	PQ **Total**	**PQ** **Free Play**	**PQ** **Organized Sports**
PQ **Free Play**	0.71356	-	-
PQ **Organized Sports**	0.88631	0.30800	-
BOTMP Percentile Rank	0.22884	0.14486	0.21500

Table C7. Pearson correlation matrix of physical activity and social competence in females (p value <.0001)

	PQ **Total**	**PQ** **Free Play**	**PQ** **Organized Sports**
PQ **Free Play**	0.71356	-	-
PQ **Organized Sports**	0.88631	0.30800	-
Social Competence	0.35010	0.30153	0.27611

Table C8. Pearson correlation matrix of motor performance and social competence in females (p values <.0001)

	Social Competence
BOTMP Percentile Rank	0.22525

Appendix D – Regression Models

Table D1. Simple Linear Regression of PQ scores in males (motor performance as independent variable)

	Intercept	Slope	R^2	F value	p value
PQ Total Score	13.22671	0.05932	0.0542	56.14	<.0001
PQ Free Play	10.72215	0.01428	0.0147	14.57	<.0001
PQ Organized Sports	1.22445	0.01160	0.0751	49.53	<.0001

Table D2. Simple Linear Regression of PQ scores in females (motor performance as independent variable).

	Intercept	Slope	R^2	F value	p value
PQ Total Score	13.73115	0.05050	0.0542	53.82	<.0001
PQ Free Play	10.37639	0.01556	0.0210	20.88	<.0001
PQ Organized Sports	1.52164	0.00866	0.0543	55.91	<.0001

Table D3. Simple Linear Regression of PQ scores in males (social competence as independent variable)

	Intercept	Slope	R^2	F value	p value
PQ Total Score	5.74354	0.59580	0.0967	104.90	<.0001
PQ Free Play	7.13907	0.23394	0.0696	73.28	<.0001
PQ Organized Sports	0.29289	0.08951	0.0790	84.08	<.0001

Table D4. Simple Linear Regression of PQ scores in females (social competence as independent variable).

	Intercept	Slope	R^2	F value	p value
PQ Total Score	5.32007	0.59113	0.1226	136.06	<.0001
PQ Free Play	6.50015	0.24782	0.0909	97.41	<.0001

PQ Organized Sports	0.46382	0.08171	0.0826	87.64	<.0001

Table D5. Simple Linear Regression of social competence in both genders (motor performance as independent variable).

	Intercept	Slope	R^2	F value	p value
Males	17.69784	0.02775	0.0435	44.61	<.0001
Females	17.72247	0.02944	0.0507	52.06	<.0001

Appendix E – Multiple Regression Model Sample Size

Model One:

Independent Variables: PQ_{Total}, $PQ_{Organized\ Sports}$, or $PQ_{Free\ Play}$

Dependent Variable: Motor Performance

Sample Size: 1958 (982 males, 976 females)

↓

Model Two:

Independent Variables: PQ_{Total}, $PQ_{Organized\ Sports}$, or $PQ_{Free\ Play}$

Dependent Variable: Motor Performance, Social Competence (PQ Total included when PQ subscores are independent variable)

Sample Size: 1958 (982 males, 976 females)

↓

Model Three:

Independent Variables: PQ Total, PQ Organized Sports, or PQ Free Play

Dependent Variable: Motor Performance, Social Competence, Personal Confounders (Age, BMI)

Sample Size: 1949 (977 males, 972 females)

Missing Observations: Age (1 female); BMI (5 males, 4 females)

↓

Model Four:

Independent Variables: PQ_{Total}, $PQ_{Organized\ Sports}$, or $PQ_{Free\ Play}$

Dependent Variable: Motor Performance, Social Competence, Personal Confounders (Age, BMI) and Parental Confounder (Parental Education)

Sample Size: 1249 (624 males, 625 females)

Missing Observations: Age (1 female); BMI (5 males, 4 females); Parental Education (358 males, 351 females)

Appendix F – Confounder Odds Ratios

Table F1. Independent odds ratios on low participation in physical activity

	Males			Females		
PQ	**Total**	**Free Play**	**Organized Sports**	**Total**	**Free Play**	**Organized Sports**
Age	1.191 (.740–1.918)	0.945 (.573–1.560)	1.108 (.690 – 1.779)	0.966 (.57 – 1.617)	0.945 (.573 – 1.560)	0.734 (.439–1.228)
BMI	0.979 (.93 –1.024)	1.024 (.984–1.066)	1.005 (.961 – 1.051)	1.031 (.989 – 1.075)	1.024 (.984 – 1.066)	1.007 (.967–1.050)
SES	0.986 (.968–1.004)	1.000 (.984–1.015)	0.983 (.964 – 1.002)	0.982 (.96 – 1.005)	1.000 (.984 – 1.015)	0.991 (.973–1.009

Table F2. Dichotomized motor performance odds ratios on low participation in physical activity

	Males			Females		
PQ	**Total**	**Free Play**	**Organized Sports**	**Total**	**Free Play**	**Organized Sports**
Age	1.257 (.784 – 2.017)	0.632 (.388 – 1.030)	1.173 (.733 – 1.877)	0.998 (.598 – 1.664)	0.96 (.582 – 1.583)	0.763 (.458–1.27)
BMI	0.988 (.045 – 1.032)	1.002 (.959 – 1.047)	1.015 (.971 – 1.060)	1.038 (.997 – 1.082)	1.028 (.988 – 1.070)	1.015 (.975–1.057)
SES	0.985 (.967 – 1.003)	0.973 (.943 – 1.005)	0.982 (.964 – 1.001)	0.981 (.958 – 1.005)	0.999 (.984 – 1.015)	0.990 (.972–1.009)

Table F3. Motor performance quartiles odds ratios on low participation in physical activity

	Males			Females		
PQ	**Total**	**Free Play**	**Organized Sports**	**Total**	**Free Play**	**Organized Sports**
Age	1.178 (.731 – 1.898)	0.631 (.386 – 1.032)	1.099 (.682 – 1.769)	0.933 (.592 – 1.666)	0.978 (.591 – 1.619)	0.747 (.446–1.253)
BMI	0.979 (.936 – 1.024)	0.999 (.955 – 1.045)	1.006 (.962 – 1.052)	1.032 (.990 – 1.075)	1.028 (.987 – 1.070)	1.007 (.967–1.050)
SES	0.985 (.968 – 1.003)	0.975 (.964 – 1.001)	0.982 (.964 – 1.001)	0.983 (.960 – 1.005)	1.000 (.985 – 1.016)	0.990 (.972–1.009)