# Associations Between Domains of Physical Literacy In 8-12 Year-Old Children, by Weight Status

Gregory Traversy

Thesis submitted to the
Faculty of Graduate and Postdoctoral Studies
in partial fulfillment of the requirements
for the Master of Science degree in Human Kinetics

School of Human Kinetics
Faculty of Health Sciences
University of Ottawa

# TABLE OF CONTENTS

**LIST OF ABBREVISIONS AND ACRONYMS**

| | |
|---|---|
| BMI | Body Mass Index |
| CAMSA | Canadian Agility and Movement Skill Assessment |
| CAPL | Canadian Assessment of Physical Literacy |
| CHMS | Canadian Health Measures Survey |
| CI | Confidence Interval |
| CSAPPA | Child Self-perceived Adequacy and Predilection toward Physical Activity |
| HALO | Healthy Active Living and Obesity research group |
| ICC | Intraclass Correlation Coefficient |
| ISCOLE | The International Study of Childhood Obesity, Lifestyle and the Environment |
| Movement-ABC | Movement Assessment Battery for Children |
| MVPA | Moderate to Vigorous intensity Physical Activity |
| NHANES | National Health and Nutrition Examination Survey |
| PA | Physical Activity |
| PACER | Progressive Aerobic Cardiovascular Endurance Run |
| PE | Physical Education |
| PL | Physical Literacy |
| PLAY | Physical Literacy Assessment for Youth |
| TV | Television |
| $VO_2$ | Oxygen consumption |
| WHO | World Health Organization |
| YMCA-YWCA | Young Men's/Young Women's Christian Association |

**ABSTRACT**

To date, only a small number of studies have examined the results of physical literacy (PL) assessments using the Canadian Assessment of Physical Literacy (CAPL). Among these studies, none have evaluated the correlations between the four domains of PL assessed within the CAPL, nor have they evaluated whether these correlations differ depending on weight status. The current study aimed to determine the strength of associations between the four domains of PL, and compare the correlation coefficients between healthy weight and overweight/obese children. Children aged 8-12 years (n=456) were assessed using the CAPL protocol and partial correlations (controlling for age, sex, and other domain scores) were calculated between domains, for healthy weight (n=275) and overweight/obese children (n=181) separately. The results of this study show that the domains of physical competence, daily behaviour, and motivation and confidence correlate significantly with one another at similar low-to-moderate levels in both body weight groups examined ($r = 0.15$ to $0.38$). The domain of knowledge and understanding did not correlate significantly with other domains in healthy weight participants, and only correlated significantly with physical competence in overweight/obese children ($r = 0.22$). Overall, the low level of correlations seen between domains in this study lends support to the psychometric architecture of the CAPL and suggests that the four domains of CAPL measure different constructs. Furthermore, the results of this study suggest that interventions aimed at improving PL in children should assess multiple domains, and do not necessarily need to be tailored based on a child's weight status.

**CONTRIBUTIONS**

The work contained in this thesis is my own, and I, along with my thesis supervisor Jean-Philippe Chaput, take full responsibility for the entirety of its content. I analyzed data from the Canadian Assessment of Physical Literacy (CAPL), of which I have been a key member of the data collection team since May 2014. I have also been involved with participant recruitment, and data entry for the CAPL study, along with my colleagues at the Healthy Active and Living and Obesity (HALO) research group in the Children's Hospital of Eastern Ontario Research Institute (CHEO RI). For the thesis manuscript, I was responsible for data analysis, interpretation and writing of the article.

This is a manuscript-based thesis, which contains one paper, found in Part 2 of the thesis, of which I am the primary author. At the time of submission, the article was under review in *Research Quarterly for Exercise and Sport.* Co-authors for the manuscript are listed in Part 2. The co-authors take responsibility for the content of the manuscript.

**ACKNOWLEDGEMENTS**

First, I would like to thank my supervisor, Dr. Jean-Philippe Chaput, for his guidance throughout my MSc. He has been more than just a supervisor, but also a collaborator and a leader for our chapter of the Canadian Obesity Network – Students and New Professionals. He has always made himself available to lend support, and has always been prompt in providing me with valuable feedback on all of the projects on which we've collaborated. He has also helped me improve my writing skills, and advance my CV by encouraging me to get involved in authoring peer-reviewed articles and other writing projects beyond my thesis.

I must also thank my committee members, Dr. Mark Tremblay and Dr. Denis Prud'homme. Their comments and feedback have been very helpful in helping me prepare my thesis proposal, and the final thesis manuscript. Dr. Tremblay has also provided feedback and important comments as a co-author on my thesis article, and went out of his way to provide additional feedback on my thesis proposal, prior to my defense. I would not have been able to create this manuscript without the help of Drs Chaput, Tremblay, or Prud'homme.

I would also like to acknowledge the support that I have received from friends and family through not only my MSc., but through my entire academic career. Certainly, without the support of my parents, Jan and Peter, I would not be where I am today. Beyond the emotional and financial support they've provided over the years, their proofreading skills are second to none. My girlfriend Samara must also be thanked for the support she has given me in helping me stay on track while writing my thesis.

The participants of the CAPL study should also be thanked. Without the enthusiasm and participation of the children and their parents, this study would not be possible. Also with respect to this study, a number of organizations have contributed financially and otherwise to the development of the Canadian Assessment of Physical Literacy (please refer to www.capl-ecsfp.ca for the full list). I must also thank the University of Ottawa for their financial support, in providing me with an Ontario Graduate Scholarship, and an Excellence Scholarship.

Finally, a number of individuals from the HALO research group have also been instrumental not only in the CAPL project, but in helping me in writing my thesis, and guiding me through various elements of my MSc. This includes Dr. Pat Longmuir, Joel Barnes, Stacey Alpous, Amélie Fournier, Mike Borghese, Kevin Belanger, Justin Lang, Laura Callender, Emily Ertel, and Anne Macartney. I would also like to thank Nadia Souriel from the CHEO RI for her statistical advice.

**PRELUDE TO THESIS**

In my thesis I use data from the Canadian Assessment of Physical Literacy (CAPL). Ethics approval for the study was provided by the Children's Hospital of Eastern Ontario Research Institute and the University of Ottawa's research ethics boards, as well as the ethical review boards of the participating school boards (see Appendix).

This is a manuscript-based thesis, which contains one original article. In part 1 of the thesis I provide a general introduction followed by a comprehensive literature review on the topics of physical literacy, and its relationship with child obesity. In part 1 the methods associated with the CAPL protocol are also explained in detail. Part 2 contains the original article, which at the time of submission was submitted to *Research Quarterly for Exercise and Sport.* Part 3 contains a global discussion of the results from the study presented in part 2. The global discussion discusses the results within the context of other published literature, strengths and weaknesses of the study, and areas for future research. Part 4 contains references cited in the thesis, as well as other appendices, including ethics approval documents, copies of questionnaires used, and results not presented in part 2.

**LIST OF TABLES**

Main tables:



Additional tables (sub-analyses):

**LIST OF FIGURES**

**PART 1**

**Introduction**

Physical activity (PA) is important for the health of children and adolescents (Carson et al., 2014a; Carson et al., 2013; Janssen & LeBlanc, 2010). Child PA ranging in intensity from light to vigorous has been associated with improvements in blood pressure, waist circumference, insulin levels, HDL-cholesterol, and mental health (Carson et al., 2013; Carson et al., 2014a; Janssen & LeBlanc, 2010). Further, childhood represents an important stage in life to promote increased PA, as high levels of PA in childhood may track into adulthood (Telama, 2009). Conversely, high levels of sedentary behaviours such as TV watching are negatively associated with a number of physical and psychosocial health outcomes (Tremblay et al., 2011a).

It is particularly concerning that physical inactivity is common among Canadian children and youth, with only 14% of 5-11 year-olds and 5% of 12-17 year-olds meeting recommended PA guidelines (ParticipACTION, 2015). Furthermore, sedentary behaviours such as TV viewing, videogame playing and sitting are prevalent, with Canadian 5-11 year-olds and 12-17 year-olds engaging in 7.6 hours and 9.3 hours of sedentary time per day, respectively (ParticipACTION, 2015). Sedentary behaviours, especially screen time, may displace time that could be spent in PA, and have been correlated with obesity and other adverse health outcomes (Carson et al., 2014b; Saunders et al., 2013). Further, physical inactivity is a significant contributor to mortality in Canada, and it is predicted that increasing PA levels and decreasing sedentary behaviour in 10% of the Canadian population could have economic benefits in the billions of dollars (Bounajm et al., 2014).

In parallel with decreasing activity levels, the prevalence of overweight and obesity has increased dramatically in North American children and adolescents over the past 30 years (Ng et al., 2014; Roberts et al., 2012). Overweight and obesity put children at risk for comorbidities such as type-2 diabetes, hypertension, and diminished social and emotional well-being (American Diabetes Association, 2000; Robertson et al., 2012; Sorof et al., 2004; Whitehead, 2010). Additionally, excess weight in childhood increases the likelihood of being obese in adulthood (Herman et al., 2009; Roberts et al., 2012). In adults, obesity is associated with all-cause mortality (Berrington de Gonzalez et al., 2010). Obesity and its related co-morbidities led to an estimated $4.6 billion in health care costs in Canada in 2008 alone (Public Health Agency of Canada, 2011). This emphasizes the importance of improving child health now, and in the future, by improving levels of PA and reducing sedentary behaviour.

Physical education (PE) programs aim to address these issues, but evidently have failed to do so (ParticipACTION, 2015). Historically, assessments of the outcomes of such programs have been based on performance in tests of physical ability (e.g., the Canada Fitness Award, and FITNESSGRAM in the USA) (Plowman et al., 2006; Tremblay & Lloyd, 2010). These assessments have been criticized for focusing on performance-related measures, undermining the confidence of those who would benefit most from improvements in PA levels, and failing to assess the true complexities of physical development (Lloyd et al., 2010; Penney & Chandler, 2000; Tremblay & Lloyd, 2010). Thus, there have been calls for improvements to these assessment tools.

In 2009, the Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute developed the *Canadian Assessment of Physical Literacy* (CAPL) with support from a number of national and provincial groups, including the Public Health Agency of Canada (Tremblay & Lloyd, 2010). This multi-dimensional assessment protocol provides a more comprehensive view of children and youth in the realm of healthy active living and behaviour, as opposed to focusing solely on fitness performance (Longmuir, 2013; Tremblay & Lloyd, 2010). The CAPL is currently the only assessment tool that incorporates the multi-dimensional nature of physical literacy, and combines multiple domains to give a comprehensive measurement of physical literacy (Longmuir, 2013; Tremblay & Lloyd, 2010). In order to ensure that the CAPL accurately captures multidimensional behaviour, and in order for stakeholders to better interpret and use the results of the CAPL, it is important to understand the relationships between the domains of physical literacy (See Figure 1). Determining how these relationships may differ between healthy weight and overweight/obese children is also important to better inform future targeted interventions to address child overweight and obesity and to increase physical literacy in these groups.

