

Does Children's Physical Literacy Mediate the Relationship Between Age and Sedentary
Behaviour?

by

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ABSTRACT

Sedentary behaviour (SB), refers to any waking behaviour that requires little to no energy expenditure. As children age, SBs are shown to increase, which can be linked to negative health outcomes (i.e. obesity). Although correlates of SB have been identified, the impact of physical literacy (PL) on children's SB has not been established. PL is defined as having the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for physical activity for life. The present study aimed to test the novel idea that children's PL mediates the relationship between age and SB, using data from the Canadian Assessment of Physical Literacy, (which measured PL in 8-12 year olds). Significant mediation was found ($b = -.0092$, 95% CI $[-.0145, -.0045]$). The results of this study suggest that further exploration of the relationship between PL and SB, is needed to help reverse the age-related increase of sedentary time in children.

LIST OF ABBREVIATIONS USED

PA- Physical activity

PIA- Physical inactivity

SB- Sedentary behaviour

PL- Physical literacy

MVPA- Moderate to vigorous physical activity.

CAPL- Canadian Assessment of Physical Literacy

FMS- Fundamental movement skills

HALO- Healthy Active Living and Obesity

PACER- Progressive Aerobic Cardiovascular Endurance Run

PE- Physical education

METs- Metabolic equivalents

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Participating regularly in physical activity (PA) can improve the health and quality of life of children, youth, and adults (Janssen & Le Blanc, 2010). An individual meeting the age-specific guidelines for PA can expect positive influences on many physical, mental, and social aspects of health (Janssen & Le Blanc, 2010; Poitras et al., 2016). The 24-hour movement guidelines suggest that children aged 5 to 17 should accumulate at least 60 minutes of moderate to vigorous PA daily, involving a variety of aerobic activities (Tremblay et al., 2016). Vigorous physical activities, and muscle and bone strengthening activities, should be incorporated at least 3 days per week. Additionally, these 24-hour movement guidelines state that children should participate in several hours of a variety of structured and unstructured light physical activities, get proficient amounts of sleep (age 5 to 13 years: 9 to 11 hours/night; age 14 to 17 years: 8-10 hours/night), and limit sedentary behaviour (SB; Tremblay et al., 2016). In terms of sedentary behaviour, it is recommended that children have limited sitting for extended periods, and screen-time SB should be limited to just 2 hours a day (Tremblay et al., 2016). SB is defined as any waking behaviour that takes place in a reclined position, requiring < 1.5 metabolic equivalents (METs) (Tremblay et al., 2017). In Canada, many children and youth are insufficiently active. The most recent evidence from the Canadian Health Measures Survey (CHMS) indicates that just 36% of 5 to 17 year olds meet the MVPA recommendations and only 17.5% meet all components of the 24-hour movement guidelines (Roberts et al., 2017). Higher percentages of children than youth, and boys than girls, meet the guidelines. The data show that particularly screen-time SB adherence, is associated with age, with 70.6% of children (age 5 to 11) and 49.3% of youth (age 12 to 17 years), limiting their screen time to <2 hours per day (Roberts et al., 2017). These insufficient levels of PA, excessive sedentary time, and lack of necessary

sleep, exist despite advocacy efforts such as ParticipACTION Report Card on Physical Activity for Children and Youth (formerly known as the Active Healthy Kids Canada Report Card on Physical Activity for Children and Youth) which is made widely available by Health Canada (ParticipACTION, 2015; 2016).

There are various health implications associated with high levels of SB in childhood, youth, and adulthood. Specifically, high levels of SB in children and youth are associated with increased cardiometabolic risk (i.e. high cholesterol, high blood pressure and other markers of the metabolic syndrome), increased risk of being overweight or obese, low bone density, and depression (Carson et al., 2016; Janssen and Leblanc, 2010; Saunders et al., 2016; Thasanasuwan et al., 2016). However, these negative health outcomes are not just associated with high levels of SB in childhood. Research has shown that children's movement and non-movement behaviours track into adolescence and adulthood (Biddle, Pearson, Ross & Braithwaite, 2010; Craige et al., 2011) Spending excessive time sedentary in childhood, whether on screens or through extended periods of sitting (without screens), may lay the foundation for maintaining these behaviours into adolescence and adulthood (Biddle et al., 2010). As a result, the chronic disease markers associated with SB magnify and increase the risk for the development of coronary heart disease, cancer, type 2 diabetes, and other chronic illnesses (Chen et al., 2014; Chinapaw et al., 2011; Dunstan et al., 2010; Owen et al., 2010b; Thorp et al., 2010). With this information in mind, one might argue that high levels of SB in childhood are one of the biggest public health challenges of our time. Consequently, there is substantial interest in exploring factors that may mediate the rise in SB as children age.

Previous literature has identified a variety of correlates of SB in school-aged children and youth. Using the social-ecological model, many intrapersonal, environmental, and social

correlates of SB have been identified (Arundell et al., 2015; Janssen et al., 2015; LeBlanc et al., 2015a&b). At the social level, the role of social support for children's PA and SB is clear. When a child does not have sufficient social support (including familial encouragement and facilitation), this can have a negative impact on his/her SB time (Stierlin et al., 2015). At the environmental level, there are many factors that can influence children's SB. Influences on children's SB include weather, play equipment availability, school environment, neighbourhood-built environment, and the quality of PA facilities (O'Donoghue et al., 2016; Stierlin et al., 2015; Storgarrd, Hansen, Aaddal, & Glumer, 2013; Timperio, Crawford, & Salmon, 2017). For example, children living in low socio-economic areas report higher levels of SB (Garcia et al., 2017). These areas may have poor PA facilities, as well as lack safe spaces, which could make children more inclined to stay inside (Molina-Garcia et al., 2017).

Intrapersonal correlates of SB that have been identified include a child's age, sex, weight status, and fundamental movement skills (FMS). For example, children who are overweight are more inclined to be sedentary (Janssen et al., 2015), and sex has been shown to determine the type of SB a child participates in (LeBlanc et al., 2015a) Research has shown that as individuals age, they are more likely to lead a sedentary lifestyle. As discussed previously, Nationally-representative data from the CHMS indicate that fewer youth meet the screen time recommendations than children. Provincial data reveal similar trends. A study conducted with Nova Scotian children in grades 3,7, and 11, investigated this relationship using objectively measured (i.e. accelerometry) SB data (Thompson, & Wadsworth, 2012). This study found that children in grade 11 spent significantly more time sedentary (boys: 425 minutes/day; girls: 438 minutes/day), than children in grade 3 (boys: 320 minutes/day; girls: 305 minutes/day). Other studies tracking children's SB as they transition from primary to secondary school have also

found a similar positive relationship between age and SB (Pearson et al., 2017). Therefore, it seems that age plays an important role in the time children spend sedentary, and the types of SBs they choose (LeBlanc et al., 2015b; Pearson et al., 2017; Thompson & Wadsworth, 2012; Wen & Su; 2015). A suggested reason for this is that as children age their priorities change towards socialization with friends and away from the influence of their parents (Hardy et al., 2007; Smetana, Robinson, & Rote, 2015). This suggests that it is important to understand factors that influence the relationship between children's age and SB.

Another intrapersonal correlate of SB is children's FMS. According to a child's age, there are a number of FMS that need to be developed. These start out as rather simple in babies (i.e. rolling, crawling, etc.) and progress to more complex skills (i.e. running, hopping, skipping, etc.) as children age (Active for Life, 2018). Stability, locomotor (e.g. running or jumping), and object control skills (e.g. throwing and catching) are all examples of FMS that should be developed during childhood (Foweather et al., 2015; Lloyd, Saunders, Bremer & Tremblay, 2014). Therefore, as children age it is expected that their FMS improve. If children do not have a chance to develop these FMS, this becomes a barrier to PA. As a result, children may be more inclined to engage in sedentary activities and spend excessive periods of their day sedentary (Foulkes et al., 2015; Stodden et al., 2008). When children have better FMS, they are more likely to spend less time in sedentary pursuits (Gu, 2015; Wrotniak et al., 2006). Additionally, FMS have been described as the building blocks of physical literacy (PL). Improving children's FMS may positively impact physical competency, which is a component of PL (Edwards et al., 2017).

However, FMS and physical competence are not the only important factors that contribute to a child's PA behaviours. Affective and cognitive components of PA are also essential in ensuring that a child is active for life. For example, it is essential to develop the

affective concept of self-efficacy in children (Bandura, 1997). When an individual has high levels of self-efficacy, they are more likely to be active, and lead an active lifestyle (Elavsky et al., 2005; Manley et al., 2014). Additionally, cognitive development and learning are crucial to ensuring that children understand the importance of PA. As children age, it is expected that their cognitive development, and learning in physical education during school will allow them to better understand the importance of PA (Whitehead, 2010). Therefore, these affective, and cognitive factors influencing PA, have the same importance as FMS and physical competence in allowing children to develop positive movement behaviours (i.e. increased PA and less excessive SB).

PL is an important concept in the realm of PA research, as it aims to understand children's PA in terms of the many important factors that influence a child's PA. The International Physical Literacy Association describes PL as “the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life” (IPLA, 2014, pg. 1). As noted, PL encompasses more than just the behavioural components of PA; considering an individual's PL may therefore help understand the cognitive, affective, physical, and behavioural factors that influence children's movement and non-movement behaviours.

With increasing attention around the importance of PL to life-long PA participation, more scientific evidence is starting to emerge on the PL levels of children worldwide. The Canadian Assessment of Physical Literacy (CAPL) (<https://www.capl-ecsfp.ca/>) is the first project to use a comprehensive assessment tool that captures the four components of PL (cognitive, behavioural, affective, and physical), to obtain baseline PL scores in children across the country (Longmuir et al., 2015). This assessment was spearheaded by the Healthy Active Living and Obesity (HALO)

research team at the Children's Hospital of Eastern Ontario (CHEO). Within this assessment tool, data are collected to represent each of the four main domains of PL (as outlined by the HALO team). These are: daily behaviours, physical competence, knowledge and understanding, and motivation and confidence (Longmuir et al., 2015). Each child (aged 8-12 years) participating in this assessment is given an overall PL score, as well as scores for each domain (Longmuir et al., 2015).

It has been proposed that as with other measures of literacy, such as reading and math, there are critical periods for the development of PL (Hills et al., 2007). Health attitudes and behaviours are developed predominantly during childhood, including PA and SB (Taylor & Sirois, 2012). Researchers have stated that PL development is essential to ensuring children are active and healthy. In fact, children with low PL levels are more likely to avoid PA, and therefore be more sedentary (Tremblay & Lloyd, 2010). As a result, it is important to improve the understanding of the role PL can play in determining SB levels.

As highlighted, there is considerable literature examining the problem with increased SBs. Additionally, it has been shown in research that there are many factors influencing sedentary lifestyles, with age and SB levels being positively associated. However, no studies have examined children's PL as an important component in the relationship between age and SB. Given the growing attention to, and importance of, lowering children's SB, and exploring the factors that might contribute to SB development, this gap in the current literature is noteworthy and demands further exploration.

1.2 Research question and hypothesis

Prior to testing the primary research question, several assumptions will be tested. These assumptions are; 1) Is there a relationship between age and SB 2) Is there a relationship between age and PL? 3) Is there a relationship between PL and SB? The literature clearly supports age as a correlate of SB, with sedentary time increasing as children age and transition into adolescence (Pearson et al., 2017; Roberts et al., 2017). Therefore, it is hypothesized that there will be a significant positive relationship between age and SB in the CAPL sample in the present study. It is also hypothesized that there will be a significant positive relationship between age and PL, as previous research has shown that a relationship exists between FMS (the building blocks of PL), and age (Lloyd et al., 2014). A further hypothesis is that there will be a significant negative relationship between PL and SB, as improvements in components of PL like FMS, and confidence in children have been shown to lead to a decrease in SB levels.

These assumptions will then lead into the primary research question, which is; does children's physical literacy mediate the relationship between age and sedentary behaviour? It is hypothesized that PL will have a significant mediating effect on the relationship between children's age and SB. However, it is worth noting that this type of question has not been studied before, and therefore this is exploratory research. It is hoped that the present study will aid in the understanding of how PL might influence the expected rise in SB as children age. If the novel hypotheses included in the present study are proved to be correct, this will provide even more support for PL development in childhood to prevent the expected increase in SB with age.

CHAPTER 2: LITERATURE REVIEW

The following literature review was conducted to present information on the importance of further research regarding SB, in particular with children. Specifically, this literature review examines the evidence to date on the importance of maintaining healthy levels of PA and limiting excessive SB, in childhood and into adulthood; presents the 24 hour movement guidelines for children (which includes daily recommendations for PA and SB); describes current levels of PA and SB in children, locally and nationally; describes correlates of SB in children; identifies risk factors associated with SB; and examines the association between age and SB. The concept of physical literacy, the importance of PL to children's health and SB, and various PL assessment tools, is also presented and discussed. The purpose of compiling this information is to gather evidence to justify the present study.

For the purpose of this literature review, a number of definitions will be used. Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (World Health Organization (WHO), 2018). When an individual does not meet the recommended PA guidelines, this is defined as physical inactivity (PIA; Tremblay et al., 2017). Additionally, sedentary behaviour (SB) is any waking behaviour that requires an energy expenditure ≤ 1.5 metabolic equivalents (METs), undertaken in a sitting, reclining, or lying posture (Tremblay et al., 2017). Sedentary behaviour can be split into two main categories: non-screen based sedentary time and screen time. The definition of non-screen-based sedentary time is any sedentary time spent without the use of screens (for example, sitting at school, reading a book, playing a board game, etc.) (Tremblay et al., 2017). Screen time is defined as time spent in screen-based behaviours that can be performed while being sedentary or active (for

example: using a smartphone, watching television, or using a computer/tablet) (Tremblay et al., 2017). For the purpose of this review, excessive SB will refer to exceeding the recommended guidelines of 2 hours of screen time per day.

2.1 Importance of Physical Activity

PA has many physiological, psychological, and socio-emotional health benefits. Ideas that PA can lead to increased longevity, as well as help to prevent illness, date back several decades (Morris & Crawford, 1958; Paffenbarger, Wing, & Hyde, 1978; Pate et al., 2008). These ideas have proven to hold true now, with many studies reporting that individuals displaying more physically active lifestyles have a decreased risk of chronic illnesses (cardiovascular disease, diabetes, metabolic syndrome, cancer, etc.) (Carson et al., 2016; Chinapaw et al., 2011; Janssen & LeBlanc, 2010; Lee et al., 2012; Owen et al., 2010a; Poitras et al., 2016). PA can also protect against the development of obesity, which is a growing health problem. As many as 2.8 million deaths per year occur worldwide as a result of obesity or being overweight (WHO, 2018). PA helps to regulate energy balance, with more active individuals having less adipose tissue and less weight gain over time (Foster-Schubert et al., 2012; Janssen & LeBlanc, 2010; Mitchell et al., 2009; Poitras et al., 2016).

As well as impacting physical health, there is evidence that PA also plays a role in an individual's psychological health. Research indicates that individuals of any age can have improvements in psychological well-being when regularly active (Biddle & Asare, 2011). It has been reported that being physically active can help alleviate an individual's symptoms of illnesses such as depression and anxiety (Babyak et al., 2000; Blumenthal et al., 1999; Dunn et al., 2005; Kremer et al., 2014; Ströhle et al., 2007). Researchers have further suggested that PA

can be used in the replacement of drug treatments such as antidepressants in mild to moderate cases of depression (Babyak et al., 2000; Blumenthal et al., 1999; Dunn et al., 2005).

PA experts recommend that children aged 5-17 should accumulate at least 60 minutes of moderate to vigorous PA (MVPA) each day (Tremblay et al., 2011). Recently, these PA guidelines have been incorporated into the new 24-hour movement guidelines. These guidelines have been created to develop a recommendation for what a child's healthy day should look like (Tremblay et al., 2016). As well as the PA guidelines, there are also recommendations for light PA, sleep, and sedentary behaviour (SB). The 24-hour movement guidelines state that children should have several hours of structured and unstructured light PA, as well as sufficient sleep (9 to 11 hours per night for 5 to 13 year olds, and 8 to 10 hours for 14 to 17 year olds), each day (Tremblay et al., 2016). Additionally, it is recommended that children should not accumulate more than 2 hours of recreational screen time per day and should limit sitting for extended periods of time (Tremblay et al., 2016).

Despite these clear recommendations, the current trend researchers are reporting worldwide, is that many children and youth are not achieving the recommended PA guidelines. In Canada, the majority of children are not sufficiently active for health benefits. Data from the most recent Canadian Health Measures Survey (CHMS) indicate that just 7% of children aged 6 to 17 years accumulate at least 60 minutes of MVPA on at least 6 out of 7 days per week, with 33% achieving a weekly average of at least 60 minutes of MVPA per day (Colley et al., 2017). In terms of the more comprehensive 24-hour movement guideline recommendations, just 17.5% of children and youth (22.9% of boys and 11.8% of girls) met the recommendations outlined above of high PA, low SB, and proficient sleep when tested (Roberts et al., 2017). Higher percentages of children than youth, and boys than girls, met the 24-hour movement guidelines.

The data show that screen-time SB adherence drops with age, with 70.6% of children (age 5 to 11) and 49.3% of youth (age 12 to 17 years), limiting their screen time to <2 hours per day (Roberts et al., 2017).

PA data collected on a large cohort of Nova Scotian children and youth reveal similar age-related declines in PA levels. Thompson and Wadsworth (2012) used accelerometers, parent questionnaires, and self-report questionnaires to measure the PA and SB of 1,855 students in grades 3, 7, and 11. The authors found that the majority of participants (80.3% of girls and 81.6% boys) in grade 3 achieved the recommended 60 minutes of MVPA per day on five or more days of the week. However, as the age of participants increased, PA decreased: 13.2% of girls and 28.4% of boys in grade 7, and just 1% of girls and 5% of boys in grade 11, met PA guidelines (Thompson & Wadsworth, 2012). This suggests that in Nova Scotia, there is a problem with physical inactivity (PIA).