**Literature Review**

Obesity is a multifaceted condition, without a single clear determinant (Public Health Agency of Canada, 2011). Much research has been done in order to examine the determinants of obesity (Chaput et al., 2011). Although there is debate about the role of PA and sedentary behaviour in the development of obesity, objectively measured levels of moderate-to-vigorous-intensity PA (MVPA) have been found to be independently associated with objective measures of adiposity in Canadian children (Chaput et al., 2014a, Chaput et al., 2014b; Hjorth et al., 2014). PA can certainly contribute to produce a negative energy balance, and it has been suggested that changes of 100 kcal/day could reduce weight gain in the majority of individuals (Hill et al., 2003). Potentially even more importantly, child PA ranging in intensity from light to vigorous has been associated with improvements in blood pressure, body composition, insulin

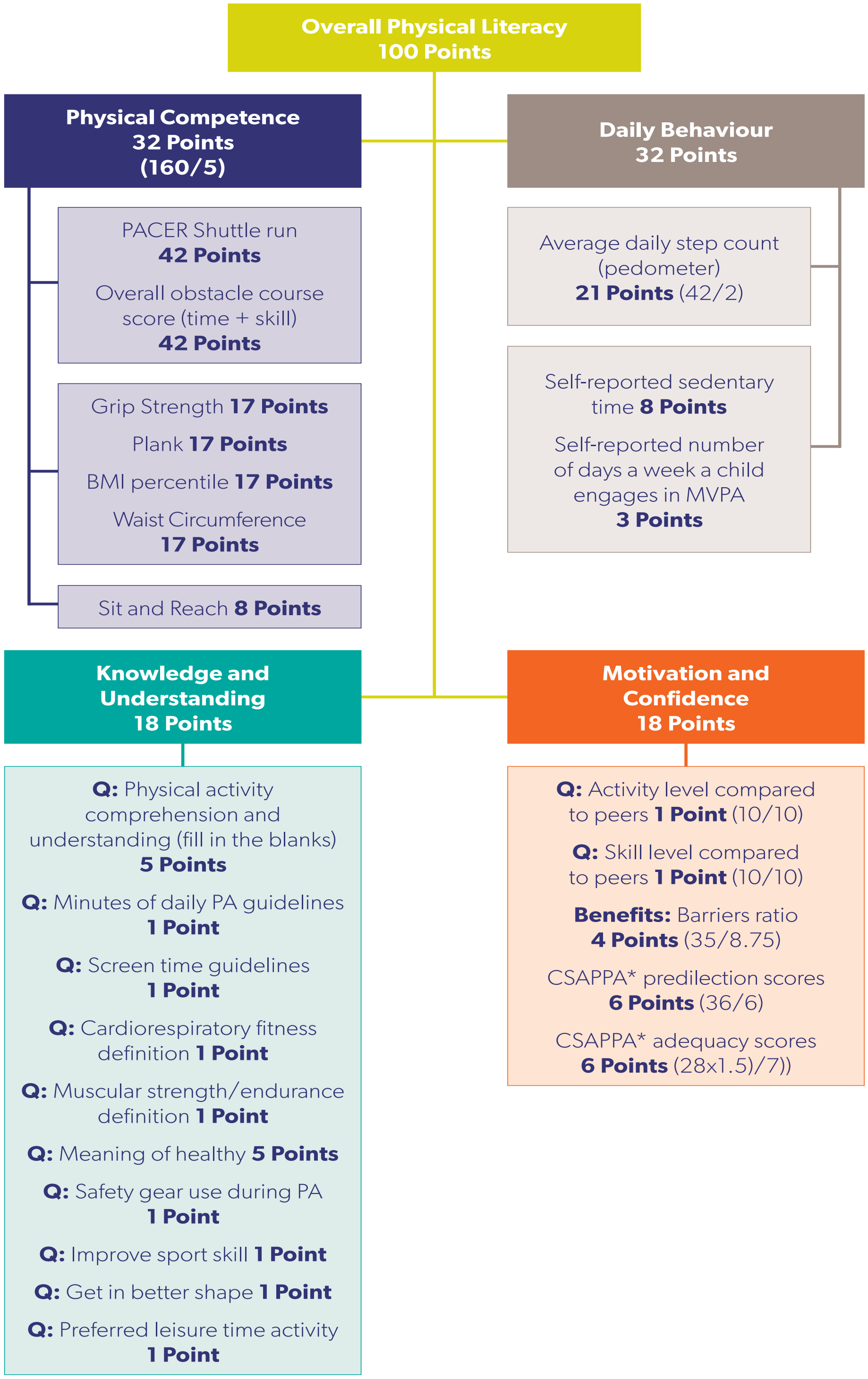


**Figure 1.** Scoring of physical literacy using the Canadian Assessment of Physical Literacy (CAPL). Maximum number of points for each test, questionnaire question, and physical literacy domain are listed. Domain scores combine to give an overall score of physical literacy. Adapted from the CAPL Manual for Test Administration (Healthy Active Living and Obesity Research Group, 2013).

sensitivity, blood lipids, and mental health, in cross-sectional and longitudinal studies, as well as controlled trials (Carson et al., 2013; Carson et al., 2014a; Janssen & LeBlanc, 2010). Thus, from a public health perspective, it seems pertinent to make efforts to improve levels of PA and fitness in children (Chaput et al., 2012). In support of this, guidelines have been developed in order to provide benchmarks for how much PA, as well as sedentary time should be included in the lives of children (Tremblay et al., 2011b; Tremblay et al., 2011c). The Canadian PA guidelines recommend at least 60 minutes of MVPA per day for 5-17 year olds (Tremblay et al., 2011c).

Several large cross-sectional studies have examined PA and sedentary behaviour in Canadian children, and the results are summarized in the annual ParticipACTION (previously Active Healthy Kids Canada) Physical Activity Report Card for Children and Youth (ParticipACTION, 2015). Across the studies summarized in the Report Card, PA was measured via questionnaires and surveys, as well as with objective measurement tools such as pedometers and accelerometers (ParticipACTION, 2015). The most recent data indicate that only 9% of Canadian children are meeting recommended PA guidelines (ParticipACTION, 2015). Thus, efforts need to be made to improve PA levels in children, and continued monitoring of activity behaviour is essential. Accurate, comprehensive assessment tools must therefore be available to those administering PA-promoting interventions, and public health officials alike.

As previously mentioned, limitations of previous PA and fitness assessment methods led to the development of the CAPL tool. This battery of tests represents a more comprehensive view of the child within the realm of physical literacy (Longmuir, 2013; Tremblay & Lloyd, 2010). The concept of physical literacy, however, is not new, and warrants further explanation.

The concept of physical literacy has been in the literature for over 20 years, and multiple definitions exist (Mandingo et al., 2009; ParticipACTION et al., 2015; Tremblay & Lloyd, 2010;

Whitehead, 2001). It has been described as ‘the motivation, confidence, physical competence, understanding and knowledge to maintain physical activity at an individually appropriate level, throughout life’ (Whitehead, 2010). In their position statement on physical literacy, Physical Health Education Canada (Mandingo et al., 2009) defines physical literacy as such:

> Individuals who are physically literate move with competence in a wide variety of physical activities that benefit the development of the whole person. [They] consistently develop the motivation and ability to understand, communicate, apply, and analyze different forms of movement. They are able to demonstrate a variety of movements confidently, competently, creatively and strategically across a wide range of health-related physical activities. These skills enable individuals to make healthy, active choices throughout their life span that are both beneficial to and respectful of themselves, others, and their environment. (p. 6-7)

More recently, a Canadian consensus statement on physical literacy was created, which describes it as ‘the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life’ (ParticipACTION et al., 2015).

Thus, physical literacy recognizes the complexities of physical development, and because of this, it has been suggested that it be incorporated in to physical education (PE) curricula (Penney & Chandler, 2000). In fact, recent research acknowledges physical literacy as the goal of PE (Roetert & MacDonald, 2015). The concept of physical literacy is also said to encompass many parameters related to proper weight management, such as feelings of competence and confidence, motivation, attitudes, in addition to physical fitness abilities (Whitehead, 2010). In children, physical literacy is also important in considering why children may or may not engage in structured or unstructured PA (Whitehead, 2010). Therefore, having the ability to assess physical literacy with one all-encompassing assessment tool is beneficial in order to more precisely assess physical literacy and activity behaviour in Canada. Prior to the CAPL, however, such a tool did not exist.

In order to operationalize physical literacy for an earlier iteration of the CAPL, Lloyd et al., (2010) conceived of it as having four key domains: physical fitness, fundamental motor skills, PA behaviour, and knowledge, awareness and understanding. While these domains represent areas that have been identified as important to physical literacy, they fail to take into account other important aspects such as motivation and confidence (Longmuir, 2013; Mandingo et al., 2009; Whitehead, 2010). Thus, as core domains, the CAPL has been re-designed to include daily behaviour (assessed via pedometer and self-report), physical competence (assessed via fitness tests and a validated test of motor skills – *The Canadian Agility and Movement Skill Assessment* (CAMSA)), motivation and confidence (assessed via questionnaire), and knowledge and understanding (also assessed via questionnaire) (Longmuir, 2013; Longmuir et al., 2013). Multiple assessments within each domain helped to provide an overall score for each domain, as well as an overall aggregate score of physical literacy for each child (Healthy Active Living and Obesity Research Group, 2013). The CAPL was initially developed through curricula review and consultation with researchers and practitioners in order to choose assessments that were established measures of motivation and confidence, fitness, and PA, in addition to including a novel measure of motor skill (Longmuir et al., 2015b). An iterative design and development process was then used to determine feasibility of the assessments, and the protocol was refined accordingly. After this, the CAPL model was validated by an external group of 19 experts in child PA and fitness through a 3-round Delphi review process which established the validity of assessments in each domain and helped guide the relative weighting of assessments within the scoring protocol (see Figure 1) and interpretation of the assessments (Francis et al., 2015;

Longmuir et al., 2015b). Generally, objective measurements are given more weight than less objective assessments within the CAPL. A recent confirmatory factor analysis based on data from 489 children has lent further support to the CAPL's four-domain model of physical literacy (Longmuir et al., 2015b).

As the CAPL provides a comprehensive assessment, various groups may use it to inform individual programs, provide evidence for resource allocation, influence policy decisions, and provide national surveillance (Tremblay & Lloyd, 2010). However, since the CAPL is relatively new, relatively few studies have examined the results of CAPL assessments outside of validity and reliability studies (Boyer et al., 2013a; Boyer et al., 2013b; Larouche et al., 2014; Lizotte et al., 2016; Longmuir et al., 2013; Longmuir et al., 2015a; Longmuir et al., 2015b).

Larouche et al. (2014) sought to determine the correlation between daily PA (daily behaviour domain) and measurements of physical fitness (physical competence domain) as assessed through the CAPL. To do so, they examined data collected from 491 children in grades 4-6 using the CAPL tools, and analyzed it using univariate analysis and multivariable linear regression, controlling for confounders such as age, sex, testing season, and socioeconomic status (Larouche et al., 2014). In univariate analysis, daily PA behaviour (as assessed by 7-day pedometer counts) was correlated with fitness and motor skill measures such as aerobic power ($r = 0.30$, $p<0.001$), CAMSA completion time ($r = -0.27$, $p<0.001$) and score ($r = 0.20$, $p<0.001$), hand grip strength ($r = 0.12$, $p=0.01$), and plank performance ($r = 0.16$, $p=0.001$) (Larouche et al., 2014). In multivariable analyses, after controlling for confounders, higher amounts of PA were associated with greater aerobic power ($\beta= 0.37$, $p<0.001$), and CAMSA completion time ($\beta= -0.15$, $p=0.009$) (Larouche et al., 2014). These results are supported by the broader, non-CAPL literature (Dencker & Andersen, 2011; Lubans et al., 2010).

A recent systematic review found that objectively measured PA levels (via accelerometer) had a consistent low-to-moderate association with aerobic fitness ($VO_2max$) across 9 studies (Dencker & Andersen, 2011). Among these studies, which looked at children ranging in age from 6-16 years, correlation coefficients ranged from 0.10 to 0.46 (Dencker & Andersen, 2011). Another review estimated the correlation between PA and aerobic fitness to be 0.17 on average (Morrow & Freedson, 1994). Additionally, another systematic review concluded that there was strong evidence for a positive relationship between PA and fundamental motor skills such as running, hopping, catching, throwing, and balancing (all of which are assessed within the CAMSA) based on 11 cross-sectional studies and one longitudinal study (Longmuir et al., 2013; Lubans et al., 2010). Similarly, a recent systematic review found that in cross-sectional studies examining the relationship between PA and fundamental movement skills using similar movement assessments in similar age groups to the CAPL, positive associations ranged between 0.10-0.33 (Holdfelder & Schott, 2014). Finally, the results of Larouche et al.'s univariate analysis concur with some of the literature, which has shown weak ($r = 0.07 – 0.29$) significant associations between child and adolescent PA levels and various measures of muscular fitness (Hands et al., 2009; Katzmarzyk et al., 1998; Martínez-Gomez et al., 2011; Sallis et al., 1991). Other studies, however, have found that accelerometer-measured PA was not significantly associated with muscular fitness measures such as hand grip strength or sit-and-reach flexibility in 6-12 year-old boys and girls (Blaes et al., 2011). Thus, it is not completely clear whether PA measurements will reliably correlate to measurements of muscular fitness.

In their analyses, Larouche et al. (2014) did not distinguish between healthy weight and overweight/obese children. Evidence suggests that many of the measures they examined could potentially differ between children of different weight statuses, and thus this is important to examine. For instance, with respect to daily PA measurements, in a longitudinal study among 8-11 year-old children, higher fat mass index (fat mass determined by dual energy X-ray absorptiometry scan, divided by height squared) at baseline predicted a decrease in total PA and MVPA, and an increase in sedentary behaviour (Hjorth et al., 2014). In contrast, accelerometer-measured steps per day were only slightly higher in healthy weight boys, and lower in healthy weight girls compared to their overweight/obese peers, in the Canadian Health Measures Survey (Colley et al., 2011). Thus, it is not entirely clear whether healthy weight children would be expected to display higher levels of daily PA than overweight/obese children within the CAPL.

Beyond PA levels, a negative association between adiposity and cardiorespiratory endurance has been observed using a number of different protocols (Brunet et al., 2007; Chatrath et al., 2002; Deforche et al., 2003; Esteban-Cornejo et al., 2014; Graf et al., 2004; Malina et al., 1995; Minck et al., 2000). Additionally, adiposity has been associated with poorer performance on tests of motor skills, such as hopping, balancing, side-to-side movement, coordination, agility, and torso strength and endurance (Brunet et al., 2007; Deforche et al., 2003; Esteban-Cornejo et al., 2014; Graf et al., 2004; Malina et al., 1995; Pate et al., 1989; Wrotniak et al., 2006). Conversely, obese children have performed better on hand grip assessments than their healthy weight counterparts, and there appears to be little difference in performance on sit-and-reach tests between children of differing weight statuses (Castro-Pinero et al., 2013; Deforche et al., 2003; Minck et al., 2000; Pate et al., 1989). These studies have looked at a variety of age ranges, some of which correspond to those examined within the CAPL, but it is important to note that differences between overweight/obese and healthy weight children in tests of physical competence may vary by age (Malina et al., 1995). Given the differences between overweight/obese and healthy weight children, further analysis of physical competence and daily PA measurements within the CAPL is warranted.

In the study by Larouche et al. (2014), associations with measures of physical competence explained 16.4% of the variance in PA levels, suggesting that other elements likely also influence PA levels. For instance, this study did not take into account external factors such as the built environment, or confounders such as pubertal stage (Larouche et al., 2014). Furthermore, this study did not examine how the other domains of CAPL (knowledge and understanding, and motivation and confidence) are correlated to daily PA behaviour, physical competence, or to each other. Nor did it discuss differences in these relationships between overweight/obese children compared to healthy weight children.

A recent systematic review of 16 earlier systematic reviews found that in children (ranging from 2-12 years-old) and adolescents (10-18 years), motivation and self-efficacy were consistent correlates and determinants of PA, whereas perception of ability to be active was consistently a determinant in adolescents but less so in children (Bauman et al., 2012). Also, De Bourdeaudhuij et al. (2005) found that the correlation between self-efficacy and physical activity was slightly higher in healthy weight children than overweight/obese children ($r = 0.39$ vs. $r = 0.27$, respectively). However, correlations with other aspects of motivation and confidence towards exercise, such as perceived barriers and benefits, and physical activity were similar in healthy weight and overweight/obese children (De Bourdeaudhuij et al., 2005). This study, however, did not perform statistical tests to determine if the slight difference between correlation coefficients were significant or not (De Bourdeaudhuij et al., 2005). Wrotniak et al. (2006) had 8-10 year-olds complete the Child Self-perceived Adequacy and Predilection for Physical Activity (CSAPPA) scales (which are an element of the CAPL), and found that CSAPPA scores did not correlate with objectively measured PA, but did correlate significantly with motor skill ability (based on elements such as agility, balance and coordination) ($r = 0.39$). Similarly, Boyer et al. (2013a), found that the CSAPPA correlates positively ($r = 0.23$-$0.40$, $p<0.001$) with aerobic fitness, plank time, and CAMSA score.

Other studies have examined differences between overweight/obese children and healthy weight children in measures related to motivation and confidence, without examining the correlations with PA, fitness, or motor skills. Similar to De Bourdeaudhuij et al. (2005), Trost et al. (2001) found significantly lower self-efficacy in obese compared to non-obese sixth graders. Other studies have found that healthy weight children hold more positive attitudes towards exercise compared to overweight/obese children (Deforche et al., 2006). This study found that although perceived benefits of PA did not differ between the groups, the perceived barriers (such as feeling that exercise is ‘not good’, or physical appearance) did (Deforche et al., 2006). Similarly, Zabinski et al. (2003) found that overweight/obese children reported more body-related barriers to PA. These barriers were particularly significant in female participants (Zabinski et al., 2003). Studies looking at aspects of motivation and confidence, and their correlations with PA and motor skills, have used a number of methods for assessing various psychosocial variables, and measuring PA, and motor skills (DeBourdeaudhuij et al., 2005; Deforche et al., 2006; Trost et al., 2001; Wrotniak et al., 2006; Zabinski et al., 2003). Examinations of these variables, and their relationships with physical competence, between overweight/obese and healthy weight children using a standardized, comprehensive assessment such as the CAPL would help provide results that would be more easily compared across studies.

Whether or not knowledge correlates with PA or fitness is less clear in the literature. Although it is recognized that knowledge is a required element for engaging in PA, it has been suggested that knowledge alone is not sufficient (Morrow et al., 2004). Morrow et al. (2004) found that American adults engaged in healthy levels of PA did not differ in their knowledge of PA guidelines and activities from those who did not. Also, systematic reviews have found limited evidence that improving knowledge through education alone leads to increased PA in children, adolescents, or adults (Kroeze et al., 2006; van Sluijs et al., 2007). Conversely, a systematic review of school-based PA interventions found that increasing knowledge by altering curriculum, and the use of educational materials, were both common in interventions that successfully increased PA (Dobbins et al., 2013). Thus, it is not clear how the knowledge and understanding of healthy living translates to behaviour change.

It is also not completely clear whether one would expect knowledge and understanding of healthy active living to differ between overweight/obese and healthy weight children. Elements of physical competency (such as higher cardiorespiratory endurance and motor skills) have been linked to improved cognition and academic performance in children, and thus, one might expect that if overweight/obese children are less fit, then they may perform more poorly on tests of knowledge, especially if they are based on school curriculum (as in the CAPL) (Esteban-Cornejo et al., 2014; Haapala, 2013). However, Esteban-Cornejo et al. (2014) found that cardiorespiratory capacity and motor abilities showed independent and combined associations with academic performance, regardless of adiposity. Thus, while one might expect that overweight/obese children may perform worse in the CAPL domain of knowledge and understanding, the evidence for this is indirect at best. Based on the available literature, it would however seem likely to see a positive correlation between physical competence and knowledge and understanding (Esteban-Cornejo et al., 2014).

The relationships between knowledge and understanding, motivation and confidence, PA, physical fitness, and motor skills have not been examined within the context of the CAPL. The associations between the four domains of physical literacy, and how they compare between overweight/obese and healthy weight children, represent a gap in current knowledge. Addressing this gap will help further the broader goals of the CAPL, inform future revisions to the CAPL, and build on the results obtained by Larouche et al. (2014). If the correlations found are very high, elements of the assessment may be able to be removed – making the test easier to administer – while still accurately capturing physical literacy. Furthermore, examining how the relationships between CAPL domains compare between overweight/obese and healthy weight children may help inform and improve the effectiveness of future interventions aimed at improving physical literacy of Canadian children.

**Objective and Research Question**

The objective of this study was to determine the relationships among the four domains of physical literacy as assessed by the CAPL in 8-12 year-old Canadian children from Southeastern Ontario, and to compare these relationships between healthy weight and overweight/obese children. Specifically, what are the associations among the domains of physical competence (fitness and motor skills), daily PA behaviour (pedometer steps and self-report behaviours), knowledge and understanding (via questionnaire), and motivations and confidence (via questionnaire) within these two populations and do they differ by weight status (overweight/obese vs. healthy weight children)?

**Hypotheses**

Although the literature surrounding the CAPL is currently sparse, we hypothesized that there would be a positive correlation between physical competence and daily PA behaviour based on the results of Larouche et al. (2014). We hypothesized that physical competence measures, in general, would be lower in overweight/obese children. Furthermore, we hypothesized that overweight/obese children would exhibit lower daily PA levels. The literature suggests that overweight/obese children would have lower scores for motivation and confidence, and they may also exhibit lower scores in the knowledge and understanding domain. Although we hypothesized overweight/obese children would perform more poorly on most aspects of the CAPL, due to the multidimensional nature of PA behaviour, and the design of the assessment, we expected that domains would correlate positively with one another in all children, and that the correlation coefficients would not differ significantly between overweight/obese and healthy weight children.

## Methods

### Participants

Approximately 600 children were assessed using the CAPL tool. Larouche et al. (2014) were able to demonstrate significant associations among domains of CAPL with 491 participants (37% of which were overweight/obese), thus we expected this sample size to give an acceptable number of both healthy weight and overweight/obese participants. Participants were recruited through middle schools in Southeastern Ontario (Upper Canada District School Board) and after-school programs such as those held at local YMCA-YWCA's. Children were assessed in groups at the location from which they were recruited (i.e. their school, or the location of their after-school program). Between 10-50 children were tested on each testing day.

Participants were included if:

- They were in grades 4, 5, or 6 (ages 8-12 years).

- Written consent from the parent/guardian was obtained, as well as verbal assent from the child.
- They had completed a screening form indicating that they have no known limitations for physical activity, including maximal effort exercise.

Participants were excluded for any of the following reasons:

- Within grades 4-6, but younger than 8, or older than 12 years old.
- Having a medical condition or disability that is likely to influence the CAPL assessment (e.g. cerebral palsy).

An initial visit was made to each of the testing locations to deliver information to parents. Parents were given packages that explained the study in detail, including all risks and benefits, and provided them with consent, assent, and medical screening forms to complete. Ethics approval for the study was obtained from the Children's Hospital of Eastern Ontario as well as the participating school board (see Appendices, p.88).

Protocol

Participants were asked to wear athletic attire for the assessments. Children were informed of their choice to participate in each assessment, to ensure ongoing informed consent. The subjects then completed the elements of the CAPL in no specific order, over 1-3 hours depending on the size of the group of participants to be tested. Three-to-six trained staff carried out the testing at each location. All appraisers were previously trained on the testing protocol by senior project staff. All testers were certified in CPR and First Aid. In the event of any adverse medical events related to the testing, emergency protocols for the host institution were followed.