2.2 The Problem with Sedentary Behaviour

Examples of popular SB have been included in research. This research has shown that children regularly participate in both non-screen-based and screen-based SB (Engelen et al., 2013; Leatherdale & Ahmed, 2011). A study by Engelen et al., (2013) explored the behaviour patterns of children aged 5 to 7. In this study, parents were asked to measure their children's activities during leisure time using a real time objective measure, the Experience Sampling Method. They were also asked to indicate whether they were indoors or outdoors at 3 random times each day. Responses showed that children spent 25% of their leisure time in PAs, and 51% of their time in sedentary behaviour (Engelen et al., 2013). A total of 22% of this sedentary time was spent as screen-time (i.e. watching TV), and 81% of activities occurred indoors. This indicates that not only are these children spending a large proportion of time sedentary, but that

this sedentary time is made up of both screen-time and non-screen time (Engelen et al., 2013). Research has shown that the type of SB a child participates in can depend on their age. Olds, Mayer, Ridley, & Kittel (2010) measured the magnitude and composition of screen time and non-screen time SBs in 9 to 16-year-old Australian children. They found that non-screen time SB was low until the peri-pubertal years (12 to 14) and was the highest in older adolescents. Screen-time SB however was the highest in peri-pubertal children (Olds et al., 2010).

It has been shown that Canadian children have similarly high levels of SB, particularly screen time (Leatherdale & Ahmed, 2011; Thompson & Wadsworth, 2012). Using a large sample of 51,922 youth in grades 6-12, Leatherdale & Ahmed (2011), reported that 50.9% spent more than 2 hours per day participating in screen-based behaviours. The average daily screen time was reported to be 7.8 (\pm 2.3) hours. Screen-time was also measured in the previously mentioned study by Thompson & Wadsworth, (2012). Results showed that many participants were exceeding the recommended 2 hours of screen time both on weekdays and weekend days. In grade 3, 45% of girls and 51% of boys exceeded the recommended screen time guidelines during weekdays. This increased with age, to 56% of girls and 66% of boys in grade 7, and 64% of girls and 77% of boys in grade 11, exceeding screen time recommendations during the weekdays. Weekend screen time was particularly high, with 70% of girls and 75% of boys in grade 3, 66% of girls and 74% of boys in grade 7, and 74% of girls and 81% of boys in grade 11, accumulating over 2 hours of screen time per day (Thompson & Wadsworth, 2012). Together, these findings highlight that the majority of Nova Scotian children are not adhering to the 24-hour movement guidelines. However, it is worth noting that these two Canadian studies do not describe non-screen time SB, which is an important component of SB in children. It has been stated that SB can not be described by screen-time alone, and that using both screen-time and

non-screen time measurements are important to understand total SB time in children (Engelen et al., 2013; Olds et al., 2010).

2.3 Risks of Sedentary Behaviour

As outlined above, as children age and transition into adolescence, their time spent sedentary (in screen and non-screen SB's) increases. This is troublesome, as research has shown that when a child has excessive levels of SB, they are at risk of developing many negative health outcomes (Carson et al., 2016; Saunders et al., 2016; Thasanasuwan et al., 2016). Children who spend a considerable amount of their day sedentary are at an increased risk for developing cardiometabolic disease (Saunders et al., 2016). Additionally, research shows that when children have poor 24-hour movement patterns (i.e. low PA level, high SB, and poor sleep), this can also be dangerous for cardiometabolic health (Saunders et al., 2016). To elaborate, when children have low PA, low sleep, and high SB levels, they have less desirable cardiometabolic health indicators (such as; blood glucose, insulin levels, and adiposity levels; Saunders et al., 2016).

Displaying insufficient amounts of PA and being more sedentary during development (especially in critical periods such as early childhood), can be a large factor in the onset of conditions such as obesity (Hills et al., 2007; Jochem, Schmid, & Leitzmann, 2018; Mitchell et al., 2009; Saunders et al., 2016; Thasanasuwan et al., 2016). Using data collected on a large sample of UK children ($n=5,434$; mean age = 11.8 years), Mitchell et al., (2009), discovered that the probability of obesity increased depending on hours spent sedentary. For every hour spent in SBs, these children increased their risk of being obese by 1.18 (95% CI: 1.08, 1.28). This increased risk of obesity when displaying more sedentary time has also been shown in Thai children. Thasanasuwan et al., (2016) measured TV viewing time, sleeping time, and PIA, and BMI measurements to determine the proportion of children who were obese. Obesity in children

was classified using BMI for age Z score in accordance with the WHO reference standards for children (Thasanasuwan et al., 2016). Children were asked to record their estimated TV viewing time during the weekday and weekend. Results showed that watching more than 1 hour of TV daily doubled a child's risk of being obese (Thasanasuwan et al., 2016).

The risk of obesity in children with excessive SBs has also been reported in Canada. Carson, Tremblay, Chaput & Chastin (2016) measured the relationship between movement behaviours (SB, PA, and sleep), and health indicators in a sample of 4169, 6 to 17 year old youth in Canada, using data collected in the Canadian Health Measures Survey. Actical accelerometers were used to measure time spent in various intensities of PA (light PA and MVPA) and time spent sedentary. Health indicators including BMI, waist circumference, blood pressure, behavioural outcomes, as well as aerobic fitness, were measured. Additionally, triglycerides, high-density lipoprotein-cholesterol, C-reactive protein, and insulin were measured in a fasting subsample, which are considered to be markers for obesity (Carson et al., 2016b). The results of a compositional analysis showed that there was a positive association between the proportion of time children spent sedentary and the obesity markers that were measured (Carson et al., 2016b). Compositional analysis uses “data that is a proportion of a finite whole (e.g. 24 h) and can be used when all parts or just some parts of the finite whole have been measured...” (Chastin et al., 2015). Compositional analysis allows researchers to measure behaviours as interconnected, instead of independent from each other. Similar to previous literature, these results support the notion that excessive SB is a risk factor for the development of obesity in Canadian children and youth.

Another worrying health outcome of excessive SB in Canadian children and youth is the impact on mental health. A study conducted in Ottawa, Ontario with 2,482 children in grades 7

to 12 explored relationships between screen time and symptoms of depression and anxiety (Maras et al., 2015). As part of the Research on Eating and Adolescent Lifestyles study, children's mental health status was measured, as well as daily screen time. Mental health status was measured using the Children's Depression Inventory and the Multidimensional Anxiety Scale for Children. Screen time (including TV, video games, and computer use) per day was assessed through the Leisure-Time Sedentary Activities Questionnaire (Maras et al., 2015). Using linear regressions, results of this study demonstrated that an increased amount of screen time SB was significantly associated with the severity of symptoms of depression ($\beta = 0.23$, $p < 0.001$) and anxiety ($\beta = 0.07$, $p < 0.01$) (Maras et al., 2015). Specifically, in this sample of Canadian youth, playing video games ($\beta = 0.13$, $p < .001$) and using a computer ($\beta = 0.17$, $p < 0.001$), were significantly and positively associated with more severe symptoms of depression, but TV time was not (Maras et al., 2015). Additionally, playing video games was significantly and positively associated with symptoms of anxiety ($\beta = 0.11$, < 0.001) and severity of anxiety (Maras et al., 2015). This evidence supports the idea that excessive participation in SB can be damaging for a child's mental health. Overall, high levels of SB in youth are a risk factor for many components of health.

Negative health outcomes of excessive SB are also evident in adults. Dunstan et al., (2010) examined how too much sedentary TV time can contribute to detrimental health issues. In this study, the researchers used a sample of 6,162 men and women, from the Australian Diabetes, Obesity, and Lifestyle study. Using self-report questionnaires, these researchers studied leisure time sedentary behaviour and various biomarkers (e.g. BMI, waist circumference, blood pressure, and fasting insulin levels), associated with cardiometabolic risks (Dunstan et al., 2010). In their adult population, it was found that self-reported time spent watching TV had a positive

association with abnormal glucose metabolism, as well as metabolic syndrome. Each one-hour increase in daily TV viewing was associated with a 12% increased risk of developing metabolic syndrome (95% CI: -0.01–27%; $p=0.07$) for male participants and 26% (95% CI: 14–46%; $p=0.0001$) for women (Dunstan et al., 2010). Negative impacts of TV viewing were even shown for those individuals who, according to PA recommendations, were sufficiently active (Dunstan et al., 2010). This suggests that it is not enough to be sufficiently active, but that achieving lower levels of SB is also very important.

More recently, Tigbe, Granat, Sattar, & Lean (2017) examined associations of time spent sitting, standing, and stepping with coronary heart disease risk and body composition, in 111 postal workers. Activity was measured for 7 days using activPAL PA monitors. Cardiovascular risk was assessed by participant's categorisation of metabolic syndrome, as well as prospective cardiovascular Munster (PROCAM) risk (Tigbe et al., 2017). They found that a longer time spent in a sedentary posture during the day was significantly associated with a higher risk of coronary heart disease, as well as a larger waist circumference (Tigbe et al., 2017).

Displaying high levels of sedentary behaviours can also contribute to the development of cancers. Researchers have hypothesized that cardiometabolic biomarkers (such as elevated blood glucose, insulin, and adiposity) play a role in an individual's potential development and progression of cancer (Lynch, 2010). Due to this reason it is claimed that high sedentary levels could be a factor in a number of cancers (Lynch, 2010). Studies have found that particularly in large, population-based samples, there is a link between SB and a number of cancers (e.g. colorectal, ovarian, prostate and endometrial) in terms of mortality and development (Lynch, 2010). These studies show results for the impact of SB in adults. With other studies including participants from the US and Canada, the United Kingdom, Australia, as well as less westernized

countries such as China, it is clear that the health issues associated with excessive SB are similar for adults across the world (Chen et al., 2014; Pate et al., 2008).

The fact that excessive SB negatively impacts health for both adults and children is important. It is reported that SBs displayed in youth often track into adulthood (Biddle, Pearson, Ross & Braithwaite, 2010; Craige et al., 2011). Data have suggested that SB in childhood may lay the foundation for such behaviours in adulthood (Biddle et al., 2010). Therefore, it is important to explore the determinants (correlates) of SB in childhood, in order to understand how to prevent excessive SB in childhood, and the tracking of these behaviours and associated health risks into adolescence and adulthood.

2.4 Correlates of sedentary behaviour

When examining correlates of SB in childhood, researchers have typically used the social-ecological model to categorize these variables (Arundell et al., 2015; Janssen et al., 2015; LeBlanc et al., 2015b). This model states that intrapersonal factors are not the only cause of an individual's behaviour (Fleury et al., 2006). Instead, behaviours are a result of multiple levels of influence (i.e. intrapersonal, interpersonal, environmental, policy, and social factors; Fleury et al., 2006). Because of this, correlates of SB in this thesis will be split into three main categories; social/cultural, environmental, and intrapersonal.

2.4.1 Social/Cultural Correlates of SB

Within the social/cultural category, many correlates of SB in children have been identified. A number of these correlates are related to a child's family (Brown et al., 2017; Janssen et al., 2015; Stierlin et al., 2015). For example, family socioeconomic status (SES) can influence children's SB level. When a family is classed as high SES, children are likely to have lower SB levels when compared with low SES families (Atkin et al., 2013). Parents are highly

influential in terms of children's behaviour, including time children spend sedentary. The literature has demonstrated that parental modelling and enjoyment of SB, types and amounts of SB parents engage in, and rules regarding SB and screen time, are all correlates of children's SB (Janssen et al., 2015). Also, when parents do not model positive PA behaviours (i.e. not playing sports, not regularly walking, etc.), their children are more likely to have higher SB levels (Arundell et al., 2015; Janssen et al., 2015). Additionally, familial facilitation of SB can influence children's SB levels; positive, significant relationships have been reported between watching TV as a family and SB (Stierlin et al., 2015).

A study conducted by Wang et al., (2015) utilised surveys to determine associations between different types of family influence and SB in 7286 children in grades 7 to 9. If a participant's family was involved in children's activity during the week, this behaviour was significantly associated with a greater accumulation of MVPA, and less time spent sedentary (Wang et al., 2015). When a family involved themselves in children's activity, this provided the biggest influence on decreasing children's SB, compared to verbal encouragement and observation of children's activity (Wang et al., 2015). However, any type of familial support (verbal, observational, or involvement) reduced SB. This evidence displays support for the impact that social support can have on children's SB. Social support is a very influential factor in determining SB, the absence of social support can increase the amount of time children spend sedentary (Stierlin et al., 2015).

2.4.2 Environmental Correlates of SB

As well as these social correlates of SB, children's activity behaviours can also be influenced by a series of environmental factors. Research has identified that factors such as weather, play equipment availability, school environment, neighbourhood-built environment, and

the quality of PA facilities, can all play a role in determining children's SB levels (O'Donoghue et al., 2016; Stierlin et al., 2015; Storgarrd, Hansen, Aaddal, & Glumer, 2013; Timperio, Crawford, & Salmon, 2017). For example, the availability of green spaces (such as parks, or forests), in a built environment can influence SB. When there are parks, forests, and other recreational areas near the home, this provides people with an easier way to be active outdoors, and therefore has been shown to decrease SB (Storgarrd et al., 2013; Timperio, Crawford, & Salmon, 2017).

Youth who live in low SES communities tend to have higher levels of SB than youth in more affluent neighbourhoods (Stierlin et al., 2015). For example, a study by Molina-Garcia et al., (2017) examined neighbourhood-built environment, SES, PA behaviours, sedentary time, and obesity indicators in 325 youth aged 14 to 18. Neighbourhood walkability was determined by measuring built environment characteristics (residential density, land use mix, as well as street connectivity); MVPA and sedentary time were measured with accelerometers; and school commute, leisure time PA and specific SBs were measured using a self-report questionnaire (Molina-Garcia et al., 2017). Participants living in high SES and high walkability areas, reported lower sedentary time. Additionally, youth living in lower SES areas spent more time watching TV, and had higher levels of obesity and body fat, than youth in high SES neighbourhoods (Molina-Garcia et al., 2017). This could be due to perceived safety of an area to allow children to walk in. Also, adolescents in low SES areas may be more inclined to stay indoors due to the lack of neighbourhood sport facilities and organised activities offered there (Molina-Garcia et al., 2017). If children are not provided these opportunities to be active, they may then spend more time inside, sedentary.

In Canada, one component of the environment that is important to consider as a correlate of SB is weather. Due to extreme winter conditions, children's SB can change. Katapally, Rainham, & Muhajarine (2016) used accelerometers to measure the SB of youth aged 10 to 14 living in Saskatoon, SK. The researchers found that when local weather was classified as warm-wet-calm, children spent less time sedentary (Katapally et al., 2016). In addition to this, when weather was classified as cold-dry-windy, children spent more time sedentary (Katapally et al., 2016). As weather is non-modifiable, it would be important to change factors that are controllable, such as the built-environment, to help reduce excessive SB.

Another important environmental factor to consider that can be modified, is children's school environment. Children spend a large amount of their weekdays in school, and therefore this environment has ample opportunity to shape activity behaviours (Morton et al., 2015). There are many factors that can influence children's SB in the school environment. These include: school size, school support for PA, existence of facilities such as a gym, or a bike rack, as well as existence of equipment (Morton et al., 2015; Stierlin et al., 2015). In boys especially, it has been reported that if a school lacks good quality PA equipment, children are more likely to experience barriers to PA (Morton et al., 2015). Hobin et al., (2012) assessed the school environment of 76 schools to determine the impact of features of the school environment on the MVPA of students in grades 9-12. MVPA was measured via self-reported PA, and demographic data (e.g. age, sex, etc.) were collected on students. Environmental data that were collected included PA facilities within the school, geographical location of the school, as well as information regarding the neighbourhood's built environment (Hobin et al., 2012). The results of the univariate analysis showed that when students attended a school that had designated rooms designed for PA, they

spent more time in MVPA [$b = 11.49(4.23)$, $p = 0.012$] than those without this designated space (Hobin et al., 2012).

Other important factors that can influence SB are the school's ethos and culture regarding PA, the school physical education (PE) climate, and the behaviours that are encouraged in PE (Morton et al., 2015). For example, if a school's ethos focuses on the competitive nature of sports and PA, this can reduce children's participation in sports and time spent physically active. However, a PE teacher's positive leadership can encourage children to improve PA levels, and decrease SB (Morton, Keith, & Beauchamp, 2010).

2.4.3 Intrapersonal Correlates of SB

As well as social and environmental correlates of SB, a number of intrapersonal correlates have been identified. Intrapersonal factors are those that occur within an individual, for example an individual's age or sex (Fleury et al., 2006). Researchers have suggested that factors such as age, sex, weight status, and fundamental movement skills (FMS), can all play a role in children's SB levels (Arundell et al., 2015; Brug & Chinapaw, 2015; Gu, 2015; Wrotniak, Epstein, Dorn, Jones & Kondilisc, 2006). In terms of weight status, children who are considered overweight or obese are more likely to have higher levels of SB than normal weight children (Janssen et al., 2015).

A child's sex also has an influential role on the amount and type of SB one engages in (LeBlanc et al., 2015a). In a study by LeBlanc et al., (2015a), parents and children reported data regarding the home environment, socio-demographic data, as well as behavioural and dietary data, using self-report questionnaire. Additionally, accelerometer data and objectively measured anthropometric data were obtained. The results showed that boys' and girls' screen time SB varied, with boys reporting a significantly higher amount of video game and computer use

(LeBlanc et al., 2015a). Another Canadian study revealed that girls tend to have higher levels of total SB compared to boys (Thompson & Wadsworth, 2012). This suggests that a child's sex should be considered when determining SB. Additionally, SB interventions may need to consider sex in their design, targeting SB's more common in girls, and those more common in boys.

2.4.3.1 Age and Sedentary Behaviour

The peer-reviewed literature clearly supports the notion that as children transition from childhood into adolescence, there is a significant increase in time spent sedentary (Hardy, Bass, & Booth; 2007; Janssen et al., 2015; Pearson et al., 2017; Van Sluijs, Page, Ommundsen, & Griffin, 2010; Wen & Su; 2015). A recent review paper by Pearson et al., (2017) identified that children's SB increases with age, and there are changes in the type of SB with age. As children transition from primary to secondary school, their SB levels increase by approximately 10-20 minutes per day (Pearson et al., 2017). The increase in SB in these transitional years is similar for both boys and girls (Pearson et al., 2017). This would suggest that the time of transition from childhood to adolescence is an important time to solidify positive physical activity behaviours (i.e. reduced SB).