The domains of physical literacy were assessed using the assessment tools described below. An in depth description of the CAPL protocol has recently been published, and it is also described much more briefly in part 2 of this thesis (Longmuir et al., 2015b). The results of the assessments were used to generate individual domain, and overall CAPL scores as per Figure 1. It is important to note that it is possible to calculate domain scores if one measurement from the domain is missing (Healthy Active Living and Obesity Research Group, 2013). An algorithm provides a full domain score by excluding the score of the missing/removed measure (in this case BMI) and re-weighting the other measures for that domain. This allowed us to exclude BMI from the scoring protocol, and use it instead to stratify the data and examine relationships among participants with differing weight statuses (healthy weight vs. overweight/obese).

Assessments/ Variables

*15 m PACER Shuttle Run Test*

The Progressive Aerobic Cardiovascular Endurance Run (PACER) was used to assess cardiorespiratory endurance (Healthy Active Living and Obesity Research Group, 2013). The test requires at least 15 m of linear space, cones, and a stereo. Cones are set up at either end of the 15 meters, and children run back-and-forth between the cones in time with beeps from the stereo (a prerecorded tape of the PACER test is available). With each lap, the time between successive beeps decreases. Children are instructed to continue to run for as long as they possibly can while keeping up with the beeps. If the participant fails to complete a lap before a beep, they must catch up and complete the next lap before the next beep. If two beeps in a row are missed, the participant is finished the test. We recorded the last successfully completed lap number. The PACER test was appropriate for this application as it can be done in a group, and it has been shown to elicit similar peak heart rate and $VO_2$ to graded exercise tests in youth (Scott et al., 2013).

*Grip Strength*

Grip strength was assessed using a hand-held dynamometer (Takei A5001, Japan) as an index of upper body strength (Committee on Fitness Measures and Health Outcomes in Youth, 2012). Hand grip strength is significantly associated with chest press strength (r = 0.70), total muscle strength (based on four muscle groups, r = 0.74- 0.89), and various other measures of strength in children and adolescents, as well as adults (Bohannon, 2008; Milliken et al., 2008; Wind et al., 2010). The dynamometer grip size was adjusted so that it fit properly between the base of the thumb, and middle phalanges. While standing in an upright position, participants were instructed to hold the dynamometer with the scale facing out, and hand held away from the body at 45 degrees with the arm straight. Participants were then instructed to squeeze the handle as hard as they can in a controlled manner, while saying the word 'squeeze' (Healthy Active Living and Obesity Research Group, 2013). Grip strength was recorded to the nearest 0.5 kg. Two measurements were taken per arm and averaged for each arm. Test-retest reliability of this method is similar to other methods such as taking the average of three trials (Hamilton et al., 1994). Test-retest reliability for grip strength with a dynamometer is as high as 0.97 (Molenaar et al., 2008).

*Plank*

The plank test has been shown to correlate significantly with other tests of abdominal muscle fitness (r = 0.43 for curl-ups), and is a reliable (Intraclass Correlation Coefficient (ICC) = 0.62 for inter-tester reliability, 0.83 for intra-tester reliability, 0.63 for test-retest reliability) test of torso muscular endurance in children aged 8-12 years (Boyer et al., 2013b; Longmuir et al., 2013). The plank was also found to be more feasible for the age group of the CAPL than other tests of torso muscles such as curl-ups (Boyer et al., 2013b; Longmuir et al., 2015b). This assessment requires a stopwatch and a mat longer than the participant's body. Participants tuck in their shirts, and go down on elbows and knees on the mat, with feet together. They then lift their knees and straighten their legs so that they assume a straight position, supported by only the forearms and toes (see Figure 2). Once the body was in the correct, straight position, the appraiser began the stopwatch. Participants were instructed to hold the position for as long as they possibly could. The participant was allowed to break from the straight body position (with hips either too high or too low) once, at which point they were given a warning. If the subject broke position a second time, the time was stopped (Healthy Active Living and Obesity Research Group, 2013). Times were recorded to 0.1 seconds.

**Figure 2.** A participant completing the plank torso muscular endurance test as part of the Canadian Assessment of Physical Literacy (CAPL). Adapted from the CAPL Manual for Test Administration (Healthy Active Living and Obesity Research Group, 2013).

*Sit and Reach Test*

The sit and reach test was used to assess flexibility, specifically of the hamstrings and trunk (Committee on Fitness Measures and Health Outcomes in Youth, 2012). This test requires floor space, and a sit and reach flexometer with the foot surface located at the 26 cm mark of the measuring rod (Healthy Active Living and Obesity Research Group, 2013). The flexometer is placed against a wall, and the participants sit in front of it with their bare feet together, dorsiflexed at 90 degrees, flat against the surface of the flexometer. They are instructed to place one hand over the other, and without lifting their knees from the floor, bend forward while slowly pushing the tab on the measuring rod forward as far as they can. At the point where they could not push any further, they were instructed to hold their position for 5 seconds. The measurement was recorded from the flexometer, to the nearest 0.5 cm (Healthy Active Living and Obesity Research Group, 2013). Two measurements were taken per participant, and the higher of the two was used.

*Weight*

Weight measurements were used in conjunction with height measurements to calculate body mass index (BMI). Weight was assessed using a digital scale (A&D Medical, Milpitas, California, USA). Participants were instructed to stand on the scale without shoes on, and weight was recorded from the scale to the nearest 0.5 kg.

*Height*

Height measurements were used in conjunction with weight, to give a measure of BMI. Height was measured with a portable stadiometer (SECA, Hamburg, Germany) placed on a flat, level surface, against a wall. Participants stood with heels against the stadiometer platform, without shoes. The measurement was taken at peak inspiration with the head in the Frankfort plane. Height was recorded to the nearest 0.1 cm (Healthy Active Living and Obesity Research Group, 2013). Two measurements were taken, and a third was taken if the first two measurements were more than 0.5 cm apart. An average of the closest two measurements was used.

*Weight Status*

Healthy weight and overweight/obese categories were determined using BMI z-scores based on the World Health Organization criteria (De Onis et al., 2007; De Onis & Lobstein, 2010). Using the widely accepted WHO standards, a child with a BMI z-score between 1 and 2 was considered overweight (z-score of 1.0 would correspond to a BMI of 25.4 kg/m$^2$ by age 19), while a z-score greater than 2 is considered obese (corresponding to a BMI of 29.7 kg/m$^2$ or higher by age 19) (De Onis et al., 2007; De Onis & Lobstein, 2010). A z-score of less than -2 was considered underweight (these participants were removed from these analyses, n=9). The BMI z-score was calculated automatically by the CAPL database platform. Children who were classified as overweight or obese were grouped together in our analyses in order to maximize power.

*Waist Circumference*

Waist circumference was used as an indicator of abdominal fat deposition (Healthy Active Living and Obesity Research Group, 2013). Waist circumference has been shown to correlate significantly with total fat mass in healthy weight boys (r = 0.72) and girls (0.82), and with percent body fat, although to a lesser extent (r = 0.40-0.68) (Mehdad et al., 2011; Wang et al., 2013). In a study of youth ages 3-19 years, the 80$^{th}$ percentile for waist circumference correctly identified 89% of girls, and 87% of boys with high amounts of trunk fat (Taylor et al., 2000). Also, waist circumference has been found to be a better predictor of cardiovascular disease markers in children than BMI (Savva et al., 2000). Measurement required a tape measure. Measurements were done in a private area, or behind a privacy screen. Measurements were taken just above the iliac crest, at the mid-axillary line. Measurements were taken at the end of a normal expiration, ensuring that the measuring tape was snug to the skin without causing indentation. Two measurements were taken to the nearest 0.1 cm, and averaged. If the two measurements differed by more than 0.5 cm, a third measurement was taken, and the closest two measurements were averaged.

*Motor Skill Assessment (Canadian Agility and Movement Skill Assessment)*

The CAMSA assesses a number of fundamental motor skills including hopping, skipping, catching, throwing, kicking and side-to-side sliding (Healthy Active Living and Obesity Research Group, 2013; Longmuir et al., 2015a). The performance level of such fundamental motor skills has been shown to positively correlate with overall physical activity levels (Lubans et al., 2010). The CAMSA has been validated against a common battery of tests for assessing movement skills in children (the Movement-ABC, $r = -0.30$ for CAMSA time, $r = 0.46$ for score), and has shown moderate-to-excellent inter-rater reliability (ICC: 0.99 for time, 0.69 for score), and moderate-to-excellent intra-rater reliability (ICC: 0.99 for time, 0.52 for score) (Longmuir et al., 2013; Longmuir et al., 2015a). The CAMSA has also shown good test-retest reliability over a period of 1-2 weeks (ICC: 0.82 for time, 0.74 for score) (Longmuir et al., 2015a).

The CAMSA requires an open space (15 m long by 5 m wide), tape to mark throwing/kicking lines, cones, hula-hoops, one soccer ball, one soft ball, and a target (24'' wide by 18'' high). The layout of the CAMSA can be seen in Figure 3.

Children were instructed to perform the CAMSA as fast as they could, while employing their best skills, as they are assessed on both factors. Based on their time, they were given a score between 1 and 14. Each skill was scored based on whether or not the participant met a predetermined movement criterion for the skill. If no mistakes were made for any of the criteria, they obtained a maximum score of 14. Scoring of the time, and skills components are illustrated in Figure 4. Two appraisers are required for the CAMSA. One appraiser (appraiser 1) timed the participant, and gave them verbal cues as they completed each section, and the other (appraiser 2) assessed the participants on the movement criteria.

One at a time, participants lined up in front of the hoops, and when instructed, they performed the following in succession:

1. Two-footed jumps across three different colored hoops.
2. Lateral slide to cone 2, touch cone 2.
3. Lateral slide to cone 1, touch cone 1.
4. Turn around and catch the ball (thrown by appraiser 1), run to the throwing line and throw the ball at the target.
5. Run around cone 2, and skip between cones 3 and 4.
6. Perform one-footed hops through each of the 6 hoops.
7. Run to the throwing/kicking line and kick the soccer ball (placed by appraiser 1) between cones 5 and 6.

CAMSA times were recorded to the nearest 0.1 second. Participants were given two practice trials, followed by two scored trials, which were averaged.

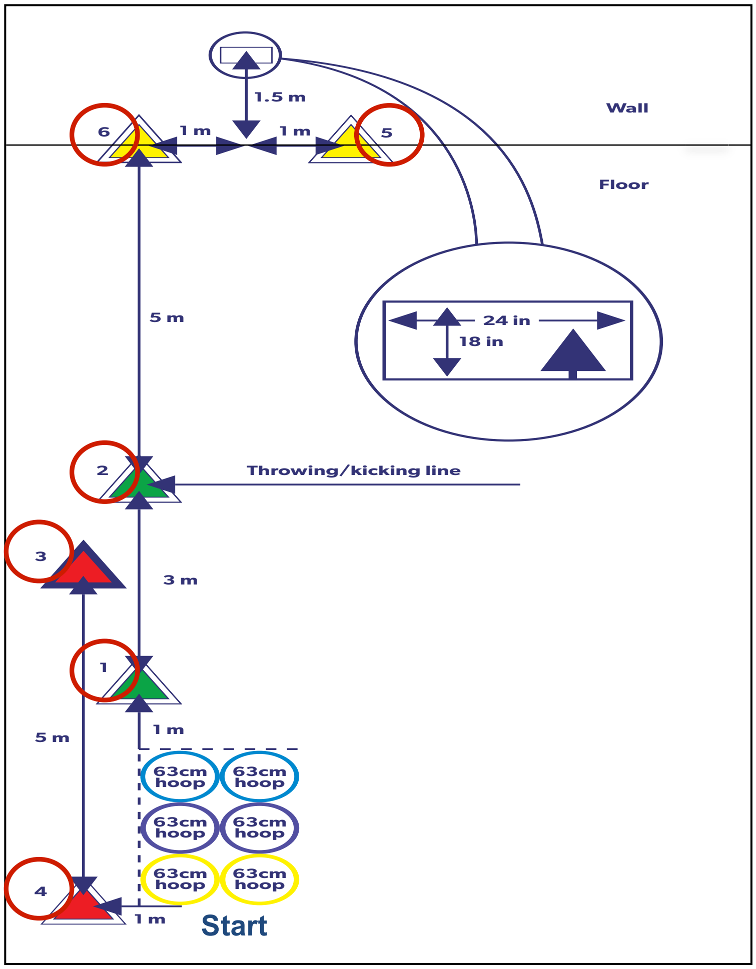


**Figure 3.** Layout of the Canadian Agility and Movement Skill Assessment (CAMSA). Colored triangles represent cones. Cone numbers are circled for emphasis. Adapted from the CAPL Manual for Test Administration (Healthy Active Living and Obesity Research Group, 2013).