Hardy et al (2007) examined the sedentary habits of 200, 12-15 year old girls living in Sydney, Australia, over a 2.5-year period in. Time spent in a number of SBs (e.g. watching TV, using computers, talking on the phone, sitting with friends) was assessed. At baseline, this cohort reported that 45% of their weekly leisure time was spent sedentary (Hardy et al., 2007). After 2.5 years, this had increased by 28%, equating to 63% of their weekly leisure time spent in SB. Small screen recreation was the most popular SB, contributing to 1/3 of total sedentary time, which was relatively stable throughout the study period (Hardy et al., 2007). Researchers suggested that this provides evidence for the idea that small screen recreation habits are

developed in pre-adolescence, suggesting that pre-adolescence is an important time to help develop more healthy habits (such as decreased SB, and increased PA; Hardy et al., 2007).

Arundell et al., (2013) also looked at changes in SB with age in children and youth. The aim of this study was to use data from two longitudinal studies to examine changes in after school PA and SB in children. The age groups of children included in the study were ages 5 to 6 years, and ages 10 to 12 years, and their PA and SB were examined over 3 and 5 years. Demographic data (e.g. child's sex, parent employment status, highest level of parental education) and movement behaviours were measured using accelerometers (Arundell et al., 2013). Both boys and girls in the study showed similar increases in SB at 3 and 5 years post-baseline measurement (Arundell et al., 2013). A suggested reason for this increase during the transition from primary to secondary school could be due to school schedules. Homework becomes more demanding as students get older, and children have previously reported that homework can be a barrier to PA in an after-school setting (Eyler et al., 2006).

Another possible explanation for this relationship between age and SB is the change in socialization that occurs as children age (Hardy et al., 2007; Smetana, Robinson, & Rote, 2015). In childhood, parents can play an important role in determining which behaviours their children participate in (Wen & Su, 2015). Parents are able to discourage their young children from participating in SBs, while simultaneously encouraging PA (Wen & Su, 2015). However, as children progress towards adolescence, the influence of parents becomes less, and the impact of friends on behaviours increases (Smetana et al., 2015). As children age, they become less dependent on their parents, and the activities they plan, and more concerned with socializing with friends (Smetana et al., 2015). As a result of this, spending time hanging out with/talking to friends starts to take up more of one's leisure activities. For example, in the Hardy et al., (2007)

study mentioned previously, this form of SB increased by 24% in the older participants. Therefore, this SB could replace other, more physically active behaviours.

2.4.3.2 Fundamental movement skills and sedentary behaviour

A further intrapersonal factor that can determine SB levels is an individual's fundamental movement skills (FMS). Childhood is a critical period for the development of many health behaviours, including PA and SB. Fundamental movement skills change and develop as children age (Active for Life, 2018; Hoeboer et al., 2018). Active for Life Canada (2018), outlines the important fundamental movement skills for children to learn at various stages of development. For children aged 0-2, simple movement skills of grasping, rolling, sitting, crawling, cruising, and walking should be developed (Active for Life, 2018). As children age, these FMS become more complex. By age 6-9 years, children should be developing skills such as striking, swimming, and dribbling that are the foundation for sport participation and participation in a variety of physical activities (Active for Life, 2018). Therefore, as a child ages, they should have more complex, and more developed, FMS.

The development of FMS early in life provides the key building blocks to lifelong PA and sport participation. Some studies highlight that if FMS are not acquired during childhood, the lack of these skills could act as a barrier to an individual adopting and maintaining an active lifestyle (Gu, 2016; Lubans et al., 2010). FMS are the important building blocks for more complex movements and are essential for the development of physical competence and physical literacy (PL; Foweather et al., 2015; Foulkes et al., 2015). Stability, locomotor (e.g. running or jumping), and object control skills (e.g. throwing and catching) are all important components of FMS (Foweather et al., 2015). If a child does not develop these skills, it can make participation in PA much more difficult, and therefore lead to a more sedentary lifestyle (Foulkes et al., 2015;

Stodden et al., 2008). In fact, FMS have been shown to have a significant inverse relationship with children's SB (Gu, 2015; Wrotniak et al., 2006). As such, when children's FMS are well developed, they are more likely to report lower SB levels.

Evidence for a relationship between children's FMS and SB is supported by a study of 256, US kindergarten children (Gu, 2015). A motor skill assessment called PE Metrics™ was used to assess children's FMS, including ball skills such as dribbling and throwing, as well as sliding and hopping (Gu, 2015). Objectively measured PA and SB data were collected using accelerometers that children were asked to wear for 5 days during school. Results showed that there was a significant negative relationship between children's FMS score and their time spent sedentary (Gu, 2015). Interestingly, a mediation analysis was also conducted using FMS as the predictor variable, MVPA as the mediator, and SB as the outcome variable. It was found that MVPA significantly mediated the relationship between FMS and SB in the kindergarten children. Gu. (2015) highlighted that these results provide support for the idea that the development of FMS in children is important in determining behaviours such as PA and SB (which are factors in obesity development).

2.5 Physical literacy

One multifactorial concept linked with FMS, and therefore potentially SB, that has garnered attention recently is physical literacy (PL). FMS are typically used as a marker of PL, and though they are not synonymous, it is suggested that FMS are important building blocks of PL (Sport for Life, 2014). As such, FMS play a role in developing PL (Edwards et al., 2017). If FMS are refined in an applied setting, this can help the improvement of PL by developing physical competence (Edwards et al., 2017). However, physical competence is not the only important component of PL that is crucial for the development of positive movement behaviours.

Researchers have demonstrated that it is important to consider affective and cognitive factors that influence a child's movement behaviours such as confidence, motivation and understanding of PA. For example, self-efficacy is an important factor that influences PA behaviours. Self-efficacy is the confidence that an individual has to complete a task, despite being presented with barriers, and is therefore considered to be a situation-specific self-confidence (Rhodes & Blanchard, 2010). Self-efficacy has a positive relationship with physical activity (Bandura, 1997; Van Der Horst, PAW, Twisk, & Van Mechelen, 2007). This relationship is also bi-directional; not only does increased self-efficacy result in higher PA levels, but the reverse is also true as higher PA levels improve an individual's self efficacy (Bandura, 1997). Self-efficacy can be considered an important outcome, as well as a cause of PA (Elavsky et al., 2005). Manley et al., (2014) reported this relationship in their research. These researchers collected anthropometric measurements (BMI), PA assessments (using pedometers), aerobic fitness (using the 1-mile walk test), and self-efficacy data from Physical Activity Self-Efficacy Scale (Manley et al., 2014). Their sample consisted of children in the U.S. aged 11-13. Using Pearson product moments, relationships between self-efficacy, PA, and aerobic fitness were tested. Results showed that there were positive correlations between self-efficacy and both children's PA, and aerobic fitness (Manley et al., 2014).

As children age and go through developmental maturation, their affective and cognitive abilities also change. As children get older, their cognitive abilities such as information processing, attention, and problem solving should improve (Boyd & Bee, 2012). These improvements allow children to develop their knowledge and understanding of many areas of life. As children grow and learn at school, they are provided opportunities through physical education to improve their understanding of PA. This learning environment that children are

exposed to, as well as the improvements in cognitive functioning should work together to improve children's knowledge and understanding. Therefore, it is expected that as children age they develop a more comprehensive understanding of the importance of PA (Whitehead, 2010). This information suggests that understanding children's PA behaviours needs to go beyond assessing FMS and physical competence.

2.5.1 What is physical literacy

The idea that we must explore children's PA by emphasising more than just physical competence, is the basis of PL research. As such, PL is currently defined as having “the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life” (IPLA, 2014, pg. 1). Spearheaded by researchers like Margaret Whitehead from the UK, PL is based on a holistic approach to viewing human life (Whitehead, 2001). The mind, environment, and body play an integrative role in an individual's life experience, and this translates into aspects of life such as PA (Whitehead, 2001). It is claimed that individuals displaying high levels of PL demonstrate confidence, motivation, understanding, knowledge, and physical competence, in relation to leading an active lifestyle (Castelli et al., 2014; Mandigo et al., 2009; Tremblay & Lloyd, 2010; Whitehead, 2007). As a result of possessing these characteristics, individuals are more likely to participate in regular PA throughout their life (Mandigo et al., 2009; Tremblay & Lloyd, 2010).

2.5.2 PL history and development

Though PL has more recently become a key component in PA research, this concept has been evolving for some time. In its early development, PL was considered as a different way of describing someone being physically educated (Mandigo & Lodewyk, 2007). Physical education (PE) traditionally had a large focus on the physical competence of activity instead of the actual

understanding of it (Mandigo & Lodewyk, 2007). School curriculums for PE debated including PL as an important concept in their teaching of school children (Giblin et al., 2014; Mandigo & Lodewyk, 2007).

As the change of the century dawned, PL was considered within school PE curriculums. At this time, some researchers regarded PL to be an important component of PE (Penney and Chandler, 2000). Additionally, researchers argued that it was essential to incorporate the knowledge and understanding of skills related to being physically active, and that physical competency was not the main aspect of ensuring physically active individuals later in life (Penney & Chandler, 2000).

Margaret Whitehead especially supported this idea. She stated that PL was more than being able to just do PA and engaging muscles, but also understanding the subject (Whitehead, 2001). Whitehead notes how “physical literacy must encompass more than physical movement, it must include an ability to read the environment and to respond effectively...” (Whitehead, 2001, pg. 130). As part of her significant work in PL development, Whitehead (2001) identified that PL was universal, appropriate for all individuals and all abilities, and a state all individuals should strive to achieve. Through Whitehead’s work, PL matured into a holistic approach (Whitehead, 2001, 2007). This means that PL is made up of interconnected parts. PL does not just encompass physical competence, but also an individual’s daily behaviours, PA-related confidence and motivation, as well a PA-related knowledge and understanding (IPLA, 2014; Whitehead, 2001, 2007).

Since Whitehead’s research has been released, many other researchers have weighed in on the topic of PL. For example, Mandigo et al., (2009) stated that it was more important for physical education to focus on all dimensions of leading a physical lifestyle and not just the skills

that sports require (Mandigo et al., 2009). Their definition stated that PL requires competency in many activities, and to have high PL levels, an individual must understand the different forms of movements and apply them to many health-related- physical activities while using their knowledge to aid them in making active, healthy life choices (Mandigo et al., 2009). At this point in time, PL has now developed into a concept that is holistic in nature, encompassing all aspects of being active. PL is no longer simply another term for physical education but is now instead an aim for students to achieve, a curricular outcome (Mandigo et al., 2009; Tremblay & Lloyd, 2010; Whitehead, 2007).

2.5.3 Importance of fostering PL in children

This emergence of PL has provided a new way of looking at PA. The benefits of focusing on the development of an individual's PL allows us to focus on many factors, both internal and external, that can impact PA throughout their life. As previously mentioned, childhood activity levels may play a role in determining how active or sedentary an individual may be as an adult (Taylor & Sirois, 2012). With this in mind, it is important to examine what impact the development of PL in children can have.

Including the affective and cognitive influences of PA, and not just the physical components, PL goes beyond the traditional teachings of PE that highlighted improving children's physical skills and not necessarily other components (such as confidence) that could lead to more PA, and less SB (Mandigo & Lodewyk, 2007). Before the introduction of PL, PE focused primarily on developing physical competence and competition in sports. These traditional ideas of PE may not have fostered long-term PA involvement in many children (Mandigo & Lodewyk, 2007). Developing PL, rather than just physical skills/abilities, may increase enjoyment, and therefore act as an encouragement for lifelong PA behaviours.

When a child does not have high levels of PL, this relates to how physically active they are. Research highlights that those children who do not have high levels of PL will go out of their way to avoid participating in a variety of PAs, and therefore may be more sedentary (Foulkes et al., 2015; Stodden et al., 2008). Another attitude related to PL development is motivation. As with self-efficacy, a child displaying lower levels of PL also demonstrates low motivation to be physically active. These factors play a role in inhibiting children from overcoming barriers that may make it more difficult for them from participating in PA (Longmuir et al., 2015; Tremblay & Lloyd, 2010). Therefore, it is not surprising that children displaying low levels of PL also show low adherence to being physically active and spend more time sedentary. This highlights the importance of developing PL in childhood as a means of preventing the increase in SB that occurs as a child progresses into adolescence and then adulthood (Janssen et al., 2015; Pearson et al., 2017).

2.5.4 Assessing PL

As the concept of PL continues to evolve and grow, so too does the development of assessment tools. The creation of assessments will provide much needed information of PL levels in children. This information can then be used to understand how best to help develop PL in children. Therefore, it is important to recognise current assessment tools. For the purpose of this thesis, the focus will be on the most common measures of PL in Canada.

In Canada, several well-established organisations have developed tools for assessing PL. The Sport for Life Society, through the Canadian Sport for Life movement, recognises the importance of PL to children's health and wellness, and developed the Physical Literacy Assessment for Youth (PLAY) tools (<http://passportforlife.ca/>). Additionally, Physical and Health Education Canada, and the Healthy Active Living and Obesity research team, have

designed the Passport for Life (<http://play.physicalliteracy.ca/play-tools>), and the Canadian Assessment of Physical Literacy (<https://www.capl-ecsfp.ca/>), respectively. It is important to understand how these tools are used, and the benefits and limitations of each.

2.5.4.1 PL Assessment for Youth (PLAY) tools

The Canadian Sport for Life (CS4L) organization developed the PLAY tools (which can be accessed from: <http://play.physicalliteracy.ca/play-tools>). These include a set of PL assessments for children ages 7-12 (Sport for Life, 2014). These tools are made up of six components (PLAYfun, PLAYbasic, PLAYself, PLAYparent, PLAYcoach and PLAYinventory), all of which serve a certain purpose (Sport for Life, 2014). The roles of each component range from evaluating the skills and abilities a child possess in PLAYfun, to a self-assessment of PL in PLAYself (Sport for Life, 2014). In PLAYfun, 18 fundamental movement skills are assessed, some of which include skipping, galloping, running a square, and kicking a ball (Sport for Life, 2014). While the child performs the skill, the assessor determines their competence, confidence, and comprehension. Competence is rated as developing (with initial or emerging) or acquired (with competent or proficient). Confidence is simply rated as existing or not (Sport for Life, 2014). Additionally, comprehension is determined by whether the child needed a prompt, mimic, description, or a demonstration for each skill they are asked to perform. PLAYself includes a self-assessment form that children can complete, which assesses their self-efficacy and how important they believe PA is (Sport for Life, 2014).

2.5.4.2 PLAYtools advantages and disadvantages

An advantage of the PLAY tools is the fact that they allow input from children and parents, as well as professionals such as coaches and exercise experts (Sport for Life, 2014). Using a number of perspectives for each child, these tools have the ability to provide a well-

rounded idea of a child's PL level. This would aid in identifying what is needed to develop a child's PL levels. The inclusiveness of the assessment is a further benefit of the PLAYtools. The CS4L team state that the PLAYtools can be easily adapted to ensure individuals with disabilities can be assessed, resulting in minimal exclusion (Sport for Life, 2014). It is in line with the belief that PL is a concept relatable to individuals of all abilities (Whitehead, 2007). The PLAYtools are also accessible. If an individual has access to the internet, they can download the assessment forms, as well as workbooks, and explanations of each assessment from the Sport for Life website. These explanations are put in simple terms, meaning they are easy to understand, and can be used by a variety of individuals (coaches, academics, and parents). Despite these advantages, the PLAYtools do not assess all components of PL (e.g. knowledge, understanding, and motivation). For example: while comprehension of the skill is assessed, the PLAY tools do not measure the knowledge a child may possess regarding PA. As these characteristics are essential components of PL (IPLA, 2014), the PLAYtools do not provide a comprehensive assessment of PL. Additionally, the fundamental movement skills are not assessed in changing environments. The skill a child is asked to perform is static (for example: when a child is asked to kick a ball, the ball is simply placed in front of them as opposed to in motion or a game environment). Therefore, it cannot be determined whether a child can adapt their skill to a changing environment.

2.5.4.3 Passport for Life

Physical and Health Education Canada (PHE Canada) also aim to develop and produce the highest quality educational resources to assist in the development of PL (<http://passportforlife.ca/>). PHE Canada endorses the Passport for Life assessment tool, which was launched for children aged 3-6 in 2013 (PHE Canada, 2014). PHE Canada (2014) state that

the Passport for Life tool helps to identify the PL level of a child and the steps that can be taken to improve PL (PHE Canada, 2014). This PL assessment tool includes questionnaires to measure Active Participation and Living Skills. In addition to this, there are three fitness assessments: balance/dynamic stability, core strength, and cardiovascular endurance. There are also three movement skill assessments: locomotor, throwing and catching, and kicking/punting (PHE Canada, 2014). All data are inputted and stored onto the Passport for Life online system, which provides a child with information on their development and further tips on how to improve their PL. The Passport for Life was developed for teachers to use in an educational setting (PHE Canada, 2014), and allows them to track a child's progress. This is beneficial as these teachers will be able to provide children opportunities to further develop their skills at school. However, these assessments are focused on the physical competence of children's PA. According to the IPLA (2014), definition of PL, three other components of PA (daily behaviours, knowledge and understanding, as well as confidence and motivation), are also important to a child's development. Therefore, it seems that the Passport for Life does not deliver a full understanding of a child's PL.

2.5.4.4 Passport for Life advantages and disadvantages

The Passport for Life tool is beneficial since it was developed for a school environment and is therefore teacher-friendly. Research indicates the school environment is among one of the perfect 'breeding grounds' for PL development, and teachers can play an important role in their students' PA and measurement of PL (Castelli et al., 2014). Therefore, by providing teachers with the ability to assess their students, this enables them to understand the development of each student's PL. Thus, teachers can use this information to set goals and facilitate the development of PL in their students during school, which is a large part of a child's daily life (Castelli et al.,

2014). A further advantage of the Passport for Life tool is that it integrates movement skills as well as living skills into the assessment. For example, the living skills section integrates “physical activity behaviours, movements understanding, communications, relationships, social skills, critical thinking, and problem solving” into the assessment (PHE Canada, 2014 pg. 1). This corresponds with the idea that PL should be a holistic concept (Whitehead, 2007). This focus allows individuals to develop the necessary skills to integrate being active and healthy into their daily lives. Both the PLAYtools and Passport for Life include tracking of the child’s activity levels and health behaviours (Sport for Life, 2014; PHE Canada, 2014). These tracking techniques are beneficial due to the fact that it has been shown that this increases motivation in many individuals (Taylor & Sirois, 2012). As a result, this could motivate the children being assessed to continue or increase positive healthy and active behaviours. However, a weakness of this technique is its subjectivity. Self-tracking can be prone to inaccurate reports of PA behaviour (De Cocker et al., 2007; Taylor & Sirois, 2012) and therefore not provide a true picture of PL levels. Individuals can have a hard time recalling their behaviours or may choose to alter their activity levels to portray themselves in a favourable way (De Cocker et al., 2007; Taylor & Sirois, 2012). Therefore, it would be beneficial to adopt a more objective technique, such as pedometers, to track physical activity levels.

Overall, these PL tools are an important step in the right direction of PL development. They provide coaches, parents, and teachers with the ability to track progress, allowing them to be better equip for helping to improve/develop PL in children. However, as stated these tools do have their disadvantages. One of the most noteworthy disadvantages is that they do not provide a comprehensive assessment of PL, due to the fact that they do not not measure fundamental components of PL such as knowledge and understanding of PA. Additionally, these tools would

benefit from the use of more objective measures of PA, to ensure PA data are more accurate and reliable. A tool that could overcome the disadvantages of the PLAYtools, and the Passport for Life PL assessment, and provide a comprehensive assessment of PL, would be very beneficial.

2.5.4.5 The Canadian Assessment of Physical Literacy.

The Canadian Assessment of Physical Literacy (CAPL) is an assessment tool developed by the Healthy Active Living and Obesity (HALO) research team (<https://www.capl-ecsf.ca/>; Longmuir et al., 2015). The CAPL assesses all four components of PL: daily behaviour, motivation and confidence, physical competence, and knowledge and understanding (Longmuir et al., 2015). Over 100 experts contributed to the development of the protocol and it was pilot tested on 2000 children aged 8-12 years. The CAPL tool incorporates a variety of assessments to provide a score for each component of PL, as well as an overall PL score out of 100 (Longmuir et al., 2015). Additionally, based on their age-applicable score, each child is categorized as beginning, progressing, achieving, or excelling in terms of their PL development (Longmuir et al., 2015). Both confidence and motivation, and knowledge and understanding, components are measured out of a score of 18. Daily behaviours and physical competence are both scored out of 32. The values for each domain were determined through a Delphi process with nineteen child PA experts (Francis et al., 2016). These experts agreed that each component of PL holds equal importance. However, due to the subjective nature of confidence and motivation, and knowledge and understanding, measurements, larger scores were given to daily behaviours and physical competence (Francis et al., 2016).

The CAPL protocol has been tested with children aged 8-12 across the country (Longmuir et al., 2015). The protocol is very complex, with tests for each component of PL. Confidence and motivation are measured from answers to self-report questionnaires (the

Physical Activity Questionnaire and ‘What’s Most Like Me’ Questionnaire). Both questionnaires can be found in the CAPL manual at <https://www.capl-ecsfp.ca/capl-manual/>. Answers from the Physical Activity Questionnaire are also used to determine a score for a child’s knowledge and understanding. To determine physical competence, participants are asked to complete a series of physical tasks to determine their physical competence domain score. These tasks include: an obstacle course (to measure fundamental movement skills), The Progressive Aerobic Cardiovascular Endurance Run (PACER) (to assess aerobic fitness), sit and reach flexibility tool, height, weight, and waist circumference, timed plank, and a grip strength measurement. For the final domain, daily behaviours, each participant’s PA behaviour is measured objectively from wearing a pedometer for 7 days. Additionally, question 19 on the Physical Activity Questionnaire indirectly measures PA, and questions 15, 16 and 17 assess sedentary behaviour, including how much screen-based and non-screen-based SB they participate in. Once the domains are scored, the CAPL system calculates an overall PL score for each child. This score is calculated as a sum of the four domain scores (maximum of 100).

Due to the complexity of the assessment, the CAPL requires specific training and completing the assessment can be time consuming. Thus, it would be hard for the public to administer this protocol, unlike the PLAYtools designed for parents and children to use (Longmuir et al., 2015; Sport for Life, 2014). However, an advantage of the CAPL is that it involves a comprehensive assessment of PL. In contrast to the PLAYtools, the CAPL integrates important attributes such as confidence and motivation, and knowledge and understanding, into the assessment (Longmuir et al., 2015; Sport for Life, 2014). This follows the majority of research stating that attributes such as these are key to the development of PL in children (Castelli et al., 2014; Mandigo et al., 2009; Tremblay & Lloyd, 2010; Whitehead, 2007), and are

components of the internationally-recognized definition of PL (IPLA, 2014). A further advantage of this protocol over the PLAYtools and Passport for Life is the fact that the CAPL uses pedometers to assess daily PA behaviour (Longmuir et al., 2015; PHE Canada, 2014; Sport for Life, 2014). This allows for an objective measure of PA behaviours in children and a more accurate depiction of PA levels (De Cocker et al., 2007). Overall, the CAPL tool is a comprehensive measure that uses both objective and subjective assessments to provide a multifaceted understanding of a child's PA as well as SB, leading to information about PL. The CAPL tool is also a measure that is evolving. While version 1 has been described above, version 2.0 is now available and can be found at <https://www.capl-eclp.ca/>.

2.5 Summary

This literature review examined the evidence to date on the importance of maintaining healthy levels of PA and limiting excessive SB, in childhood and into adulthood; presented the 24 hour movement guidelines for children (which includes daily recommendations for PA and SB); described current levels of PA and SB in children, locally and nationally; described correlates of SB in children; examined risk factors associated with SB; and provided evidence of an association between age and SB. The concept of physical literacy, the importance of PL to children's health and SB, and various PL assessment tools, were also presented and discussed. Evidence provided in this review shows that excessive SBs have been increasing in children and youth in Canada, and around the world. This is a problem due to the many deleterious health consequences of participating in excessive SB. While there are many factors that can influence SB levels in children, evidence suggests that SB may be a construct of age, and that as children get older they are more likely to spend more time sedentary. FMS also play a role in determining children's SB, and these skills may be essential for the development of PL in children. The

concept of PL is important as it takes a holistic approach into looking at children's PA, and incorporates affective and cognitive domains, as well as physical competence. Currently, there is a lack of PL data, and children's PL has not yet been examined as a mediator to the expected increase in SB with age. Early prevention of SB is very important in child development. The question then becomes, what can be done to help reverse this hazardous trend, and prevent children from being excessively sedentary?

2.5.1 Research question and hypothesis

The primary research question is: does children's physical literacy mediate the relationship between age and sedentary behaviour? It is hypothesized that PL will have a significant mediating effect on the relationship between children's age and SB. However, it is worth noting that this type of question has not been studied before, and therefore this is exploratory research.

In addition to this research question, the present study will test several assumptions. These are: 1) Is there a relationship between age and SB 2) Is there a relationship between age and PL? 3) Is there a relationship between PL and total sedentary time? Research has shown that age has been reported as a correlate of SB, with increased SB being reported as children age. Therefore, it is hypothesized that there will be a significant positive relationship between children's age and SB in the present study. It is also hypothesized that there will be a significant positive relationship between age and PL, as previous research has shown that a relationship exists between FMS (the building blocks of PL), and age. A further hypothesis is that there will be a significant negative relationship between PL and SB, as improved FMS in children have been shown to lead to a decrease in SB levels. Finally, it is hypothesized that PL will have a significant mediating effect on the relationship between children's age and SB. However, it is

worth noting that this type of question has not been studied before, and therefore this is exploratory research. There is a lack of research regarding the role PL plays in SB, and so more research is needed to improve understanding.

CHAPTER 3: METHODOLOGY

The aim of the study was to determine if children's physical literacy mediates the relationship between age and sedentary behaviour. The present study aimed to accomplish this through secondary data analysis, using data collected on children aged 8 to 12 years in the CAPL study. This chapter identifies how the present study was carried out, presenting information on the study design, ethics approval, participants, procedure, and data analysis.

3.1 Study Design

The sample for the present study consisted of existing participants from the Canadian Assessment of Physical Literacy (CAPL) project from one of the data collection sites. Children's PL scores were obtained from the CAPL database. As outlined in Chapter 2, the CAPL project was a national project that utilized the most comprehensive measure of PL to date. Children's data were collected at schools and recreation centres in the Halifax Regional Municipality, as well as in Pictou County. Data collection occurred from June 2014 to December 2016. All data were transferred from data collection sheets, questionnaires, and pedometers to a secure online CAPL database managed by the central CAPL team at the Children's Hospital of Eastern Ontario, Canada. Raw data are stored under lock and key in the Physical Activity and Health Research Lab at Dalhousie University, and will be appropriately destroyed five years after the completion of the study. All participants in the original CAPL study were given a unique identifier, and no names were included in the CAPL data set. Therefore, no individual data will be singled out during the dissemination of results, including the present study.

3.2 Ethics

Ethics approval for the original CAPL project was obtained from the Dalhousie University Research Ethics Board (REB; Appendix A), and the Halifax Regional School board

(HRSB; Appendix B). Ethical approval was also granted by the Dalhousie University REB for the present study (Appendix C)

3.3 Participants

855 children aged 8-12 years from Halifax and the surrounding area (from the Halifax Regional School Board, as well as local private schools, and recreation centres in Pictou County), were given permission by their parents to participate in the CAPL study. A child's parent had to provide informed consent (Appendix D), as well as meet the inclusion criteria in a health screening form (Appendix E), to be a participant in the CAPL assessments. Additionally, a child was asked to provide his/her verbal assent immediately prior to assessments in order to participate. If at some point a child did not assent to either the entire assessment or one component of assessments, this superseded the previously provided informed consent from parents, and they were no longer included in the CAPL. For a child's data to be included in the present study, they must have participated in the CAPL project, and have enough data measured to calculate a PL score using the CAPL protocol (Longmuir et al., 2015). Additionally, for the child to be included in the present study, age and sedentary behaviour data must have been provided.

3.4 Procedure

The Canadian Assessment of Physical Literacy is a comprehensive assessment tool developed by the Healthy Active Living and Obesity Research Team (HALO, 2014). This measures the four domains of PL; confidence and motivation, knowledge and understanding, physical competence, and daily behaviours, in 8-12-year-old children (Longmuir et al., 2015). Each domain is scored, to give a total PL score out of 100, as outlined in Figure 1.

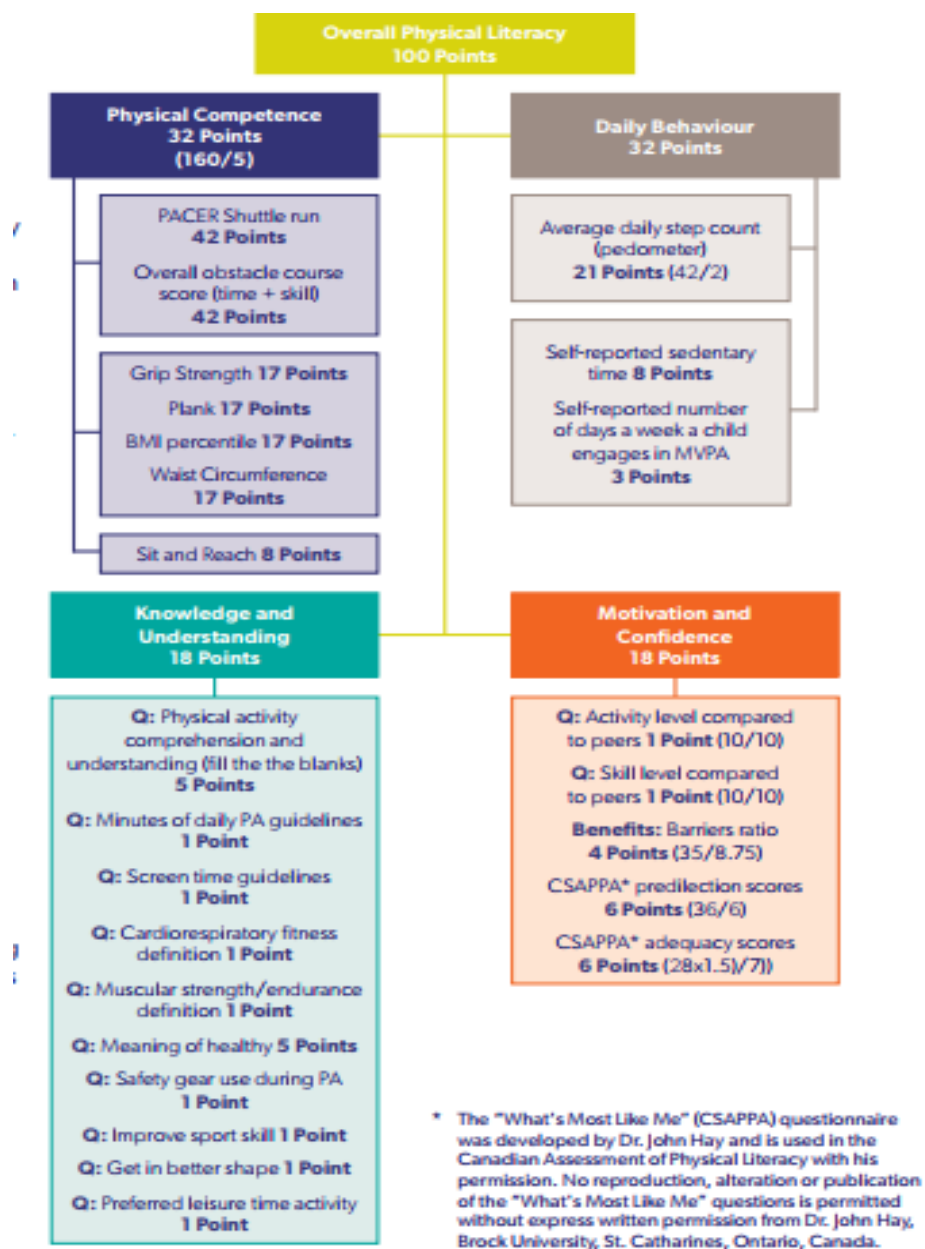


Figure 1: Scoring of CAPL PL domains, (HALO, 2014)

3.4.1 Physical competence

The physical competence domain was worth 32 points of the PL score. Measurements of musculoskeletal fitness, body composition, motor competence, and aerobic fitness are included in this domain score. Musculoskeletal fitness was measured using grip strength, plank, and

flexibility measurements, and had a possible score ranging from 6-42. To measure muscular strength, grip strength was assessed using a handgrip dynamometer, following the Canadian Society for Exercise Physiology (CSEP) protocol (CESP, 2013). Two trials were recorded (to the nearest 0.5kg) on each hand, and the maximum score for each hand was combined. A plank test was used to measure muscular endurance, following the protocol outlined by Boyer et al., (2013). Participants were asked to hold a plank in the correct position for as long as possible, measured using a stopwatch. Additionally, flexibility was measured using the sit and reach assessment in accordance with the CSEP (2013) protocol. Participants were given two trials, which were recorded to the nearest 0.5cm, and the highest value from each trial was used for the final score. Body composition (range of 8-34 points), was measured using height, weight, and waist circumference assessments. Height was measured following the CSEP protocol, using a stadiometer. Two trials were completed and recorded to the nearest 0.1cm, with a third trial being used if there was a discrepancy larger than 0.5cm between the two measurements. According to the CSEP protocol, weight was measured in two trials with a digital scale. The measurements were taken to the nearest 0.1kg, with a third trial administered if there was a difference of over 0.5kg between the two trials. The height and weight measurements were then used to calculate Body Mass Index (BMI). This was calculated using the following equation; $BMI = \text{Weight (kg)} / [\text{Height (m)}]^2$. This BMI score was then converted to age and gender z-scores, using the WHO (2007) growth charts. Additionally, waist circumference was measured using the hip bones as bony landmarks to identify where to measure around the participant's waist, as per the CSEP protocol (CSEP, 2013). This measure was taken over two trials to the nearest 1mm, with a third trial administered if there was a difference bigger than 0.5mm between the first two (HALO, 2014). Motor competence (range of 1.5-42 points) was measured using an

obstacle course, which included several fundamental movement skills. Participants completed a practice round, and two scored (out of 14) timed trials. The obstacle consisted of 3 two-foot jumps in and out of hoops, sliding between two cones, catching a small ball, throwing the ball at a target on the wall, skipping back to the hoops, one-foot hopping through each hoop, and finally, kicking a ball to hit a target (HALO, 2014). Finally, aerobic fitness was assessed using the 15/20-meter Progressive Aerobic Cardiovascular Endurance Run (PACER, score range 10.5-42). According to the Meredith and Welk (2010) protocol, participants had to run either 15 or 20 meters, with their foot reaching the line before a beep sounds. The beeps got progressively closer together, and participants were instructed to continue running until they feel they can no longer continue, or they miss two beeps (HALO, 2014). These four components were then summed to give the physical competence domain score (range of 26-160 points), which was then divided by 5, giving a final range score of 5.2 to 32.

3.4.2 Daily Behaviour

Like the previous domain, the daily behaviour domain was also worth 32 points out of the 100 PL score. To calculate this domain score, pedometer step count (worth 21 points), self-reported screen time (worth 8 points), and self-reported moderate to-vigorous physical activity (worth 3 points), scores were used. Participants were instructed to wear pedometers for 7 days and completed a pedometer log sheet for time on/off. To have a pedometer score, participants needed to have had at least 3 days of valid data (HALO, 2014; Tudor-Locke et al., 2009). Valid data also required the following criteria: between 1000 and 30,000 steps per day (Pabayo et al., 2010; Tudor-Locke et al., 2009), with at least 10 hours of wear time per day (Colley et al., 2010; Eisenmann et al., 2007). Screen time was measured based on answers 15, 16, 17, and 18, in the Knowledge of Physical Activity Questionnaire (Appendix F; CAPL, 2014). In these questions,

participants were asked about how much time they spent participating in screen-based SB habits during weekdays and weekends. Specifically, question 15 asked the child to report how many hours they spent watching TV on a school day. Question 16 asked the child to report how many hours they spent playing video/computer games or using a computer for something other than school work on a school day. Question 17 asked the child to report how many hours they spent watching TV on a weekend day. Finally, Question 18 asked the child to report how many hours they spent playing video/computer games or using a computer for something other than school work on a weekend day. Questions 20 and 21 of the questionnaire were centred around children's non-screen time SB. Question 20, asked children how much time on a school day they spent sitting down doing non-screen-based activities (e.g. reading a book), and asked them not to count the time they spent at school. Question 21 asked children to report this non-screen-time behaviour for a weekend day. For each question, children could choose one option. These options were "I did not spend time" = 0 hours/day, "Less than 1 hour" = 0.5 hours/day, "1 hour" = 1 hour/day, "2 hours" = 2 hours/day, "3 hours" = 3 hours/day, "4 hours" = 4 hours/day and "5 or more hours" = 5 hours/day. As these questions suggest, the goal of the CAPL was to develop an understanding of children's leisure time SB, and so did not capture sedentary time during school hours. Total screen-based SB was calculated by summing the reported average daily hours for both computer use and TV time. This average daily screen-based SB score was then summed with average daily non-screen-based SB to calculate average daily total SB. In total, three SB variables were available for analysis: 1) screen-based SB, 2) non-screen-based SB, and 3) total SB. While an objective measure of SB was not used in the CAPL tool, previous research has shown that self-reported SB can be a reliable measure of children's sedentary time (Lubans et al., 2011). For self-reported MVPA, participants completed question 19 of the Knowledge of

Physical Activity Questionnaire. In this question, participants were asked how many days a week they were physically active for at least 60 minutes, and to think of all the time they spent in activities that increased their heart rate and made them breathe hard. These components were then summed to determine the score for the daily behaviours domain. These questions were created through a Delphi process, in which 19 professionals were consulted (Francis et al., 2016). Consensus support was provided by this group of professionals for these measures of self-reported SB (Francis et al., 2016).