A

| ID Number: | | | |
|---|---|---|---|
| Time(s) | | | |
| **Two foot jumping** | 3 two-foot jumps in and out of the yellow/ purple/blue hoops | | |
| | No extra jumps and no touching of hoops | | |
| **Sliding** | Body and feet are aligned sideways when sliding in one direction | | |
| | Body and feet are aligned sideways when sliding in opposite direction | | |
| | Touch cone with low centre of gravity and athletic position | | |
| **Catching** | Catches ball (no dropping or trapping) | | |
| **Throwing** | Uses overhand throw to hit target | | |
| | Transfers weight and rotates body | | |
| **Skipping** | Correct hop-step pattern | | |
| | Uses arms appropriately (alternates arms and legs, arm swinging for balance) | | |
| **One foot hopping** | Land on one foot in each hoop | | |
| | Hops once in each hoop (no touching of hoops) | | |
| **Kicking** | Smooth approach to kick ball and hit target | | |
| | Elongated stride on last stride before impact | | |
| **Total** | | | |

B

| Time (sec) | Score |
|---|---|
| < 14 | 14 |
| 14 < 15 | 13 |
| 15 < 16 | 12 |
| 16 < 17 | 11 |
| 17 < 18 | 10 |
| 18 < 19 | 9 |
| 19 < 20 | 8 |
| 20 < 21 | 7 |
| 21 < 22 | 6 |
| 22 < 24 | 5 |
| 24 < 26 | 4 |
| 26 < 28 | 3 |
| 28 < 30 | 2 |
| ≥ 30 | 1 |

**Figure 4.** Scoring of the Canadian Agility and Movement Skill Assessment (CAMSA). A) Summary of 14 skill performance criteria. B) Conversion of CAMSA time into 14-point score. Adapted from the CAPL Manual for Test Administration (Healthy Active Living and Obesity Research Group, 2013).

*Daily Step Counts*

Participants' daily PA behaviour was assessed through average daily step counts, obtained via a pedometer worn for 7 days. Pedometers are a cost-efficient way of measuring PA behaviour under free-living conditions, particularly given the size of our sample (McNamara et al., 2010). Further, pedometers have been validated against other measures of PA, such as accelerometers (r = 0.47-0.99), self-report (r = 0.33-0.39), and direct observation (r = 0.80- 0.82) in adults and children (McNamara et al., 2010; Tudor-Locke et al., 2002). The current study used YamaxDigiWalker SW-200 (Yamax Corporation, Tokyo, Japan) pedometers. These pedometers have been shown to have high inter-unit agreement (ICC: 0.96 for one week of wear) (Barfield et al., 2004).

Participants were provided pedometers to be worn attached to the waistband of their pants, over the right hip. This site has been shown to result in the smallest amount of pedometer inaccuracy in children (McNamara et al., 2010). The day that children received the pedometer was considered a 'practice day'. For the following 7 days, children recorded how many steps they took, ideally before going to bed at night. They also recorded how much time, if any, that the pedometer had been taken off for throughout the day. Children were informed on how to properly fill out the pedometer log sheets, and were instructed to do their best not to remove the pedometer throughout the day, unless required. As the pedometers are not waterproof, participants had to remove them to shower, or for water-based activities such as swimming.

*Questionnaires*

The domains of knowledge and understanding, and motivation and confidence were assessed by questionnaire.

The knowledge and understanding aspects of the questionnaires are designed to test aspects of health behaviour knowledge that are rooted in the Canadian curriculum (Longmuir, 2013; Longmuir et al., 2015b). Questions include those testing the participants' knowledge about daily activity and screen time guidelines, use of safety equipment during activity, and how to improve fitness and health. The concepts of aerobic fitness, muscular strength and endurance, and health are also tested. Application of these concepts is assessed through the completion of a short paragraph using a list of provided words. Children are also asked to indicate their preferred activities from a list, which includes both sedentary and active behaviours. The participants also self-reported on their sedentary behaviour and MVPA within the past week (Healthy Active Living and Obesity Research Group, 2013; Longmuir, 2013). The knowledge and understanding questionnaire can be seen in the appendix.

Motivation and confidence was assessed based on several series of questions. The first series required the participant to rate a number of reasons why or why not they might be active (5-point likert scale from ‘Disagree a lot’ to ‘Agree a lot’). This gives an indication of the child’s perception of their barriers, compared to their perceived benefits of PA (Garcia et al., 1995). The ratio of perceived benefits to perceived barriers is correlated with exercise behaviour as measured with the Child/Adolescent Exercise Log ($R^2$= 0.193 for regression model with gender, access to facilities, and barrier/benefit differential, B= 1.27 for barrier/benefits differential) (Garcia et al., 1995). They were also asked to rate how often they are active, and how good they are at sports and skills, compared to their peers (from ‘A lot less active’ or ‘Others are better’, to ‘A lot more active’ or ‘I’m a lot better’). Finally, the participants were required to complete the Adequacy and Predilection subscales of the Child Self-perceived Adequacy and Predilection toward Physical Activity (CSAPPA) questionnaire (Hay, 1992). These scales provide an index of the child’s self-perceived ability to achieve in the realm in physical competence, as well as an index of how likely they are to choose physically active behaviours over sedentary ones (Hay, 1992). They require children to choose which of two opposing statements (e.g. ‘Some kids are good at active games’ or ‘Other kids find active games hard to play’) is most like them, and whether it is ‘really true for me’, or ‘sort of true for me’. The questionnaire includes 17 such statement pairs, which are scored from 1 to 4, with 1 indicating the most ‘inactive’ response, and 4 indicating the most ‘active’ response (e.g. ‘Some kids are good at active games – really true for me’ = 4; ‘Other kids find active games hard to play – really true for me’ = 1) (Hay, 1992). These subscales have been shown to be reliable (test-retest reliability coefficients of 0.81 and 0.78 for adequacy, and predilection, respectively), and predictive of self-reported PA (r = 0.45) and teacher-rated PA ability (r = 0.50), as well as significantly correlated with tests of motor skills, cardiorespiratory endurance (r = 0.40), torso strength (r = 0.23), and CAMSA score (r = 0.30) and time (r = -0.32) in children in grades 4-6 (Boyer et al., 2013a; Hay, 1992).

Statistical Analysis

Data from participants in Southeastern Ontario, Canada were analyzed. Only participants with sufficient data to calculate scores in each CAPL domain were included. If participants were missing >1 measurement from any of the four domains, they were not included in the dataset. Pedometer data were considered complete if the participant achieved between 1,000 and 30,000 steps per day, wore the pedometer for at least 10 hours per day, and had at least 4 days of valid data, including one weekend day (Larouche et al., 2014). Only participants with full physical competence data were included, as BMI was removed from the scoring protocol to stratify the groups (115 participants were removed due to lack of full physical competence data). Thus, all physical competence scores do not include BMI in the scoring analysis and are calculated using the algorithm designed for the CAPL protocol (Healthy Active Living and Obesity Research Group, 2013).

Demographic data presented as mean (SD) were compared between groups using independent t-tests. Levene's test was used to determine equality of variance between groups, and p-values were adjusted as necessary. Comparison of physical literacy domain scores and total CAPL scores between groups was also accomplished using independent t-tests. Categorical participant data such as age distribution were compared across groups using chi-squared analysis.

Partial correlations were used to assess the relationships between overall scores in each of the domains of physical literacy separately, while controlling for age and sex (which have been shown to influence some CAPL domain scores and CAPL total score), as well as other domain scores (Longmuir et al., 2015b). Confidence intervals for correlation coefficients were calculated, and effect sizes were determined with the proportion of explained variance ($r^2$). Correlations were classified as weak ($0.1 \leq r < 0.3$), moderate ($0.3 \leq r < 0.5$), or strong ($r \geq 0.5$) (Kenny, 1987). Analyses were performed on data from participants with healthy weight, and those who were overweight/obese separately. Fisher's r-to-z test was used to determine if the correlation coefficients between domains of physical literacy differed significantly between children who were overweight/obese and those who were healthy weight (Fisher, 1921; Weaver & Wuensch, 2013).

**PART 2**

**Article**

# Associations between domains of physical literacy in 8-12 year-old children according to weight status

**Submitted for publication in *Research Quarterly for Exercise and Sport***

Gregory Traversy, BSc[1,2], Mark S. Tremblay, PhD[1,3], Patricia E. Longmuir, PhD[1-3], Jean-Philippe Chaput, PhD*[1-3]

[1] Healthy Active Living and Obesity Research Group, Children's Hospital of Eastern Ontario Research Institute, Ottawa, Ontario, Canada.
[2] School of Human Kinetics, Faculty of Health Sciences, University of Ottawa, Ottawa, Ontario, Canada.
[3] Department of Pediatrics, Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada.

***Correspondence to:**

Jean-Philippe Chaput, Ph.D., Healthy Active Living and Obesity Research Group, Children's Hospital of Eastern Ontario Research Institute, 401 Smyth Road, Ottawa, Ontario, Canada, K1H 8L1. Phone: +1 613 737 7600 ext. 3683. Fax: +1 613 738 4800.
E-mail: jpchaput@cheo.on.ca

**Acknowledgements**
A number of organizations have contributed to the development of the Canadian Assessment of Physical Literacy. Please refer to www.capl-ecsfp.ca for the full list. Gregory Traversy is supported by an Ontario Graduate Scholarship.
The authors would like to thank Joel Barnes, Stacey Alpous, Amélie Fournier, Mike Borghese, Justin Lang, Laura Callender, Emily Ertel, and Anne Macartney for their help with data collection and recruitment of participants, and Nadia Souriel for her statistical advice.

**Abstract**

**Purpose:** This study analyses the associations among the four domains of physical literacy (physical competence, daily behavior, motivation and confidence, knowledge and understanding) as measured using the Canadian Assessment of Physical Literacy (CAPL) and evaluates whether these associations differ by weight status. **Method:** Canadian children, aged 8 - 12 (n = 456) completed the CAPL protocol. Partial correlations between domains were calculated, controlling for age, sex, and other domain scores, for healthy weight and overweight/obese children separately. Correlation coefficients were then compared statistically between groups. **Results:** The associations (r) between physical competence and daily behavior were .15 (95 % CI: .03 - .26; $p < .05$) and .23 (95 % CI: .08 - .36; $p < .01$) for children who were healthy weight and overweight/obese, respectively. Associations between daily behavior and motivation and confidence were .21 (95 % CI: .09 - .32; $p < .01$) and .29 (95 % CI: .15 - .42; $p < .01$), respectively. Associations between physical competence and motivation and confidence were .38 (95 % CI: .27 – .48; $p < .01$) and .31 (95 % CI: .17 - .44; $p < .01$). There were no significant differences in these correlations between groups ($p \geq .37$). No significant correlations were seen between knowledge and understanding and the other domains in healthy weight children. Conversely, knowledge and understanding was associated with physical competence in children who were overweight/obese (r = .22, 95 % CI: .08 - .35; $p < .01$). **Conclusions:** Most domains of the CAPL correlate positively with one another to the same extent regardless of weight status. The overall low level of correlation between domains suggests that different domains of the CAPL are not measuring the same constructs, providing support for its psychometric architecture.