3.4.3 Confidence and Motivation

The confidence and motivation domain was worth 18 points, which came from answers to the questionnaires. This score was based on children's responses to specific questions in the questionnaire portion of the CAPL protocol. Topics of these questions included PA participation and skills compared to peers, barriers to PA participation, as well as children's PA adequacy (HALO, 2013). Questions 2 and 3 of the Knowledge of Physical Activity questionnaire were worth 4 points and asked children about barriers to PA (HALO, 2013). Children were asked to complete a 1-5 Likert scale regarding reasons to be or not to be active. An answer of 1 represented 'disagree a lot,' 2 was 'disagree a little,' 3 was 'in between,' 4 was 'agree a little,' and 5 was 'agree a lot.' For questions 4 and 5 participants were asked to rank themselves on a scale of 1-10 regarding how active they were compared to their peers, and how good they were at sports compared to peers (HALO, 2013). Their score for these questions was calculated by dividing their circled number by 10. Additionally, 12 points were allotted to answers from the 'What's Most Like Me' Children's Self Perceptions of Adequacy in and Predilection for Physical Activity (CSAPPA) Questionnaire (see Appendix G). In this questionnaire, developed by Hay (1992), participants were presented with two statements (for

example: some kids are good at active games or other kids find active games hard to play). They were then asked to choose one statement and state whether that was sort of true for them or really true for them. The aim of this questionnaire was to examine children's predilection and adequacy of PA (HALO, 2013).

3.4.4 Knowledge and Understanding

The remaining 18 points of the PL score came from the final domain of knowledge and understanding. The points for this domain were provided from the Knowledge of Physical Activity questionnaire. At the beginning of this questionnaire, participants were asked a number of descriptive questions such as what grade they were in, their sex, and their age. Additionally, participants were asked how old they were at the time of assessment, and his/her month of birth. Therefore, the age variable was in decimal years (e.g. 8.5). Questions, 1, 6, 7, 8, 11, 12, 13, and 14, focus on items such as MVPA, screen time, preferred leisure activities, activity safety, and understanding of fitness terms, which were all worth 1 point. Questions 9 and 10 are worth a maximum of 5 points and asked participants to explain what healthy meant to them, as well as a fill in the blank question about PA, respectively (HALO, 2014).

Once the domains were scored, they were summed to calculate an overall physical literacy score for each child out of 100 (HALO, 2014). The physical literacy score was also categorized as beginning, progressing, achieving, or excelling. Researchers using the CAPL assessment tool were provided with a manual that outlined how to interpret scores for each domain, as well as the overall physical literacy score (HALO, 2014).

3.5 Data analysis

Due to the quantitative nature of the data collected in the present study, all data were analysed using the Statistical Package for Social Sciences (SPSS v. 24.0) for analyses. Before

analysis, CAPL data were checked for any outliers using boxplots, and none were found. Data were also checked for coding errors or missing values. If more than one protocol was missing from a domain during the CAPL assessment, a PL score could not be calculated (HALO, 2014). Any child with a missing PL score was removed from analysis. Additionally, if a child did not answer questions 15, 16, 17, and 18, 20, and 21, they would not have a total SB time score. Consequently, these children were also removed from analysis.

The three main variables that were used in the present study were decimal age, total time spent sedentary, and adjusted PL score. Decimal age was collected in the CAPL project in the Knowledge of PA questionnaire. To calculate a weighted daily mean for each type of SB (screen and non-screen) the following equation was used: $[(\text{hours of SB on school days} \times 5) + (\text{hours of SB on weekends} \times 2)]/7$. Total time spent sedentary was calculated by summing the times reported for total daily screen time, and total daily non-screen-based SB. For the purpose of the present study, SB the questions asking about children's screen time (worth 8 points) were removed from the Daily Behaviour domain score, as done in a previous study (Saunders et al., in press). Questions about children's screen time were the only SB questions to be included in the original CAPL score. Therefore, the re-calculated domain score was 24, meaning that the adjusted PL score was a maximum of 92.

In the first step of analysis, descriptive statistics were completed to describe the entire sample (means, standard deviations, and ranges for the 3 main variables: age, SB (screen based, non-screen based, and total), and PL). For the next step of analysis, the assumptions of the main statistical tests had to be checked. The first statistical test to be used was Pearson's correlation coefficient, to determine whether or not there was a significant relationship between age and

time spent sedentary, age and PL, and PL and time spent sedentary. These relationships were the assumptions that would lead into the mediation analysis.

The four assumptions of correlational analysis are: normal distribution of data; no significant outliers are present in the data; analysed variables are continuous; a linear relationship. These assumptions were all checked before conducting these analyses. During this time, it was discovered that time spent sedentary did not meet the assumption of normality. Therefore, a log transformation was conducted to correct for this. As a result, the variable log sedentary time was included in the final correlation analysis. The remaining assumptions of correlation were met. Pearson's correlation is a measure of the direction and strength of a relationship between two variables (Field, 2013). The Pearson correlation coefficient (denoted by r), ranges from +1 to -1. A value of 0 indicates that no relationship exists between two variables, less than 0 displays a negative relationship, and more than 0 shows a positive relationship (Field, 2013). Additionally, how close r is to +1 or -1 determines strength of relationship. If r is close to 0, this indicates little/no relationship (Field, 2013). A weak relationship is denoted by an r of 0-0.3, a moderate relationship is denoted by 0.3-0.6, and an r above 0.6 is considered a strong relationship.

The next step of data analysis was to answer the research question: does children's PL mediate the relationship between age and sedentary behaviour? To do this, mediation analysis was utilised, and the assumptions of regression analysis were checked. The assumptions of regression include; a linear relationship between the outcome and independent variable (tested using scatter plots), multivariate normality (tested using a histogram), no multicollinearity (tested using Variance Inflation Factor of <10), independent errors (tested with the Durbin-Watson test),

and finally no Homoscedasticity. Analyses showed that these assumptions were met, and mediation could be performed.

Mediation analysis is a form of regression analysis that determines whether the relationship between an independent variable and outcome variable can be explained due to their relationship to a third variable (Field, 2013). In the present study, the independent variable was children’s decimal age, the outcome variable was children’s sedentary time (in the form of log time spent sedentary), and the mediator variable was children’s PL score (in the form of the adjusted PL score (e.g. total score of 92)). In the statistical model, three regression models are used to test mediation (Field, 2013). The first model is a regression that predicts the outcome from the independent variable (Denoted by “c” in Figure 2). Second, there is a regression predicting the mediator from the independent variable (denoted by “a” in Figure 2). Thirdly, there is a regression predicting the outcome variable from both the mediator and independent variable (denoted by “b” in Figure 2). Mediation is tested by assessing the size and confidence interval of the indirect effect (see Figure 2). If the confidence interval that is generated does not include zero, it will be possible to conclude that mediation occurs in this data set. Additionally, in the mediation output from SPSS, the coefficient allows us to determine the amount of variance that is explained by the mediation. For example, a coefficient of 0.08 would suggest that the mediation model accounts for 8% of the variance in the relationship between the independent and dependent variable.

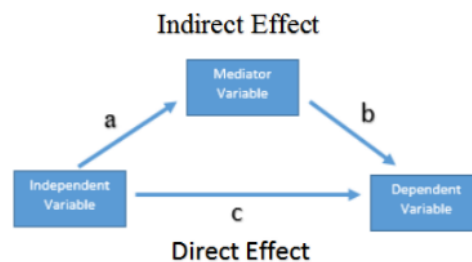


Figure 2: Diagram of mediation model (Field, 2013).

CHAPTER 4: RESULTS

4.1 Descriptive Statistics

CAPL data were collected on 855 children (424 boys and 431 girls) aged 8-12 years from the Halifax Regional Municipality (HRM) and surrounding area (Halifax Regional School Board, local private schools, and Pictou County).

Table 1: Age and Sex of Participants in the Original Sample

| Age (in years) | Girls (n) | Boys (n) |
|----------------|-----------|----------|
| 8 | 129 | 119 |
| 9 | 103 | 90 |
| 10 | 93 | 102 |
| 11 | 83 | 89 |
| 12 | 23 | 24 |
| Total | 431 | 424 |

Only 705 participants (358 girls and 347 boys) had complete data (valid sedentary time data, decimal age score, and adjusted PL score data). Therefore, the total sample size for the correlations and mediation analysis was 705. The mean age for this sample was 9.98 (\pm 1.24). The minimum recorded decimal age was 8.00, and the maximum was 12.90 (range of 4.90).

To better understand the SB habits of children in this sample, descriptive statistics were calculated. The average total daily sedentary time (i.e. weekday + weekend screen-based and non-screen based) for the sample was 3.45 hours (SD = 2.33 hours), with a minimum recorded

time of 0 hours, and a maximum score of 15 hours. This was then broken down into average daily non-screen-based sedentary time (mean (SD) = 1.58 ± 1.24 hours), and average daily screen time (mean (SD) = 1.87 ± 1.71 hours). Average daily screen time was further broken down into average daily computer time (mean (SD) = 0.91 ± 1.08 hours) and average daily TV time (mean (SD) = 0.96 ± 0.96 hours). The average CAPL score was 67.42 (±11.12). The mean adjusted PL score was 61.46 (SD = 9.73) out of a possible 92 points, with a minimum recorded score of 27.00, and a maximum score of 84.04 (range of 57.04). As well as the numerical score, the CAPL provided a PL categorization for children (HALO, 2014). Children could be considered 'beginning,' 'progressing,' 'achieving,' or 'excelling.' Results showed that 7.5% of children were categorised as beginning, 37.6% of children were progressing, 25.8% of children were achieving, and 29.1% of children were excelling in terms of their PL. Descriptive statistics for these variables according to age are presented in Table 2.

Table 2: Adjusted PL score (/92), total daily sedentary time (hours), average daily non-screen-based sedentary time (hours), average screen-based SB (hours), average TV time (hours), and average computer time (hours) in participants, by age.

| Age | Adjusted PL score Mean (SD) | Total Daily Sedentary time (hours) Mean (SD) | Average daily non-screen based sedentary time (hours) Mean (SD) | Average daily screen time (hours) Mean (SD) | Average daily computer time (hours) Mean (SD) | Average daily TV time (hours) Mean (SD) |
|-----------------------|--|---|--|--|--|--|
| 8 (n=195) | 59.88 (8.85) | 3.18 (2.49) | 1.40 (1.29) | 1.79 (1.75) | .84 (1.03) | .94 (.99) |
| 9 (n=155) | 59.95 (9.87) | 3.21 (2.29) | 1.57 (1.29) | 1.64 (1.65) | .78 (1.05) | .86 (.86) |
| 10 (n=174) | 62.74 (10.24) | 3.32 (2.18) | 1.49 (1.13) | 1.83 (1.66) | .93 (1.08) | .90 (.94) |
| 11 (n=152) | 63.49 (9.42) | 4.15 (2.32) | 1.91 (1.26) | 2.24 (1.76) | 1.08 (1.09) | 1.16 (1.04) |
| 12 (n=29) | 61.69 (10.70) | 3.62 (1.75) | 1.61 (.84) | 2.02 (1.54) | 1.14 (1.27) | .88 (.84) |

Prior to data analysis, the assumptions of correlation and regression analyses were tested. The data met the assumptions of linearity, homoscedasticity, use of continuous variables, multicollinearity (all variance inflation factors (VIFs) were under 3), and lack of outliers. However, total sedentary time was not normally distributed. Therefore, a log transformation ($\log(\chi_i)$) was done to reduce the skewness of this variable. Once this transformation was completed, the log sedentary time variable met the assumption of normality.

4.2 Correlation analysis

The three variables included in the correlation analysis were: age, log sedentary time, and adjusted PL score. Results of correlation analysis showed a weak significant positive relationship between adjusted PL score and age. There was also a weak significant positive relationship between age and log sedentary time. Finally, a moderate significant negative relationship was displayed between adjusted PL score and log sedentary time. The results of the correlation analyses can be seen in Table 3.

Table 3. Results of correlation analyses using age, log sedentary time, and adjusted PL score.

| | | Adjusted PL Score | Age (decimal years) | Log sedentary time |
|---------------------|---------------------|-------------------|---------------------|--------------------|
| Adjusted PL Score | Pearson Correlation | 1 | .140** | -.334** |
| Age (decimal years) | Pearson Correlation | .140** | 1 | .187** |
| Log sedentary time | Pearson Correlation | -.334** | .187** | 1 |

** . Correlation is significant at the 0.01 level (2-tailed).

4.3 Mediation analysis

For the 705 participants, age, log sedentary time, and adjusted PL score were put into mediation analysis. Bootstrap confidence intervals were used to determine if the mediation model was significant. The bootstrapping estimation method used 1000 resamples. As illustrated by figure 2, the standardized regression coefficient between children's age and PL was significant, as was the standardized regression coefficient between children's PL and SB. The

indirect effect (mediation) is significant if the bootstrap confidence intervals do not contain zero. There was a significant indirect effect of age on SB through PL, $b = -.0092$, Bca CI $[-.0145, -.0045]$. Effect size was given by the completely standardized indirect effect, $r^2 = -.0514$, 95% Bca CI $[-.0799, -.257]$. This shows that 5.1% of the variance in the relationship between age and sedentary time can be explained due to the mediation of adjusted PL score. A diagram of the completed mediation model is shown below.

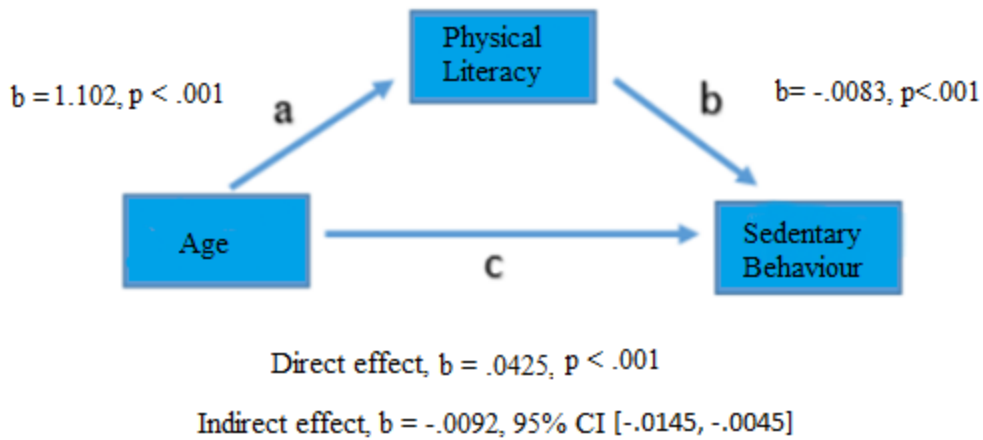


Figure 3: Model of age as a predictor of sedentary behaviour, mediated by physical literacy.

CHAPTER 5: DISCUSSION

The purpose of the present study was to examine whether children's physical literacy mediates the relationship between age and sedentary time. It was hypothesized that there would be a significant positive relationship between children's age and sedentary time. Secondly, it was hypothesized that there would be a significant positive relationship between children's age and physical literacy. Thirdly, it was hypothesized that there would be a significant negative relationship between children's physical literacy and sedentary time. Finally, it was hypothesised that children's physical literacy would significantly mediate the relationship between age and sedentary time.

As hypothesized, there was a significant positive relationship between age and sedentary time ($r = .187$) in this cohort of children ($n = 705$) aged 8 to 12 years from the Halifax Regional Municipality and Pictou County. The results of this analysis suggest that as the age of children in this sample increased, so did their sedentary time, in screen and non-screen sedentary activities. There was also a significant positive relationship between children's age and physical literacy ($r = .140$), which suggests that as the age of the children increased, so did their total physical literacy score. The final correlation showed that there was a significant negative relationship between children's physical literacy and sedentary time ($r = -.334$). This demonstrates that for this sample, as children's total physical literacy score increased, their sedentary time decreased.

5.1 Relationship between children's age and sedentary time

The relationship between age and sedentary time was not surprising, as previous research studies demonstrated that age is a correlate of sedentary behaviour (SB). For example: in a large sample ($n=1855$) of children in grades 3, 7, and 11 from Nova Scotia, the older children had the highest levels of objectively recorded SB (Thompson & Wadsworth, 2012). In the present study it was the 11 year olds, and not the 12 year olds, who self-reported the highest levels of SB (an average of 4.19 hours/day vs. 3.62 hours/ day for 12-yr old children). This finding is contrary to what is expected as the younger age group spent more time (on average), in sedentary activities. However, there were a greater number of 11 year olds ($n= 152$), than 12 year olds ($n= 29$). Therefore, if more 12 year olds had participated in this study, the average sedentary time may have been different.

It is worth noting that the strength of this relationship was weak ($r= .187$). The age range of the children in this study could play a role in the strength of this relationship. In the Thompson & Wadsworth (2012) study, the youngest participants were children in grade 3 (typically 8 to 9 years olds), and the oldest were in grade 11 (typically 16 to 17 years olds). A larger age range would encompass the transition from childhood to adolescence. It is during this transition, especially when children move from elementary to junior school and again to high school, where an increase in sedentary behaviours is prevalent (Pearson et al., 2017). The children in this study were in elementary school and had not transitioned into adolescence (which is typically described as reaching 13 years of age (Buhrmester, 1990)). As such, if a sample of children with a larger age range that included the transition into adolescence had been used in this study, a stronger relationship between age and SB may have been shown.

5.2 Relationship between children's age and physical literacy

The significant, positive relationship between children's age and physical literacy is expected. While, this is one of the first time these two variables have been analysed this way, FMS have previously been linked with age. As mentioned in the literature review, fundamental movement skills (FMS) have been used as a marker for physical literacy and are an important part of the physical competence domain. FMS have been reported to improve with age as children's ability to perform more complex skills increases (Hoeboer et al., 2018); an improvement could therefore be expected in physical literacy with age. The results of the present study seem to support this idea.

As previously stated, physical literacy is comprised of four interrelated domains: physical competence, daily behaviours, confidence and motivation, and knowledge and understanding (Longmuir et al., 2015) A change in one domain could result in a change in others, and therefore an improvement in overall PL. For example, developing FMS can result in mastery of these skills. As a child ages, and becomes more competent in his/her FMS, this could enhance a child's PA-related confidence (Alston & Griffiths, 2015). Additionally, the development of FMS is a correlate of movement behaviours. For example, Barnett et al., (2009) found that when children (age 7.9-11.9 years) were proficient at object control FMS, they were more likely to be physically active in adolescence. This impact of FMS on PA could be described then as when a child's FMS increases, they are more likely to choose to participate in PA rather than SB and then overall are more likely to be active. The interconnection of these components of PL, and how they develop with age, could help to explain the relationship seen in the present study. While the relationship between children's age and PL was significant, it should be noted that this relationship was weak ($r = .140$). It could be argued that because the age range of children was

small, developmental differences may be less than one might expect in a population with a wider age range to test this idea further, a study could be conducted using a wider age range of children, to see if this relationship becomes stronger. As the CAPL tool has only been validated on 8 to 12 year olds, this suggests that other physical literacy measurement tools need to be designed to test children of other ages.

While the results of this study suggest that there is a positive relationship between age and PL, this linear relationship may not always exist. It is hoped that domains such as knowledge and understanding, physical competence, and daily behaviours would continue to improve with age. As children age, they master FMS, improve their knowledge through education, and this would hopefully lead to an improvement in daily behaviours. However, the domain of confidence and motivation may not always have a linear relationship with age. As children transition into adolescence, they go through a number of physical and emotional changes as they reach puberty (Schunk & Meece, 2006). While they go through these changes, they can experience fluctuations in their self-efficacy. For example, changes in the body associated with puberty can be specifically hard on girls, with research showing that adolescent girls show a decrease in self-efficacy when they hit puberty (Paxton, Neumark-Sztainer, Hannan & Eisenberg, 2006). Therefore, these changes in self-efficacy could cause fluctuations in PL. As a result, the relationship between age and PL may not be completely linear if a larger age range was used in a future study.

5.3 Relationship between children's physical literacy and sedentary time

As the narrative surrounding physical literacy develops, this is one of few studies to date to explore the relationship between children's physical literacy and sedentary time. This study used a large cohort (n= 705) of Nova Scotian children aged 8 to 12 years and found a significant

negative relationship between children's physical literacy and sedentary time, as hypothesized. The results from this study support the findings of Saunders et al., (in press), who also examined the relationship between children's physical literacy and SB, running separate models for screen based and non-screen based sedentary behaviours, in a larger ($n= 8307$), nationally-representative cohort of Canadian children aged 8 to 12 years. As with this study, physical literacy and sedentary behaviour were measured using the CAPL protocol. Unlike the present study, Saunders et al., (in press) explored the relationship between PL and the different modes of SB (screen, non-screen, total SB). The domains of PL, as well as components of the CAPL (such as; PACER score, and BMI z-score) were used in linear regression analysis to determine their relationship with the modes of SB. Results revealed that all domains of PL, were significantly associated with children's SB, with the confidence and motivation exhibiting the strongest association of the domains (standardized β 's: -0.300 to -0.078, $P < 0.05$). Additionally, overall PL score was significantly associated with all modes of children's SB (standardized β 's: -0.272 to -0.038, $p < 0.05$). The results from Saunders et al., (in press), provide support for the present study in a cohort from Halifax Regional Municipality and Pictou County. While this study made use of linear regression to develop models for the relationship between PL and modes of SB, it differs from the present study. Unlike Saunders et al., (in press), the present study creates a mediation model to determine if PL plays a role in the relationship between children's age and sedentary time.

While it is difficult to completely determine reasons as to why this relationship was found, the components of PL could play a role. Previous research has shown that when certain components of physical literacy (e.g. fundamental movement skills, confidence) improve, children are more likely to choose to be physically active rather than spending their time in

various sedentary activities (Foulkes et al., 2015; Stodden et al., 2008; Feltz & Magyar, 2006). For example, Lloyd, Saunders, Bremer, & Tremblay (2014), found that when children were classed as having high motor proficiency at age 6, they were more likely to have higher levels of PA 20 years later. They also found that women who perceived their motor skill proficiency to be high, spent less time in sedentary activities as adults (Lloyd et al., 2014). These results suggest that as well as actual ability, confidence in one's abilities also promotes a more active lifestyle. Both skill, and confidence are components of PL. Therefore, this could mean that children who are more physically literate are likely to choose PA over SB.

5.4 The mediating effect of physical literacy on the relationship between children's age and sedentary time

The findings from this study indicate that physical literacy partially mediates the relationship between children's age and sedentary time. Specifically, results from the model showed that physical literacy explained 5.1% of the increase in children's sedentary time with age. In other words, physical literacy development in childhood could have an important role in preventing/reducing excessively high levels of SB in children as they age and transition into adolescence. This would make sense, as if an individual is more physically literate, this means that their confidence and motivation could be higher, they may be more proficient in their FMS, and they potentially could have greater knowledge which could lead them to choose more positive daily behaviours. Therefore, high PL levels can dampen the age-related increase in SB, as an individual is more likely to choose active pursuits as opposed to sedentary ones.

The mediation of PL in the relationship between age and SB reported in this study, is considered a partial mediation. This means that when the indirect effect of PL was introduced, the direct effect of age on SB was still significant. Additionally, the mediation of PL accounted

for 5% of the variance in the SB of children with age. This suggests that while the mediating effect of PL was significant, it was also weak. Despite this, the mediation analysis uncovers the potential importance of the development of PL, as it may dampen the age-related increase in SB in children. The results of this study warrant further research into this mediation relationship, to see if stronger relationships can be shown.

Previous research included PA, FMS, and SB within a mediation analysis to examine if the relationship between FMS and SB was mediated by MVPA in children (Gu, 2016). However, Gu (2016) used an arguably simpler form of PA measurement than in the current analysis. The use of PL as a mediating factor in a model with age as an independent variable and SB as the outcome variable, is novel. The significant partial mediation of PL warrants further attention, as this suggests that the development of PL can play a role in decreasing SB as children age. It would be beneficial to explore this relationship in a sample that included children with a larger range of ages – assuming appropriate measures could be used to identify if a stronger mediation effect would exist.

While the results of this study suggest that a child's PL level may explain some of their SB, the partial mediation may be due to the fact that there are a number of correlates that contribute to the amount of sedentary time a child displays. As mentioned within the literature review, as well as intrapersonal correlates of SB, there are also many environmental and social factors that contribute to the amount of sedentary time children display (Morton et al., 2015; Stierlin et al., 2015). The present study suggests that explaining SB through the influence of just one factor is not enough, and that factors such as PL, school, and home environment, the influence of friends and parents, among others may combine to impact children's SB. Therefore,

going forward into future research, the importance of a multi-faceted approach to decreasing excessive SB can not be understated.

5. 5 Factors influencing age, sedentary behaviour, and physical literacy relationships

5.5.1 Time spent in screen and non-screen sedentary behaviour

Time spent in screen and non-screen sedentary behaviours may have had an impact on the findings in the present study. Average self-reported total screen time was 1.87 ± 1.70 hours a day with no age group exceeding the recommended two hours (Table 2). This is surprising as other publications report that Canadian children are consistently not meeting the sedentary behaviour guidelines (Roberts et al., 2017; Thompson & Wadsworth, 2012). Additionally, this screen-time score is lower compared to the national CAPL data set. Saunders et al., (in press) examined the national CAPL data set ($n=8307$) and found that the children reported an average of 2.4 hours of daily screen time. However, this population self-reported slightly higher levels of non-screen-based SB (1.6 ± 1.25 hours per day) compared to the national sample (1.3 ± 1.3 hours per day). Thus, suggesting that there is a slight difference in the modes of SB in children from the present study, compared to the national sample.

Previous studies have used screen-time as a measure of children's SB, though according to these results, that may not be appropriate as non-screen time behaviours also make up a portion of children's sedentary time. This is like findings from Engelen et al., (2013) and Olds et al., (2010). Both studies found that although children spent a large proportion of leisure time participating in screen-based SBs, a considerable amount of time was also spent in non-screen-based SB (such as homework, quiet play, sitting, etc.) (Engelen et al., 2013; Olds et al., 2010). Since children's SB is made up of more than just screen-time, other non-screen-based sedentary

behaviours (like reading or talking with friends) should be measured and included in analyses exploring relationships of children's age and physical literacy with SB.

5.5.2 Physical literacy scores

The mediating effect of children's physical literacy on the relationship between age and sedentary time may have been influenced by high physical literacy scores in this population. The average physical literacy score was 67.42 out of 100. For the purpose of this study, 8 points (that represented answers regarding children's screen time) were removed from the CAPL daily behaviours domain score. As such, this resulted in an adjusted PL score out of 92. With this in mind, children's average adjusted PL score was 61.46 out of 92. As well as a numerical score, the CAPL tool also provides a categorical PL score. Using the CAPL, children can be categorised as 'Beginning, progressing, achieving, or excelling.' In the present study, 7.5% of children were categorised as beginning, 37.6% of children were progressing, 25.8% of children were achieving, and 29.1% of children were excelling in terms of their PL. The classifications for each age group are noted in Table 4 (HALO, 2014). In this study, 54.9% of children were meeting the recommended PL levels by achieving or excelling in their PL. Children who are considered 'achieving' PL, "have the physical competence, knowledge, motivation, or daily behaviours that are usually associated with the health benefits of a physically active lifestyle..." (HALO, 2014 pg. 18). These children are considered on their way towards PL excellence. Those that are considered to be 'excelling' exceed the minimum level of PL recommended, and receive substantial health benefits from doing so (HALO, 2014). As previously stated, the results of the present study suggest that when children's PL levels are higher, their SB levels are lower. The average PL score was 67.5, which is considered as 'achieving' in each age group, and as such could explain their lower self-reported SB levels. Caution is warranted, however, as this is one of

the first studies examining the relationship between PL and SB with more information needed regarding how this relationship works, and whether cause and effect can be determined.

Table 4. Classification of PL scores (HALO, 2014).

| | Beginning | Progressing | Achieving | Excelling |
|--|-----------|--------------|----------------|-----------|
| Physical Literacy Overall (max 100) | < 43.8 | 43.8 to 63.8 | > 63.8 to 74.0 | > 74.0 |
| 8 | < 39.2 | 39.2 to 61.5 | > 61.5 to 72.6 | >72.6 |
| 9 | < 47.3 | 47.3 to 63.7 | > 63.7 to 72.0 | > 72.0 |
| 10 | < 41.2 | 41.2 to 61.6 | > 61.6 to 71.7 | >71.7 |
| 11 | < 44.8 | 44.8 to 66.7 | > 66.7 to 77.6 | > 77.6 |
| 12 | < 41.3 | 41.3 to 64.0 | > 64.0 to 75.3 | > 75.3 |

5.6 Strengths and Limitations

5.6.1 Strengths

One important strength of the present study is that physical literacy data were collected using a comprehensive assessment tool considered to be valid and reliable in children ages 8 to 12 years (Longmuir et al., 2015). As mentioned, the CAPL tool is the first assessment tool in Canada to encompass all four of the PL domains, utilizing both subjective and objective measures within assessments. This helps to create a more complete image of children’s PL level. Also, the present study combined screen and non-screen sedentary time into one variable. While this is not the first study to use children’s, total sedentary time in its analyses, other research projects have included just screen time as a marker of children’s SB. As this study and previous studies have shown, children participate in different types of SBs including both screen and non-screen based activities. Thus, the inclusion of both screen-based and non-screen based SB to create a total SB time score is beneficial as it provides a distinct description of children’s sedentary time.

5.6.2 Limitations

5.6.2.1 Study Design

One limitation of this study is its cross-sectional design, which precludes the ability to determine cause and effect. For example: while the study revealed that significant relationships exist between age and sedentary time (positive), age and physical literacy (positive), and physical literacy and sedentary time (negative), and that physical literacy mediates the rise in sedentary time with age, it is not possible to determine whether an increase in physical literacy would cause a decrease in sedentary behaviour with age. Margaret Whitehead (2001) suggests that PL is a lifelong journey. As such, physical literacy levels fluctuate over time, throughout a child's development, and their transition into adolescence and adulthood. Therefore, this cross-sectional analysis is merely a 'snapshot' of PL in children in the Halifax Regional Municipality and Pictou County. Therefore, this data does not provide information on how PL and sedentary time in these children may change over time. A longitudinal research design, with frequent, repeated measures of children's physical literacy and their sedentary time as they age, would illustrate how physical literacy and sedentary time develops/changes over time, and unlike the present study, could help tease out cause and effect relationships between these variables. Another limitation linked to age, is the fact that children's BMI score was normalized for age. This could therefore limit age related changes in PL shown within the data analysis.

The present study used children's decimal age as the variable in the correlations and mediation analysis. While age is a good indicator of a child's development, maturation may be another appropriate measure for this. For example, a child with the decimal age of 8.0, may be at a different developmental stage than a child with the decimal age of 8.9. As the present study did not account for this difference, this is a potential limitation.

Additionally, children's sex was not considered in the data analysis in the present research study. Previous research has shown sex differences in SB levels as well as modes of SB (LeBlanc et al., 2015a; Thompson & Wadsworth, 2012). For example, LeBlanc et al., (2015a), found that boys are more likely to report higher video game and computer use compared to girls. Additionally, Thompson & Wadsworth. (2012) reported that girls in Nova Scotia, displayed higher total SB levels compared to boys. While it was determined that the impact of sex on the relationships between children's age and sedentary time, age and physical literacy, physical literacy and sedentary time, and the mediation of physical literacy on the relationship between age and sedentary time was outside the scope of this study, it would be beneficial to include this variable in future studies. In the present study, the mediation of PL accounted for only 5% of the variance in time spent sedentary with age. Consequently, it would be beneficial to determine which other factors (such as sex) played a role in determining the variance in children's SB.

5.6.2.2 CAPL Tool Limitations

While the CAPL tool is an important measure for assessing PL comprehensively, it is not without limitations. It has been stated that "physical literacy must encompass more than physical movement, it must include an ability to read the environment and to respond effectively..." (Whitehead, 2001, pg.130) This suggests that in terms of physical literacy, the importance of affective and cognitive components of PA cannot be ignored. However, the CAPL tool still weighs physical competence and daily behaviours higher than the cognitive and affective domains of confidence and motivation, and knowledge and understanding. Physical competence and daily behaviour domains were worth 32 points, whereas the confidence and motivation and knowledge and understanding domains were worth 18 points (HALO, 2014). The researchers behind the CAPL tool argued that this was due to experts deeming the objective nature of the physical competence and daily behaviour domains, meant that they were more accurate/reliable

than the subjective nature of the confidence and motivation, and knowledge and understanding domains (Francis et al., 2016). However, this seems to undermine the importance of the affective and cognitive components of PL. This is a limitation as it calls into question whether or not the tool can completely determine a child's PL level.

The measurement of sedentary behaviour may also be a limitation in this study. Within the CAPL project, SB was measured using a series of self-report questions that were part of the Knowledge of PA questionnaire (Appendix F). These questions asked children to think of their SB levels (both screen and non-screen), in the past week and separately for weekdays and weekend days. Responses to these questions may not be completely accurate as they rely on a child's ability to recall their SB behaviours. Children do not always have the best ability to recall their PA, as they are not as time-conscious as adults (Adamo, Prince, Tricco, Connor-Gorber, & Tremblay, 2009). Self-report measures can result in an underestimation of light to moderate PA behaviours, and an overestimation of MVPA (Adamo et al., 2009). Therefore, the self-report measurements used in the CAPL tool could be prone to recall and response bias.

To add to this, the CAPL tool only measured weekday/weekend leisure time SB, therefore this does not consider sedentary time during the school day. As time spent at school is such a large portion of a child's day, this measure of SB may therefore not capture a full understanding of children's sedentary time. To gain a better understanding of children's sedentary time, a more comprehensive measure of SB would be necessary, including objective measures throughout the entirety of a child's day. Though children's weekday and weekend SB was measured, the present study used an average daily total SB variable. Therefore, the present study does not consider that children's SBs can vary on weekdays compared to weekends. For example, Steele et al., (2010), measured SBs in children aged 9 to 10 years old using

accelerometers. Their results showed that these children spent less time sedentary during weekdays, than they did on weekends (Steele et al., 2010). This suggests that children's movement behaviours differ on a weekend vs. a weekday. Therefore, it would be important to determine if the relationship between PL and SB changes depending on the time of the week.

As well as this, the questionnaires that are used were sometimes hard for children to understand. Especially with the 'What's most like me' questionnaire, children had a hard time following instruction for these questions. As a result, this questionnaire may not truly capture children's PA motivation. It would be beneficial for a PL assessment to include an observational component linked to the confidence and motivation, and knowledge and understanding domains. This would allow an adult assessor, to determine if they see a child reading the PA environment and responding effectively, which as Whitehead (2001) suggests, is an important component of being physically literate. While the CAPL is the first comprehensive measure of PL, and provides some needed PL data, it does not completely follow Margaret Whitehead's philosophical approach to the concept. In her papers, Whitehead (2001) states that an important aspect of PL are the cognitive and affective aspects of PA, and that you can't compare one person's PL with another's. With the scores, and categorizations the CAPL provides, as well as the larger emphasis on physical competence, the tool seems to go against some of Whitehead's ideas of PL. However, one could argue that this tool is necessary to measure PL levels of children and provide quantitative data in order to understand how/ where improvements can be made. The CAPL 2.0 has now changed the scoring to improve the emphasis on the confidence and motivation domain. This domain, as well as physical competence, and daily behaviours are now all worth 30 points, and the knowledge and understanding domain is now worth 10 points (HALO, 2017). The new scoring seems to be slightly more in line with Whitehead's ideas, as it

seems to value the importance of affective influences of PA in the same way that physical competence and daily behaviours are valued.