**Key words**: physical literacy, adiposity, pediatric population

## Introduction

It is well understood that physical activity (PA) is critical for the health of children and adolescents (Janssen & Leblanc, 2010). However, very few Canadian children meet current recommendations for daily PA (~ 10 %) (ParticipACTION, 2015). The concept of physical literacy (PL) has gained popularity as being an important construct that may help to explain why children may or may not engage in PA (Whitehead, 2010). PL has been described as 'the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life' (ParticipACTION et al., 2015). Thus, being more physically literate allows children to be healthier and more active right now, and across the lifespan (Mandigo, Francis, Lodewyk, & Lopez, 2009).

The Canadian Assessment of Physical Literacy (CAPL) represents the first all-encompassing battery of tests designed to measure the construct of PL, combining multiple domains to give a comprehensive measurement (Longmuir, 2013; Longmuir, Boyer, Lloyd, Yang, Zhu, & Tremblay, 2015; Tremblay & Lloyd, 2010). Aligned with the consensus definition for PL, the four core domains of PL as measured by the CAPL are daily behavior, physical competence, motivation and confidence, and knowledge and understanding (Longmuir, 2013; ParticipACTION et al., 2015). Using the CAPL, participants can receive scores for individual domains, as well as a total aggregate PL score (Healthy Active Living and Obesity Research Group, 2013). The CAPL can be used to inform individual programs, provide evidence for resource allocation, influence policy decisions, and provide national surveillance (Tremblay & Lloyd, 2010). In order to ensure that the CAPL accurately captures multidimensional behaviors, and in order for stakeholders to better interpret and use the results of the CAPL, it is important to understand the relationships between the domains of PL. In addition, PL has been described as encompassing many parameters related to healthy weight management, such as feelings of competence and confidence, motivation, attitudes, and physical fitness abilities (Whitehead, 2010). Thus, it is important to understand whether the domains of PL and their relationships with one another, as assessed via the CAPL, differ between children of differing weight status.

A recent study examined the associations between physical competence (fitness and motor skills) and daily PA (part of the daily behavior domain) as assessed using the CAPL, finding significant positive associations between measures within the two domains (Larouche, Boyer, Tremblay, & Longmuir, 2014). To date, however, no studies have investigated the correlations among all four domains of PL, and how these correlations may vary by weight status. Better understanding of this issue will help to determine if domains of PL are related to each other and whether weight status may influence these relationships. Also, if domains correlate strongly with one another, it would suggest that they assess very similar constructs of PL, which may help to reduce the number of tests within the CAPL battery.

The objective of this study was to determine the relationships among the four domains of PL as assessed by the CAPL in 8-12 year-old Canadian children, and to compare these relationships between children who are healthy weight versus those who are overweight/obese. Previous studies showing associations between adiposity and lower levels of physical fitness, daily PA, and self-efficacy suggest that children who are overweight/obese may score lower on the physical competence, daily behavior, and motivation and confidence domains of the CAPL (Brunet, Chaput, & Tremblay, 2007; Deforche et al., 2003; Esteban-Cornejo et al., 2014;

Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). They may also exhibit lower scores in the knowledge and understanding domain depending on fitness level (Esteban-Cornejo et al., 2014). However, although we suspect that overweight/obese children may have lower absolute scores on some aspects of the CAPL, we hypothesized that domains would correlate positively with one another in all children, and that the correlation coefficients would not differ significantly between overweight/obese and healthy weight children, as we had no evidence that would suggest that this would be the case.

## Methods

### Participants

We collected data for this study in 8 to 12 year-old children in Eastern Ontario as part of the CAPL protocol (convenience sample). A total sample of approximately 500 participants was sought out on the results of Larouche et al. (2014), who demonstrated significant associations between domains of the CAPL with 491 participants (37 % of which were overweight or obese). We recruited participants through middle schools and after-school programs such as those held at local YMCA-YWCA's. In all cases informed parental consent and child assent, as well as a medical screening questionnaire, were required before a child could participate in data collection. We included participants if they were in grades 4, 5, or 6 (age 8-12) and they had completed a screening form indicating that they had no known limitations for PA, including maximal effort exercise. We excluded participants if they were younger than 8, or older than 12 years of age, or if they reported having a medical condition or disability that would be likely to influence the CAPL assessment (e.g., cerebral palsy). All study procedures were approved by the Research Ethics Board at the Children's Hospital of Eastern Ontario and the collaborating school boards.

**Protocol**

We assessed children in groups of 10 - 50 at the location from which they were recruited (i.e., their school, or the location of their after-school program). Participants completed the elements of the CAPL in no specific order, being appraised by three-to-six trained research staff. We assessed the domains of PL using the assessment tools briefly described below. In-depth explanation of the CAPL protocol design and validity analysis has been recently published (Longmuir, Boyer, Lloyd, Yang et al., 2015) and detailed descriptions of the assessments can be found in the CAPL manual (Healthy Active Living and Obesity Research Group, 2013) and training videos (available at https://www.capl-ecsfp.ca).

The variables of interest for this study were individual PL domain scores and the total CAPL score. It is important to note that the CAPL protocol has been designed to allow calculation of a domain score if one measurement within the domain is missing (Longmuir, Boyer, Lloyd, Yang et al., 2015). This allowed us to exclude body mass index (BMI) from the scoring protocol, and use it instead to stratify the data and examine relationships among participants with differing weight statuses. A detailed breakdown of the scoring protocol, and explanation of its development, can be found elsewhere (Francis et al., 2015; Longmuir, Boyer, Lloyd, Yang et al., 2015).

**Study variables**

**Physical Competence.** We assessed physical competence using the PACER shuttle-run test (Scott, Thompson, & Coe, 2013), hand grip dynamometer (Committee on Fitness Measures and Health Outcomes in Youth, Food and Nutrition Board, & Institute of Medicine, 2012), sit-and-reach test (Committee on Fitness Measures and Health Outcomes in Youth et al., 2012), abdominal plank test (Boyer, Tremblay et al., 2013), body composition measurements (Canadian Society for Exercise Physiology, 2013) (height, weight, waist circumference) and the Canadian Agility and Movement Skill Assessment (Longmuir, Boyer, Lloyd, Borghese et al., 2015) (which involves running, hopping, balancing, kicking, throwing and skipping). In the CAPL, the PACER and agility tests are scored equally (26 % of the total domain each). Similarly grip strength, plank, BMI and waist circumference each make up approximately 10.5% of the domain score. Sit and reach score makes up 5 % of the domain score (Longmuir, Boyer, Lloyd, Yang et al., 2015). It is important to note that in this study we did not include BMI in the scoring protocol for this variable, as it was used to stratify the groups. An algorithm included in the CAPL protocol allows for calculation of a domain score with the exclusion of a maximum of one measurement within the domain (Longmuir, Boyer, Lloyd, Yang et al., 2015). This algorithm provides a full domain score by excluding the scores of the missing/removed measure (in this case BMI) and re-weighting the other measures for that domain.

**Daily Behavior.** We assessed daily behavior using steps per day as measured by a pedometer worn for one week, as well as self-reported sedentary behavior and moderate-to-vigorous physical activity (MVPA) (Longmuir, Boyer, Lloyd, Yang et al., 2015). The objectively measured daily step count makes up 66 % of the domain score, while the self-reported sedentary behavior and MVPA make up 25 % and 9 % of the score, respectively (Longmuir, Boyer, Lloyd, Yang et al., 2015).

**Motivation and Confidence.** We assessed motivation using elements of the Child Self-predicted Adequacy and Predilection for Physical Activity (CSAPPA) subscales (Hay, 1992) (67 % of the score for the domain), the ratio of perceived benefits and barriers of PA (Garcia et al., 1995) (22 % of domain score), and the child's perception of how their skills and activity level compares to their peers (11 % of domain score) (Longmuir, Boyer, Lloyd, Yang et al., 2015).

**Knowledge and Understanding.** Questionnaires that we used to assess knowledge and understanding included questions testing the participant's knowledge surrounding healthy active living, as well as current PA and sedentary behavior guidelines (Longmuir, Boyer, Lloyd, Yang et al., 2015). Each question is equally weighted within this domain (Longmuir, Boyer, Lloyd, Yang et al., 2015).

**Total CAPL score.** The total CAPL score is a composite of the four domains, with physical competence and daily behavior being weighted more heavily, due to their use of objective measurements as recommended by a consensus of experts (Francis et al., 2015; Longmuir, Boyer, Lloyd, Yang et al., 2015). A CAPL score with a possible total of 100 points consists of a possible 32 points each from the physical competence and daily behavior domains, and 18 points each from the motivation and confidence and knowledge and understanding domains (Longmuir, Boyer, Lloyd, Yang et al., 2015).

**Interpretations vs Raw Scores.** The CAPL protocol provides raw scores for each assessment protocol within a domain, as well as for overall domain scores. The scoring protocol has been recently published (Longmuir, Boyer, Lloyd, Yang et al., 2015), and can also be found in the CAPL manual (available at https://www.capl-ecsfp.ca).

The scoring protocol also allows for domain and total PL scores to be interpreted in a progression, from ‘beginning’, ‘progressing’, ‘achieving’, to ‘excelling.’ Children who are ‘beginning’ are likely to require significant additional support to improve their PL, and are below their peers. Children who are ‘progressing’ are at less than the required level for healthy active living, but are performing at approximately the typical level for Canadian children. Children who are ‘achieving’ are at the minimum level associated with the optimal health benefits of being active. Children who are ‘excelling’ are substantially above the recommended minimum level for health benefits (Longmuir, Boyer, Lloyd, Yang et al., 2015). Detail on how the total PL score and each domain score are interpreted by age can be found in the CAPL manual (Healthy Active Living and Obesity Research Group, 2013).

**Weight status categories**

We determined healthy weight and overweight/obese categories using BMI z-scores based on the World Health Organization criteria (De Onis & Lobstein, 2010). BMI was calculated using the participants’ height and weight, measured by research staff, using a portable stadiometer (SECA, Hamburg, Germany) and a digital scale (A&D Medical, Milpitas, California, USA), respectively. Using the widely accepted WHO standards, a child with a BMI z-score between 1 and 2 is considered overweight (z-score of 1.0 would correspond to a BMI of 25.4 $kg/m^2$ by age 19), while a z-score greater than 2 is considered obese (corresponding to a BMI of 29.7 $kg/m^2$ or higher by age 19) (De Onis & Lobstein, 2010). A z-score of less than -2 is considered underweight (these participants were removed from these analyses, n=9). Children who classified as overweight or obese were grouped together in our analyses in order to maximize power.

**Statistical Analysis**

The original dataset included individuals who had sufficient data to calculate scores in each CAPL domain (i.e., were only missing 1 or fewer measurements from any domain). Of this dataset, we included only participants with full physical competence data, as BMI was removed from the scoring protocol to stratify the groups (115 participants were removed due to a lack of full physical competence data). Thus, all physical competence scores do not include BMI in the scoring analysis and are calculated using the algorithm designed for the CAPL protocol (Healthy Active Living and Obesity Research Group, 2013). Data from the excluded participants did not differ significantly with respect to the percent overweight/obese (38.3 % vs. 39.7 % for main sample) or gender distribution (56.5 % female vs. 51.8 % female) compared to those who were included in the analysis (data not shown). There were however significant differences in age distribution (average age of 10.4 vs 11.0, due to a larger proportion of children between 8 - 9 years of age; $t(148.2) = 4.50$, $p < .01$).

We present demographic data as mean (SD) and compared between groups using independent t-tests. We used Levene's test to determine equality of variance between groups, and p-values were adjusted as necessary. Our comparison of PL domain scores and total CAPL scores between groups was also accomplished using independent t-tests. We compared categorical participant data such as age distribution across groups using chi-squared analysis.

We used partial correlations to assess the relationships between overall scores in each of domains of PL separately, while controlling for age and sex (which have been shown to influence some CAPL domain scores and CAPL total score) (Longmuir, Boyer, Lloyd, Yang et al., 2015), as well as other domain scores. We calculated confidence intervals for correlation coefficients, and determined effect sizes with the proportion of explained variance ($R^2$). We classified correlations as weak ($.1 \leq r < .3$), moderate ($.3 \leq r < .5$), or strong ($r \geq .5$) (Kenny, 1987). We performed analyses on data from participants with healthy weight, and those who were overweight/obese separately. We used Fisher's r-to-z test to determine if the correlation coefficients between domains of PL differed significantly between children who were overweight/obese and those who were healthy weight (Kenny, 1987). In all analyses, we set significance at an alpha level of .05. We did not perform analyses of associations between demographic data and CAPL scores as this was not the focus of this analysis, and this has been reported elsewhere (Longmuir, Boyer, Lloyd, Yang et al., 2015).

## Results

We present descriptive characteristics of participants in Table 1. 39.7 % of included children (n = 181) were overweight or obese. Of these 181 participants, 42.5 % classified as obese, and 57.5 % classified as overweight. The average ages of children who were overweight/obese, and healthy weight children, did not differ significantly. Chi-squared analysis revealed that there were no significant differences between these two groups with respect to age or gender distribution.

Total CAPL scores and scores for each CAPL domain for the two groups can be found in Table 2. There was a significant difference in total CAPL score between the children who were healthy weight and those who were overweight/obese, with healthy weight children having higher (better) scores. However, based on the mean age of 11 years, both groups' mean CAPL scores were interpreted as 'progressing'. Healthy weight children also had higher scores in the physical competence and daily behavior domains. Healthy weight children's physical competence scores were considered 'progressing' while overweight/obese children's scores were considered 'beginning.' In terms of daily behavior scores, healthy weight children's mean score was 0.02 points from being interpreted as 'achieving' while children who were overweight/obese had scores considered 'progressing.' No significant differences were found between groups for the domains of knowledge and understanding or motivation and confidence. In both groups, mean scores for these domains would be interpreted as 'achieving' and 'progressing,' respectively.

Partial correlations between domains (controlling for age, sex, and other domain scores) in healthy weight participants revealed a number of significant positive associations (Table 3). There was a significant weak positive correlation between the domains of physical competence and daily behavior, a significant moderate positive correlation between physical competence and motivation and confidence, and a significant weak positive correlation between scores in the daily behavior and motivation and confidence domains. No significant correlations were found between the domain of knowledge and understanding and the other CAPL domains in healthy weight children (Table 3).

Partial correlations between domains of PL in children who are overweight/obese (controlling for age, sex, and other domain scores) revealed similar results to those in the healthy weight group (Table 4). There was a significant weak positive correlation between scores in the domains of physical competence and daily behavior, and a significant moderate positive correlation between physical competence and motivation and confidence. A significant weak-moderate correlation was found between scores in the daily behavior domain and the motivation and confidence domain. In contrast to the healthy weight group, in the participants who were overweight/obese there was a significant weak positive correlation between physical competence scores and knowledge and understanding scores. There were no significant correlations between scores in the knowledge and understanding domain and either of the motivation and confidence, or daily behavior domains.

When correlation coefficients that were significant in both groups (healthy weight vs. overweight/obese) were compared statistically, no significant differences were found between any of the correlation coefficients ($p$ values ranging from .37 to .41). Additional partial correlation analyses were performed in which the other domain scores were not controlled for, and this did not result in any material changes to the results (i.e., no significant differences were found between groups; data not shown). Similarly, further additional analyses were performed on children who were overweight, and children who were obese, separately, which also did not result in any changes to the results (i.e., no significant differences in correlations between either of these groups, and healthy weight children; data not shown).

## Discussion

Our objective for the current study was to assess the associations between domains of PL as assessed by the CAPL, and compare those associations in children who were healthy weight and those who were overweight/obese. We found similar associations between the domains of physical competence and daily behavior for both groups (r = .15 and r = .23 for healthy weight and overweight/obese children, respectively). Also, we found similar weak-moderate positive associations between daily behavior and motivation and confidence for both groups (r = .21 and r = .29 for healthy weight and overweight/obese children, respectively), and similar moderate positive correlations between physical competence and motivation and confidence (r = .38 and r = .31, respectively), with no significant differences across groups ($p \geq .37$ for all comparisons). Our results suggest that motivation and confidence remain important correlates of PA behavior and physical competence, regardless of weight status.

One difference found between groups was that, in healthy weight children, no significant associations were found between knowledge and understanding, and any of the other domains. In contrast, children who were overweight/obese showed a significant weak positive association between knowledge and understanding, and physical competence (r = .22; but not between knowledge and understanding and either of daily behavior, or motivation and confidence). The reason for this is unclear and deserves further investigation. One explanation could be that in this group, individuals who have higher levels of physical competence may possibly also have higher levels of knowledge due to a common source (e.g., higher levels of participation in physical education), although this is purely speculative at this stage.

The association identified between the domains of physical competence and daily behavior is supported by the broader literature. For example, the correlation coefficient between habitual PA and aerobic fitness were found to range from .10 - .45 in one review, and was estimated be .17, on average, in another review (Dencker & Andersen, 2011; Morrow & Freedson, 1994). Studies have also found that the relationship between PA and aerobic fitness holds after controlling for body mass (Dencker et al., 2006). Additionally, Larouche et al. (2014) found that daily step counts were significantly associated with a number of the CAPL physical competence assessments, including hand grip strength (r = .12), plank time (r = .16), and CAMSA time (r = -.27) and score (r = .20). Finally, in a recent systematic review examining the relationship between fundamental movement skills and PA, the majority of cross-sectional studies with similar age groups and similar movement assessments showed positive associations ranging from .10 - .33 (Holfelder & Schott, 2014). A study cited within this review found that BMI did not influence the relationship between motor skills and levels of PA (Hume et al., 2008).

In examining correlations between elements of motivation and confidence, and daily behavior, De Bourdeaudhuij et al. (2005) found that the correlation between self-efficacy and PA was slightly higher in healthy weight children than in children who were overweight/obese (r = .39 vs. r = .26), but that correlations between PA and other aspects of motivation and confidence towards exercise, such as perceived barriers and benefits, as well as general attitude towards PA, were similar in children with healthy weight and those who were overweight/obese (ranging from .20 - .41). With respect to the associations between motivation and confidence and physical competence, the CSAPPA (67% of the score for motivation and confidence in the CAPL) has also been shown to correlate positively (r = .23 - .40) with aerobic fitness, plank time, and CAMSA score, but not with other elements of the physical competence domain (flexibility, grip strength, height, weight, waist circumference) (Boyer, McFarlane, et al., 2013).

The lack of association between knowledge and understanding, and other domains is not necessarily surprising, as it has been suggested that although knowledge is a required element for engaging in PA, knowledge alone is not sufficient to change behavior (Morrow, Krzewinski-Malone, Jackson, Bungum, & FitzGerald, 2004). It is unclear whether greater knowledge of healthy active living would be expected to be associated with higher levels of motivation or confidence towards PA; however, the results of this study suggest that this is not the case. Participants in general showed relatively high levels of knowledge and understanding – it is unclear whether knowledge and understanding may correlate more strongly with other elements of PL in children with low levels of knowledge (i.e., if there may be greater variability in other domain scores in children with low knowledge). Given that correlations between domains were analyzed in isolation from one another (i.e., other domain scores were controlled for when looking at associations between two domains) there is a possibility that knowledge levels may play a mediating role on the other relationships between CAPL domains; however, when partial correlations were recalculated without controlling for knowledge scores, none of the coefficients increased in size (data not shown). This could be a focus of future research.

A major strength of our study is the integrity of the CAPL protocol. The protocol was designed with input from many experts in the field, objective measures are weighted more heavily, and all of the protocols included have been assessed for validity and reliability (Boyer, Tremblay et al., 2013; Francis et al., 2015; Longmuir, Boyer, Lloyd, Borghese et al., 2015; Longmuir, Boyer, Lloyd, Yang et al., 2015). Other strengths include the large sample size for a study using direct measurements of PL domains, and controlling for elements known to influence CAPL domain scores such as age and sex in the statistical analysis (Longmuir, Boyer, Lloyd, Yang et al., 2015). Limitations of the study include its cross-sectional design, which limits interpretations of causality. Also, as the participants were not randomly chosen, the sample may not be representative of the Canadian population; for instance, the proportion of overweight or obese participants was higher than what has been reported for North American adolescents (Ng et al., 2014). The use of pedometers to measure daily PA does not give an indication of activity intensity or information on water-based or non-ambulatory activity. Because of this, participants are also asked to self-report on their MVPA, which could be subject to recall or social desirability biases, and this measure is weighted less heavily in the scoring protocol accordingly. Although correlations were controlled for age, the CAPL protocol does not include a measure of developmental stage, which could influence the results. This effect is likely limited, however, due to the fact that all participants were 12 years or younger. As some of the assessments within the physical competence domain are done in groups, there is the possibility that performance could be influenced by social dynamics (Tomkinson, Leger, Olds, & Cazorla, 2003). Finally, the Fishers r-to-z transformation is a relatively low power test, and thus there is the possibility of type II errors in comparing correlation coefficients between the two groups (Kenny, 1987). However, the significant correlations were very similar between groups, with the major difference being the lack of statistically significant correlation between physical competence and knowledge and understanding in healthy weight participants.

## Conclusions

Although children who were overweight/obese scored lower than healthy weight children in some domains of PL, we found significant positive associations for both groups between the domains of physical competence, daily behavior, and motivation and confidence. The strength of these associations was not significantly different between groups. One difference that we found between the two groups was that knowledge was not found to be significantly associated with other domains in healthy weight children, but was found to be significantly associated with physical competence in children who were overweight/obese.

Thus, while participants who are overweight/obese may score lower in some domains of PL, the relationships between most of the domains appear stable across children of different weight status, highlighting the importance of targeting multiple elements of PL in interventions. Our results also suggest that interventions aimed at increasing PL do not necessarily need to be tailored specifically based on weight status. Much of the variance in domain scores was not explained by the correlations examined in this study ($R^2$ values ranged from .02 - .14). The low level of association among domains suggests that the CAPL domains are not duplicating one another, and are in fact measuring different constructs of PL, providing further evidence of the validity of the CAPL architecture.

## What does this article add?

This is the first study to look at the relationships between domains of physical literacy using the CAPL protocol. Given that the elements of the CAPL measure factors that may be related to one another (e.g., physical fitness and physical activity level), there may be concerns that domains may be measuring the same constructs, or constructs that are overly similar. If this is the case, the CAPL protocol should be shortened. However, the low levels of correlation seen between domains in this study suggest that this is not the case. Further, the similar results obtained in healthy weight and overweight/obese children suggest that interventions aimed at improving physical literacy may not need to be specifically tailored based on weight status.