A further limitation from a functional perspective, was that the CAPL tool was hard to implement. The assessments required a large group of appraisers in order to make sure all of the data was collected in a timely manner. As well as this, the assessments took up a lot of time, and it was more desirable for the researchers to complete them during school time, taking up valuable class time away from teachers. For this reason, it was hard to get buy-in from schools to participate in the study. As a result, the data could be prone to sampling bias, with more motivated teachers being more willing to take part in the study. Therefore, it would be important to develop a tool that is easier to use within the school environment, and perhaps is not so invasive into teacher's classroom time. This is something the CAPL 2.0 tries to achieve, as it has less protocols in each domain, making the assessments shorter and less time consuming (HALO, 2017).

5.7 Study Implications

The novelty of this project means that the partial mediation of children's physical literacy in the relationship between age and sedentary time, is just being unearthed. The results revealed that children's physical literacy explains 5% of the increase in sedentary time with age, in a sample of children aged 8 to 12 years. While the mediating effect is quite small, it still provides support for the role of physical literacy in helping to dampen the typical increase in sedentary time in mid-late childhood. As well as having a dampening effect on the relationship between age and SB, PL may also have a protective effect on the development of excessive SB in children. Children with higher PL levels may be less likely to develop sedentary habits. However, more longitudinal research is needed to determine if this protective benefit of PL

exists. The findings of the present study add to the emerging literature on relationships between physical literacy and sedentary time. While the study cannot determine cause and effect, the significant associations between physical literacy and sedentary time, and its partial mediating role in the relationship between age and sedentary time, might lead one to theorize that promoting physical literacy development at a young age could be one strategy to prevent an expected rise with sedentary behaviour from mid-late childhood and into adolescence. Longitudinal research measuring children's physical literacy development and sedentary behaviour with age, is needed to tease out cause and effect relationships and determine the value of physical literacy development in preventing rises in SB as children age.

5.8 Future Research

As mentioned above, an important step in PL research would be to create interventions centred around the development of the four PL domains. To date, most PL-specific studies have utilised methods that allow for the description and exploration of relationships between child variables and PL. Although relationships between PL and SB have been shown in these studies, cause and effect has not been established. Previous studies have demonstrated that interventions for separate components of PL have been successful. For example, research has shown that interventions that target the school and community of children can significantly improve FMS, when children are provided with learning experiences delivered by PE teachers or highly trained classroom specialists (Morgan et al., 2013). Further, PA interventions that include targeting a child's school, family, or community can help to improve levels of PA (Van Sluijs, McMinn & Griffin, 2007). However, little has been done to examine the success of interventions targeting the holistic concept of PL by focusing on the four domains together (physical competence, daily behaviours, knowledge and understanding, confidence and motivation). Therefore, an

intervention that targets these four domains of PL would be important. An experimental longitudinal study design, with both control and intervention groups, could be used to determine if PL development results in a decrease in SB.

Further to this, it would be important for future studies to determine if the relationship between age and SB continues to be mediated by PL when SB is broken down into its different modes (screen-time and non-screen-time). The present study did not do this, but research suggests that different modes of SB, may need to be targeted in interventions differently. SBs such as TV viewing, playing video games, and typing at a computer can vary slightly in the METs required to complete the task (Mansoubi et al., 2015). Additionally, TV viewing may be more modifiable than non-screen-based SB (LeBlanc et al., 2015b), and therefore these SBs may need to be targeted differently to result in positive changes in behaviour. As well as looking at these different modes of SB, a future research study could flip the mediation analysis conducted in this study. As this study has shown that there is a relationship between age and PL. It would be interesting to explore SB as the mediating variable in this relationship between age and PL.

In addition, it would be important for future research studies to include a sample with a larger age range (e.g. early childhood through adolescence). As children transition from childhood to adolescence, their movement behaviours can change, with many children demonstrating large declines in PA and increased levels of SB in late adolescence. By including an age range that incorporates this transitional period into analyses like those conducted in the present study, it may be possible to identify a specific point in a child's life where the biggest changes in movement behaviours occur. A larger age range, could also encompass the changes that children experience during puberty. As mentioned previously, the changes that occur within puberty can cause fluctuations in domains of PL such as a decrease in a child's self-efficacy.

Therefore, it would be important for future research to explore how various components of PL with the CAPL tool change with age.

Additionally, sex should be considered as part of the model, as research has shown sex differences in modes of SB. A longitudinal study, would benefit from measuring these components of PL and SB early in childhood, and then tracking them into adolescence. As well as sex, it may be beneficial to consider how children's maturation may be related to SB and PL. While age can be a good indicator of development, children of the same age may still differ in their maturation, and this could impact a child's movement behaviours. This would help to account for the developmental differences in children who are at the beginning of a decimal age (i.e. 8.0), compared to those towards the end of a decimal age (i.e. 8.9), as this wasn't accounted for in the present study. Maturation can be determined by measuring a child's peak height velocity (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002). Peak height velocity is the period of time in which a child will experience the fastest upward growth in their stature (Mirwald et al., 2002). A non-invasive method for predicting physical maturation includes calculating maturity offset, which can be completed by recording children's, gender, date of birth, date of measurement, standing height, sitting height, and weight (Mirwald et al., 2002). This would be beneficial as the non-invasive nature of these measurements could make it easy to include in data collection.

If an intervention is going to successfully dampen the age-related increase in children's sedentary time, multiple correlates of SB need to be targeted. For example, the literature review outlined a number of influences that parents, and the school environment can have on children's sedentary time (Morton et al., 2015; Stierlin et al., 2015). Therefore, if a PL intervention is to be successful, it should encompass changes to the important environments in a child's life such as

home and school, as well as targeting social influences of SB such as SES by making PA facilities and equipment more accessible to children. By targeting multiple influences of movement behaviours, this could discourage children from choosing sedentary activities. Additionally, future studies should make use of objective measures of children's SB (such as an accelerometer) that track sedentary time during the school day, as well as during leisure time. Children's weekday, vs. weekend sedentary time and how each relate to PL should also be compared in future research. Children have more discretionary time on the weekends, and this could therefore impact their movement behaviours. By using objective measures of SB, and comparing weekday vs. weekend SB, this would allow researchers to have a comprehensive understanding of children's sedentary time.

5.9 Conclusion

The results of this study highlight that there is a significant, positive relationship between children's age and sedentary time, and children's age and physical literacy, where both physical literacy and sedentary time increase with age. The findings also indicate that as physical literacy increases, sedentary time decreases. Physical literacy also partially mediates the increase in sedentary behaviour with age. These results emerged in a sample of 705 Nova Scotian children aged 8 to 12 years. The expected relationships between age and sedentary time, age and physical literacy, and physical literacy and sedentary time, support previous research, yet in a large sample of Nova Scotian children, using a valid and reliable measure of physical literacy and sedentary time (CAPL). The partial mediating effect of physical literacy on the relationship between age and sedentary time in children aged 8 to 12 years, is novel and adds to the literature supporting the importance of physical literacy in shaping the behaviours of young children. These results suggest that as children's PL increases, they are less likely to choose to spend their

time in sedentary pursuits. The understanding of the importance of physical literacy development to the behaviours of children and youth, is still emerging. Longitudinal research is needed to determine how the relationships between PL, age, and SB change over time. Future research should also aim to target the correlates of SB, by introducing PL interventions that incorporate home and school environments to ensure children are given every opportunity to lead an active, healthy lifestyle.

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Appendix A: CAPL Dalhousie Ethics Approval Letter



**Health Sciences Research Ethics Board
Annual Renewal - Letter of Approval**

June 10, 2015

Dr Michelle Stone
Health Professions\Health & Human Performance

Dear Michelle,

REB #: 2014-3270
Project Title: CAPL-RBC Learn to Play Project

Expiry Date: July 21, 2016

The Health Sciences Research Ethics Board has reviewed your annual report and has approved continuing approval of this project up to the expiry date (above).

REB approval is only effective for up to 12 months (as per TCPS article 6.14) after which the research requires additional review and approval for a subsequent period of up to 12 months. Prior to the expiry of this approval, you are responsible for submitting an annual report to further renew REB approval. Forms are available on the Research Ethics website.

I am also including a reminder (below) of your other on-going research ethics responsibilities with respect to this research.

Sincerely,

Appendix B: CAPL, HRSB approval letter



June 8, 2016

Dear Dr. Stone:

"Canadian Assessment of Physical Literacy"
Approved Project Duration: October 01, 2016 to May 31, 2017

I am writing in response to your request to extend your research activities in the Halifax Regional School Board and to advise that your project extension is approved.

It is the Research Committee's requirement that all projects with student participation have signed parental/guardian consent. Further to that requirement, it is the request of the Research Committee that the parental/guardian consent form clearly outlines the information to be collected.

You are required to seek school's permission from the principal regarding the school's participation in the project. As noted in the Halifax Regional School Board's Guidelines for Researchers section 4, the participation of a school or an individual in your research is voluntary. Our approval does not compromise a school's or an individual's right to decline participation in external research projects.

You are reminded that the personal identity of all participants must remain confidential and may not be included in any publication or communication describing the research; nor released to any other party. Any media publicity regarding the project must be reviewed and discussed fully with the Halifax Regional School Board's Communications Unit prior to publication.

Researchers are required to request, in writing to nlutwick@hrrsb.ns.ca, approval of any changes to the research protocol or extensions to the program of research.

Your approved project duration is noted above. Please keep in mind that due to the large number of activities that take place in schools during the early and final weeks of school, external research activities are not permitted during the months of September or June.

Should you have any questions regarding this approval, please contact Natalie Lutwick at 464-2000, extension 2007.

We wish you every success with this effort and look forward to reading your final report.

Sincerely,

Appendix C: Dalhousie Ethics Board Approval Letter for the Present Study

Health Sciences Research Ethics Board
Letter of Approval

January 04, 2018

Bethany Taylor
Health\Health & Human Performance

Dear Bethany,

REB #: 2017-4373

Project Title: Does Physical Literacy Mediate the Relationship Between Age and Sedentary Behaviour?

Effective Date: January 04, 2018

Expiry Date: January 04, 2019

The Health Sciences Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans*. This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

Appendix D: CAPL Parent Informed Consent Form



INFORMED CONSENT

What is the title of this research study?

The Canadian Assessment of Physical Literacy (CAPL)

Who is doing this research?

In partnership with researchers at the Children's Hospital of Eastern Ontario the following local researchers are leading this study.

Dr. Michelle Stone, Principal Investigator
Dalhousie University, School of Health and Human Performance (Division of Kinesiology)

Ph: 902-494-1167

Email: michelle.stone@dal.ca

Dr. Melanie Keats, Co-Investigator
Dalhousie University, School of Health and Human Performance (Division of Kinesiology)

Ph: 902-494-7173

Email: melanie.keats@dal.ca

Dr. Laurene Rehman, Co-Investigator
Dalhousie University, School of Health and Human Performance

Ph: 902-494-6389

Email: laurene.rehman@dal.ca

Sherry Huybers, Research Coordinator
Dalhousie University, School of Health and Human Performance (Division of Kinesiology)

Ph: 902-494-3815

Email: shuybers@dal.ca

The Children's Hospital of Eastern Ontario (CHEO) and the Dalhousie University Health Sciences Research Ethics Board have approved of this research study.

Why are we doing this study?

We are doing this study because teachers, coaches and other physical activity leaders have told us they need a new way of measuring how well children are doing in physical and health education. The test we have created is called the Canadian Assessment of Physical Literacy. "Physical Literacy" means everything that children need to have or learn so that they can lead a healthy, active and enjoyable life. There are many ways to measure how well children are learning in many school subjects, like math and language. However, at the moment there is no measure of physical literacy, which is why we are creating a new one. Having an accurate and reliable way to measure physical literacy will help us to help children who are not learning everything they need to know for a healthy, active lifestyle. It will also help us to better evaluate programmes designed to encourage physical activity and healthy living so that children will not be at risk for the health problems that result from not being active.

What will your child do during the study?

The Canadian Assessment of Physical Literacy includes many activities that are similar to what your child would typically do during physical education class. If you agree to your child taking part in this study, **your child will be asked to "do the best that you can" and "try your hardest" for each activity.** As a result, your child may exercise very strenuously during the study although your child will be allowed to stop any activity at any time.

Before your child tries any of the study activities, we will ask your child whether they want to participate. Your child can say either "Yes" or "No", and their choice will be respected even if you want your child to participate. If your child agrees to participate, we will record your child's gender, age and grade. Your child will then be asked to complete each of the following tasks:

- Obstacle Course – Includes jumping, running, hopping, catching, throwing and kicking balls while running

- Grip Strength – Squeezing a handle as hard as possible
- Plank – A core strength exercise commonly used in yoga-like activities and sport training: holding a Push Up position while resting only on the toes and forearms
- Sit and Reach - Reach toward the toes while sitting with their legs straight, to measure flexibility.
- PACER (Beep Test) - Run laps back and forth across the gym, starting at a slow speed and gradually getting faster. They will continue running until they are too tired or do not wish to continue running at the faster speed.
- Body measurements - Have their height and weight and size of their waist measured while they are dressed in their gym clothes. Waist size will be measured while wearing their gym clothes. The measurements will be done in a private area away from others.
- Questionnaire - Answer questions about physical activity by writing their answers on a questionnaire or using a computer to answer the questions. The questions will tell us what children know about physical activity, physical fitness and the skills they need to be active. The questions will also ask about your child's interest in physical activity.
- Pedometers - a small square device, worn clipped to a belt or pant waistband, to measure the number of steps your child takes daily every day for 7 days. The pedometer should be worn at all times during waking hours except when the child is swimming or bathing. It does not measure the type of activities or where the child is, it only measures how much movement the child makes. Your child will also be asked to write down the times that the pedometer is not worn, as well as the activities that were done when your child was wearing the pedometer. It is very important that the pedometer is returned to us at the end of the study. However, if it is misplaced and absolutely cannot be found you will not have to purchase a replacement.

Children who participate in this research will perform study activities over two or three days. All of the research activities for both test days will take place at the organization where your child is registered and your child's instructor/leader/teacher will be present at all times. Most activities will take place in the gymnasium. The examiners carrying out the activities will be the named researchers and research coordinator as well as other trained research assistants.

The timing and duration of each testing session will vary based on the nature of the program that your child is registered. However, your child can expect to complete the physical literacy test in approximately 60-180 minutes (1 to 3 hours) depending on the number of examiners. The length of time required for individual assessment varies from less than 1 minute for the measurement of weight or height, to up to 30 minutes to complete the knowledge questionnaire (depending on age and reading abilities of your child). These times do not include the time (7 full days) that your child will be asked to wear the pedometer (step counter) to

measure daily physical activity behaviour. While wearing the pedometer, your child will be asked to complete a log sheet to record the time the pedometer was worn or not worn. Completion of daily log sheets should not exceed 5 minutes/day. Over the course of the study, your child's total time commitment should not exceed 4 hours.

If you choose not to allow your child to participate in this study, your child will be supervised by their own instructor and engaged in appropriate program-focused activities while the other children in the program are completing the study.

Who can participate in this research?

We are asking 18,000 children (8 to 12 years of age) from across the nation to complete the study. Over the course of the 3-year project, approximately 2600 children will be recruited in Nova Scotia.

We have approached your child's instructor/leader/teacher and your child's Recreation Provider and/or School and they are interested in having children in their programmes participate in this research.

Physical activity and fitness testing are safe for most children, and the activities done in this study are similar to what your child normally does during physical education. Providing us with more information about your child's health and your family's history will help us to make the research study fun and safe for your child. Please complete the "Physical Activity for Kids" screening form enclosed, and return it with the consent form to your child's program leader. If you have questions about the information we are asking you to provide on the screening form, please contact: Sherry Huybers by telephone at (902)-494-3815 or by sending an email to shuybers@dal.ca.

Could something bad happen to my child during this study?

We do not expect bad things to happen to children who participate in this study. All the activities for the study are similar to what your child does in their regular physical education programs. There are no needles or invasive procedures. As with any type of physical activity, there is a small risk of falling or getting hurt. However, all the research equipment is similar to what your child uses in physical education and safety is our first priority. All study personnel are trained in First Aid and CPR, and in the event of an injury, standard organizational policies will be followed. The pedometers are very durable, however if one happens to break the smaller broken off pieces may present a choking hazard to children under the age of 3. For this reason, please keep the pedometer out of reach of children under the age of 3.

In the unlikely event that your child is injured as a direct result of participating in this research, by signing this consent form you are in no way waiving your legal rights or releasing the investigator and the sponsor from their legal and professional responsibilities.

Some participants may be uncomfortable with measures relating to physical ability or height and weight as this data is of a personal and sensitive nature. Participants are informed that they have the option of declining participation, to skip questions on the knowledge survey, or not complete any measure that they are not comfortable with.

Will my child or family get something for being in this study?

You and your child will not be paid or given a reward for being in this study. We cannot promise that you will get any benefit from your child's study participation.

The information that we gather during this study will help us to assess physical literacy of Canadian children 8 to 12 years of age. Knowing more about the current levels of physical literacy in Canadian children will help to inform future studies.

Your child's participation in this study is completely voluntary. You or your child are free to withdraw from this study at any time, even after the research testing has been completed. Neither participation nor withdrawal from the study will affect your child's outcomes in their programs.

Who will know that my child is in this research study?

The information we collect about your child will not identify your child. We will use a coded identification number instead of your child's name so that only the researchers will know who the information is about. The data collected in this study will be locked in a safe place. All information from your child will be numbered and will not contain your child's name. A list of names and matching code numbers will be stored separately.

It is intended that only the staff involved in this research study will have access to the research information collected during this study. However, there are specific situations where other people may be given access to the research information. A member of the Research Ethics Board at the Children's Hospital of Eastern Ontario (CHEO) or Dalhousie University may be given access to the research records for auditing purposes. There are also limits to the

confidentiality of research information in situations of suspected child abuse, concerns of harm to self or others, or any request for information by court order.

The coded information collected during this research study will be stored for 7 years after all of the results of this research have been published. After that time, all records will be destroyed. Information on hard drives will be permanently erased and the paper materials will be shredded. Overall study results may be published for scientific purposes, but the identity of the research participants will remain confidential. No information that could identify your child or your child's school or recreation program will be published.

Who should I contact if I have questions about the research study?

If you have questions about this study please contact Sherry Huybers. She can be contacted by telephone at (902) 494-3815 or by email (shuybers@dal.ca).

This study has been reviewed and approved by both the CHEO and Dalhousie Health Sciences Research Ethics Boards. The Research Ethics Boards includes individuals from different backgrounds. The Board reviews all research done by scientists at the hospital and university that involves people. The goal of research ethics boards is to ensure the protection of the rights and welfare of people participating in research. The Board's work is not intended to replace a parent or child's judgment about what decisions and choices are best for them. You may contact the Director of Research Ethics at Dalhousie University at (902) 494-1462, or by email at ethics@dal.ca. The Board could review your child's study records in fulfilling its roles and responsibilities.

CAPL Parent/Guardian Informed Consent

I, _____ (Your Name),
the parent/guardian of _____ (Your Child's Name)

___ **Give** consent to my child's participation in the above study.

___ **Do not give** consent to my child's participation in the above study.

(check one of the above sentences to indicate whether or not you give consent)

I have read and understood the attached study information or had the attached information verbally explained to me. I understand that my child will be asked to exercise strenuously, and to do the best that they can for each type of exercise. I have been fully informed of the details of the study and have had the opportunity to discuss my concerns. I understand that I am free

to withdraw my child at any time or not answer questions that make us uncomfortable, and that my child's performance outcomes will not be affected if I do. I have received a copy of the study information and consent form.

Name of Parent/Guardian Signature of Parent Date

If you are interested in learning about your child's research study results, please provide us with your home mailing address and/or email address and after your child completes the study, you will receive a letter or email containing a login and password. The information will enable you to confidentially obtain your child's research study results.

Name of Parent signing: _____

Home mailing or email address: _____

To ensure that your child's pedometer data is collected an email reminder will be sent out to you the day before we collect pedometers and pedometer log sheets. Please provide us with an email address to send this reminder.

Email address: _____

As well, an incentive of entry into a draw for one \$200 Sport Chek gift certificate to be drawn on June 8, 2016 will be offered to each participant on the condition that he/she return the pedometer lent to them.

I, _____ (Your Name),
the parent/guardian of _____ (Your Child's Name)

____ **Give** consent to my child's participation in the draw for one \$200 Sport Chek gift certificate.

____ **Do not give** consent to my child's participation in the draw for one \$200 Sport Chek gift certificate.

(check one of the above sentences to indicate whether or not you give consent to participation in the draw)

| | | |
|-------------------------|---------------------|------|
| Name of Parent/Guardian | Signature of Parent | Date |
|-------------------------|---------------------|------|

In addition to the CAPL assessment, we will be running a related study that involves collecting physical activity information from parents of participating children. If you would like to learn more about this study and give permission for us to contact you by phone and send you additional information by mail or email please indicate in the box below. Please note that only those people who tick this box and provide contact information will be contacted.

I wish to learn more about the parent physical activity study and give the research team permission to contact me and send additional information by mail or email.

YES, I would like additional information. I can be contacted by phone at: _____

Please send information to the following address (email/mail):

More information can be found at: <http://www.cheori.org/halo/>

Appendix E: CAPL Health Screening Form



Parent/Guardian Name: _____

Child's Name: _____

Physical activity and fitness testing are safe for most children. However, sometimes children need to be careful when they do specific types of activity.

Help us to supervise your child's activity appropriately by answering the following question(s).

1. Has a doctor ever told you that there are some types of exercises or physical activity that your child should not do? (please circle)

Yes No

2. If you answered yes, please describe the types of exercises or physical activity that your child cannot do at this time:

3. In the following list of activities, please check any that your child cannot do at this time:

- Run through an obstacle course with jumping, throwing and kicking a ball.
- Squeeze a handle as hard as they can with each hand.
- Keep a straight body while leaning only on their toes and elbows.
- Reach toward their toes while sitting with their legs straight.
- Run laps back and forth across the gym, starting slowly and then getting faster.
- Wear a small step counter (smaller than a cell phone) every day for 7 days. It is worn clipped to a belt or pant waistband, and counts the number of steps your child takes.

Appendix F: Knowledge of PA Questionnaire

Physical Activity Questionnaire

(Canadian Assessment of Physical Literacy)

What school grade are you in:

1 2 3 4 5 6 7 8 (please circle one)

Are you a: boy girl (please circle one)

What month is your birthday: (please circle one)

Jan Feb Mar Apr May Jun Jul Aug Sept Oct Nov Dec

How old are you:

5 6 7 8 9 10 11 12 13 (please circle one)

In this project, when we talk about physical activity, we mean when you are moving around, playing or exercising. Physical activity is any activity that makes your heart beat faster or makes you get out of breath some of the time.

Why are we asking you these questions? We want to know what kids like you think about physical activity, sports and exercise.

Please remember:

- ☺ There are no right or wrong answers. We only want to know what you think.
- ☺ If you do not know an answer, please write your best guess.
- ☺ There is no time limit, so please take all the time you need.

1. How many minutes each day should you and other children do physical activities that make your heart beat faster and make you breathe faster, like walking fast or running? Count the time you should be active at school and also the time you should be active at home or in your neighbourhood.
 - a) 10 minutes
 - b) 20 minutes
 - c) 30 minutes
 - d) 60 minutes or 1 hour

2. Kids say there are many different reasons that they like to be active or play sports. Being active is anything that you do when you are moving, exercising or not sitting still. Below are some reasons that other kids have told us why they like to be active. For each reason, tell us what you think. If you think it is a good reason then you would “Agree a little” or “Agree a lot”. If you do not think it’s a good reason, then you would “Disagree a little” or “Disagree a lot”. If you are not sure or you don’t think the reason is good or bad then you are “in between”.

| A reason that I might be active is because when I am active. . . | Disagree a lot | Disagree a little | In between | Agree A little | Agree a lot |
|--|----------------|-------------------|------------|----------------|-------------|
| ...I look better | 1 | 2 | 3 | 4 | 5 |
| ... I have more energy | 1 | 2 | 3 | 4 | 5 |
| ...I feel happier | 1 | 2 | 3 | 4 | 5 |
| ...I have fun | 1 | 2 | 3 | 4 | 5 |
| ... I make more friends | 1 | 2 | 3 | 4 | 5 |
| ...I get stronger | 1 | 2 | 3 | 4 | 5 |
| ... I like myself more | 1 | 2 | 3 | 4 | 5 |
| ...I get in better shape | 1 | 2 | 3 | 4 | 5 |
| ...I feel healthier | 1 | 2 | 3 | 4 | 5 |

3. Kids say there are also reasons that make it hard for them to be active. For each reason, tell us what you think. If you think it is a good reason then you would “Agree a little” or “Agree a lot”. If you do not think it’s a good reason, then you would “Disagree a little” or “Disagree a lot”. If you are not sure or you don’t think the reason is good or bad then you are “in between”.

| I might <u>not</u> be active if. . | Disagree a lot | Disagree a little | In between | Agree a little | Agree a lot |
|--|-------------------|----------------------|------------|-------------------|----------------|
| ...I didn't have enough time to be active | 1 | 2 | 3 | 4 | 5 |
| ...I have too many chores to do | 1 | 2 | 3 | 4 | 5 |
| ...I didn't have a good place to be active | 1 | 2 | 3 | 4 | 5 |
| ...If the weather was too bad | 1 | 2 | 3 | 4 | 5 |
| ...I didn't have the right clothes/shoes | 1 | 2 | 3 | 4 | 5 |
| ...I didn't know how to do the activity | 1 | 2 | 3 | 4 | 5 |
| ...I didn't have the right equipment | 1 | 2 | 3 | 4 | 5 |
| ...I had too much homework | 1 | 2 | 3 | 4 | 5 |
| ...I didn't have anyone to be active with | 1 | 2 | 3 | 4 | 5 |

(circle the right answer)

- a) How well the muscles can push, pull or stretch.
- b) How well the heart can pump blood and the lungs can provide oxygen.
- c) Having a healthy weight for our height.
- d) Our ability to do sports that we like.

9. Draw a line to all the words you think describe what “Healthy” means.



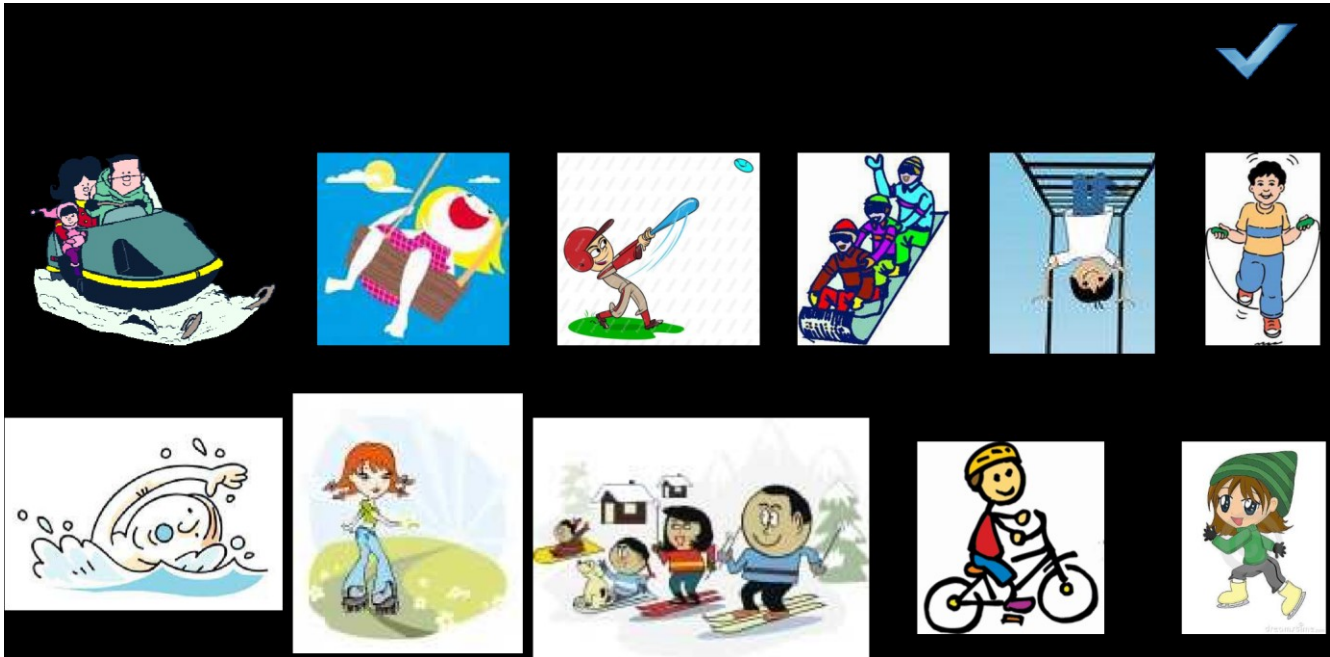
10. This story about Sally is missing some words. Fill in the missing words below. Each word can only be used to fill one blank space in the story.

Fun Endurance Good
 Pulse Strength

Sally tries to be active every day. Running every day is good for her heart and lungs.
Sally thinks that physical activity is _____ and is also _____ for her. At her
sport team’s practice she does more running to improve her _____. The team

also does exercises like push-ups and sit-ups that increase her _____. After exercising, she checks her heart rate which is also called a _____.

11. **Circle** each activity that you do. If you always or almost always wear safety gear (like



12. If you wanted to GET BETTER AT A SPORT SKILL like kicking and catching a ball, what would be the best thing to do? (circle one answer)

- a) Read a book about kicking and catching a ball
- b) Wait until you get older
- c) Try exercising or being active a lot more
- d) Watch a video, take a lesson or have a coach teach you how to kick and catch

13. If you wanted to IMPROVE YOUR FITNESS, what would be the best thing to do?
(circle one answer)

- a) Read a book about improving your fitness
- b) Wait until you get older
- c) Try exercising or being active a lot more
- d) Watch a video, take a lesson or have a coach teach you how to improve your fitness

14. If you were allowed to pick what you do after school, which activity would you pick? (circle only one activity)

Play video/computer games

Go to my sports team's practice

Read

Walk my dog

Do homework

Chat with friends online

Play outside with my friends

Watch television

When answering the following questions (questions 15-21), please tell us about what you did LAST WEEK

15. On a school day, how many hours did you watch TV?

- I did not watch TV on school days
- Less than 1 hour 1 hour 2 hours 3 hours 4 hours 5 or more hours

16. On a school day, how many hours did you play video or computer games or use a computer for something that was not school work?

- I did not play video/computer games or use a computer other than for school work on school days
- Less than 1 hour 1 hour 2 hours 3 hours 4 hours 5 or more hours

17. On a weekend day, how many hours did you watch TV?

- I did not watch TV on weekend days
- Less than 1 hour 1 hour 2 hours 3 hours 4 hours 5 or more hours

18. On a weekend day, how many hours did you play video or computer games or use a computer for something that was not school work?

I didn't play video/computer games or use a computer other than for school work on weekend days

Less than 1 hour 1 hour 2 hours 3 hours 4 hours 5 or more hours

19. During the past week (7 days), on how many days were you physically active for a total of at least 60 minutes per day? (all the time you spent in activities that increased your heart rate and made you breathe hard)

a) 0 days

b) 1 day

c) 2 days

d) 3 days

e) 4 days

f) 5 days

g) 6 days

h) 7 days

20. On a school day how many hours did you spend sitting down doing non-screen based activities (e.g. reading a book, doing homework, sitting and talking to friends, drawing, etc.). Do not count the time that you sit at school.

I did not spend time sitting down in non-screen based activities (e.g. reading a book, doing homework, sitting and talking to friends, drawing, etc.) on school days

Less than 1 hour 1 hour 2 hours 3 hours 4 hours 5 or more hours

21. On a weekend day how, many hours did you spend sitting down doing non-screen based activities (e.g. reading a book, doing homework, sitting and talking to friends, drawing, etc.). Do not count the time that you sit at school.

I did not spend time sitting down in non-screen based activities (e.g. reading a book, doing homework, sitting, and talking to friends, drawing, etc.) on a weekend day

Less than 1 hour 1 hour 2 hours 3 hours 4 hours 5 or more hours

Appendix G: (CSAPPA) Questionnaire

What's Most Like Me Children's Self- Perceptions of Adequacy in and Predilection for Physical Activity (CSAPPA) Questionnaire

For the rest of the questions you have to read 2 sentences and then circle the sentence you think is MORE LIKE YOU.

Try the following SAMPLE QUESTION:

| | | |
|--|-----|--|
| Some kids have one nose on their face! | BUT | Other kids have three noses on their face! |
|--|-----|--|

That shouldn't be too hard for you to decide! Once you have circled the sentence that is more like you, then you have to decide if it is REALLY TRUE for you or SORT OF TRUE for you.

Here is another sample question for you to try. Remember, first circle the sentence that is more like you and then put a check in the correct box if it is really true or only sort of true for you.

THERE ARE NO RIGHT OR WRONG ANSWERS, JUST WHAT IS MOST LIKE YOU.

SAMPLE QUESTION #2:

| | | |
|---|-----|--|
| Some kids like to play with computers | BUT | Other kids don't like playing with computers |
| <input type="checkbox"/> REALLY TRUE for | | <input type="checkbox"/> REALLY TRUE for |
| <input type="checkbox"/> SORT OF TRUE for | | <input type="checkbox"/> SORT OF TRUE for |
| me | | me |

Now you are ready to start filling in this form. Take your time and do the whole form carefully. If you have any questions, just ask! If you think you are ready you can start now.

BE SURE TO FILL IN BOTH SIDES OF EACH PAGE

What's Most Like Me

1.

| | | |
|--|-----|--|
| Some kids can't wait to play active games after school | BUT | Other kids would rather do something else after school |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

2.

| | | |
|--|-----|--|
| Some kids don't like playing active games | BUT | Other kids really like playing active games |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

3.

| | | |
|--|-----|--|
| Some kids don't have much fun playing sports | BUT | Other kids have a good time playing sports |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

4.

| | | |
|--|-----|--|
| Some kids are good at active games | BUT | Other kids find active games hard to play |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

5.

Some kids don't like playing sports

BUT

Other kids really enjoy playing sports

REALLY TRUE for

SORT OF TRUE for me

me

REALLY TRUE for

SORT OF TRUE for me

me

6.

Some kids always hurt themselves when they play sports

BUT

Other kids never hurt themselves playing sports

REALLY TRUE for

SORT OF TRUE for me

me

REALLY TRUE for

SORT OF TRUE for me

me

7.

Some kids like to play active games outside

BUT

Other kids would rather read or play video games

REALLY TRUE for

SORT OF TRUE for me

me

REALLY TRUE for

SORT OF TRUE for me

me

8.

Some kids are among the last to be chosen for active games.

BUT

Other kids are usually picked to play first.

REALLY TRUE for

SORT OF TRUE for me

me

REALLY TRUE for

SORT OF TRUE for me

me

9.

| | | |
|--|-----|--|
| Some kids do well in most sports | BUT | Other kids feel they aren't good at sports |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

10.

| | | |
|--|-----|---|
| Some kids learn to play active games easily | BUT | Other kids find it hard learning to play active games |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

11.

| | | |
|--|-----|--|
| Some kids think they are the best at sports | BUT | Other kids think they aren't good at sports |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

12.

| | | |
|---|-----|--|
| Some kids find games in physical education hard to play | BUT | Other kids are good at games in physical education |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

13.

| | | |
|--|-----|---|
| Some kids like to watch games being played outside | BUT | Other kids would rather play active games outside |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

14.

| | | |
|--|-----|---|
| Some kids like to take it easy during recess | BUT | Other kids would rather play active games at recess |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

15.

| | | |
|---|-----|--|
| Some kids aren't good enough for sports teams | BUT | Other kids do well on sports teams |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

16.

| | | |
|--|-----|--|
| Some kids like to read or play quiet games | BUT | Other kids like to play active games |
| <input type="checkbox"/> REALLY TRUE for me | | <input type="checkbox"/> REALLY TRUE for me |
| <input type="checkbox"/> SORT OF TRUE for me | | <input type="checkbox"/> SORT OF TRUE for me |

17.

Some kids like to play active games outside on BUT weekends

REALLY TRUE for

SORT OF TRUE for me

me

Other kids like to relax and watch TV on weekends

REALLY TRUE for

SORT OF TRUE for me

me