Outside the context of physical literacy assessment, this study adds to the body of literature examining the associations between PA, and factors that may influence PA behavior, such as fitness, motivation and confidence, and knowledge (De Bourdeaudhuij et al., 2005; Dencker & Andersen, 2011; Holfelder & Schott, 2014; Morrow et al., 2004). Among such studies, few have examined whether or not these relationships differ depending on weight status, adding to the novelty of the current study.

**References**

Boyer, C., McFarlane, A., McClelland, K., Barnes, J., Borghese, M., Larouche, R., . . . Longmuir, P. (2013). Children's physical Activity self-efficacy is related to physical fitness, motor skill and perceived social support. *Pediatric Exercise Science, 25*(Supp.), S3.

Boyer, C., Tremblay, M., Saunders, T. J., McFarlane, A., Borghese, M., Lloyd, M., & Longmuir, P. (2013). Feasibility, validity and reliability of the plank isometric hold as a field-based assessment of torso muscular endurance for children 8-12 years of age. *Pediatric Exercise Science, 25*, 407-422.

Brunet, M., Chaput, J. P., & Tremblay, A. (2007). The association between low physical fitness and high body mass index or waist circumference is increasing with age in children: The 'Quebec en Forme' project. *International Journal of Obesity, 31*, 637-643.

Canadian Society for Exercise Physiology. (2013). *Canadian society for exercise physiology-physical activity training for health (CSEP-PATH)*. Ottawa, Ontario: Canadian Society for Exercise Physiology.

Committee on Fitness Measures and Health Outcomes in Youth, Food and Nutrition Board, & Institute of Medicine. (2012). *Fitness measures and health outcomes in youth.* Washington, DC: National Academies Press.

De Bourdeaudhuij, I., Lefevre, J., Deforche, B., Wijndaele, K., Matton, L., & Philippaerts, R. (2005). Physical activity and psychosocial correlates in healthy weight and overweight 11 to 19 year olds. *Obesity Research, 13*, 1097-1105.

De Onis, M., & Lobstein, T. (2010). Defining obesity risk status in the general childhood population: Which cut-offs should we use. *International Journal of Pediatric Obesity, 5*, 458-460.

Deforche, B., Lefevre, J., De Bourdeaudhuij, I., Hills, A. P., Duquet, W., & Bouckaert, J. (2003). Physical fitness and physical activity in obese and nonobese flemish youth. *Obesity Research, 11*, 434-441.

Dencker, M., & Andersen, L. (2011). Accelerometer-measured daily physical activity related to aerobic fitness in children and adolscents. *Journal of Sports Sciences, 29*, 887-895.

Dencker, M., Thorsson, O., Karlsson, M. K., Linden, C., Svensson, J., Wollmer, P., & Andersen, L. B. (2006). Daily physical activity and its relation to aerobic fitness in children aged 8-11 years. *European Journal of Applied Physiology, 96*, 587-592.

Esteban-Cornejo, I., Tejero-Gonzalez, C. M., Martinez-Gomez, D., del-Campo, J., Gonzalez-Galo, A., Padilla-Moledo, C., . . . UP & DOWN Study Group. (2014). Independent and combined influence of the components of physical fitness on academic performance in youth. *The Journal of Pediatrics, 165*, 306-312.

Francis, C. E., Longmuir, P. E., Boyer, C., Andersen, L. B., Barnes, J. D., Boiarskaia, E., . . . Tremblay, M. S. (2015). The Canadian Assessment of Physical Literacy: Development of a model of children's capacity for a healthy, active lifestyle through a delphi process. *Journal of Physical Activity & Health,* Epub ahead of print. doi:2014-0597 [pii]

Garcia, A. W., Broda, M. A. N., Frenn, M., Coviak, C., Pender, N. J., & Ronis, D. L. (1995). Gender and developmental diferences in exercise beliefs among youth and prediction of their exercise behavior. *Journal of School Health, 65*, 213-219.

Hay, J. A. (1992). Adequacy in and prediliction for physical activity in children. *Clinical Journal of Sport Medicine, 2*, 192-201.

Healthy Active Living and Obesity Research Group. (2013). *Canadian Assessment of Physical Literacy - manual for test administration*. Ottawa, ON: Healthy Active Living and Obesity Research Group (HALO).

Holfelder, B., & Schott, N. (2014). Relationship of fundamental movement skills and physical activity in children and adolescents: A systematic review. *Psychology of Sport and Exercise, 15*, 382-391.

Hume, C., Okely, A., Bagley, S., Telford, A., Booth, M., Crawford, D., & Salmon, J. (2008). Does weight status influence associations between children's fundamental movement skills and physical activity*? Research Quarterly for Exercise and Sport, 79*, 158-165.

Janssen, I., & Leblanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth*. The International Journal of Behavioral Nutrition and Physical Activity, 7*, 40.

Kenny, D. A. (1987). *Statistics for the social and behavioral science*s. Canada: Little, Brown and Company.

Larouche, R., Boyer, C., Tremblay, M., & Longmuir, P. (2014). Physical fitness, motor skill, and physical activity relationships in grade 4 to 6 children. *Applied Physiology, Nutrition, and Metabolism,* 39, 553-559.

Longmuir, P.E., Boyer, C., Lloyd, M., Borghese, M.M., Knight, E., Saunders, T.J., . . . Tremblay, M.S. (2015). Canadian agility and movement skill assessment of motor skill: Validity, objectivity and reliability evidence for children 8 to 12 years of age. *Journal of Sport and Health Science, (in press).*

Longmuir, P. (2013). Understanding the physical literacy journey of children: The Canadian Assessment of Physical Literacy. *Bulletin of the International Council of Sport Science and Physical Education ICSSPE, 65*, 1-6.

Longmuir, P. E., Boyer, C., Lloyd, M., Yang, Y., Boiarskaia, E., Zhu, W., & Tremblay, M. S. (2015). The Canadian Assessment of Physical Literacy: Methods for children in grades 4 to 6 (8 to 12 years). *BMC Public Health, 15*, 767.

Mandigo, J., Francis, N., Lodewyk, K., & Lopez, R. (2009). *Position paper: Physical literacy for educators*. Brock University: Physical & Health Education Canada.

Morrow, J., Krzewinski-Malone, J., Jackson, A., Bungum, T., & FitzGerald, S. (2004). American adults' knowledge of exercise recommendations. *Research Quarterly for Exercise and Sport, 75*, 231-237.

Morrow, J., & Freedson, P. S. (1994). Relationship between habitual physical activity and aerobic fitness in adolescents. *Pediatric Exercise Science, 6*, 315-315.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., . . . Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the global burden of disease study 2013. *Lancet, 384,* 766-81.

ParticipACTION. (2015). *The biggest risk is keeping kids indoors. The 2015 ParticipACTION report card on physical activity for children and youth*. Toronto, Canada: ParticipACTION.

ParticipACTION, Sport for Life Society, Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute, Physical and Health Education Canada, Canadian Parks and Recreation Association, & Ontario Society of Physical Activity Promoters in Public Health. (2015). *Canada's physical literacy consensus statement*. Canada.

Scott, S. N., Thompson, D. L., & Coe, D. P. (2013). The ability of the PACER to elicit peak exercise response in youth. *Medicine and Science in Sports and Exercise, 45*, 1139-1143.

Tomkinson, G. R., Leger, L. A., Olds, T. S., & Cazorla, G. (2003). Secular trends in the performance of children and adolescents (1980-2000): An analysis of 55 studies of the 20m shuttle run test in 11 countries. *Sports Medicine, 33*, 285-300.

Tremblay, M. S., & Lloyd, M. (2010). Physical literacy measurement - The missing piece. *Physical and Health Education, Spring*, 26-30.

Whitehead, M. (Ed.). (2010). *Physical literacy: Throughout the lifecourse*. New York, NY: Routeledge.

Wrotniak, B. H., Epstein, L. H., Dorn, J. M., Jones, K. E., & Kondilis, V. A. (2006). The relationship between motor proficiency and physical activity in children. *Pediatrics, 118*, e1758-e1765.

**Table 1**.

*Descriptive Characteristics of Participants*

| Variable | Healthy weight (N=275) | Overweight/obese (N=181) | *P* |
| --- | --- | --- | --- |
| **Sex (%)** | | | |
| **Boys** | 44.7 | 53.6 | .06 |
| **Girls** | 55.3 | 46.4 | - |
| **Age (years)** | 11.0 (0.95) | 11.0 (0.99) | .95 |
| **Age 8 (%)** | 1.5 | 2.2 | .94 |
| **Age 9 (%)** | 17.5 | 16.6 | - |
| **Age 10 (%)** | 23.6 | 25.4 | - |
| **Age 11 (%)** | 43.6 | 43.6 | - |
| **Age 12 (%)** | 13.8 | 12.2 | - |
| **Height (cm)** | 145.0 (8.8) | 149.8 (8.3) | **< .01** |
| **Weight (kg)** | 36.2 (6.7) | 53.3 (16.4) | **< .01** |
| **Body mass index (kg/m$^2$)** | 17.0 (1.6) | 23.6 (5.9) | **< .01** |
| **Waist circumference (cm)** | 60.7 (7.2) | 76.6 (11.5) | **< .01** |

Data are presented as mean (standard deviation) unless otherwise indicated. Statistical significance was assessed by unpaired t-test for continuous variables and by a chi-squared test for categorical variables.

**Table 2**.

*Physical Literacy Domain Scores in Children of Different Weight Status*

| Physical Literacy Domain | Scores Healthy weight (N=275) | Overweight/obese (N=181) | *P* |
|---|---|---|---|
| **Physical competence (/32)** | 16.5 (3.8) | 14.5 (3.5) | **< .01** |
| **Daily behavior (/32)** | 19.6 (7.3) | 17.6 (7.7) | **< .01** |
| **Motivation and confidence (/18)** | 12.7 (2.5) | 12.4 (2.8) | .30 |
| **Knowledge and Understanding (/18)** | 12.7 (2.7) | 12.3 (2.6) | .15 |
| **Total CAPL Score (/100)** | 61.4 (10.6) | 56.7 (11.7) | **< .01** |

Data are presented as mean (standard deviation).

CAPL, Canadian Assessment of Physical Literacy.

Physical literacy domain scores were compared using an unpaired t-test.

**Table 3**.

*Partial Correlations Between Scores in Domains of Physical Literacy in Healthy weight Children, Controlling for Age, Sex, and Other Domain Scores. 95 % Confidence Intervals are Indicated in Parentheses for Significant Correlations.*

| | **Physical competence** | **Daily behavior** | **Motivation and confidence** | **Knowledge and understanding** |
|---|---|---|---|---|
| **Physical competence** | 1 | - | - | - |
| **Daily behavior** | .15 * (.03 - .26) | 1 | - | - |
| **Motivation and confidence** | .38 ** (.27 - .48) | .21 ** (.09 - .32) | 1 | - |
| **Knowledge and understanding** | .11 | - .09 | .05 | 1 |

*Significant correlation, $p < .05$

**Significant correlation, $p < .01$

**Table 4**.

*Partial Correlations Between Scores in Domains of Physical Literacy in Overweight/Obese Children, Controlling for Age, Sex, and Other Domain Scores. 95% Confidence Intervals are Indicated in Parentheses for Significant Correlations.*

| | **Physical competence** | **Daily behavior** | **Motivation and confidence** | **Knowledge and understanding** |
|---|---|---|---|---|
| **Physical competence** | 1 | - | - | - |
| **Daily behavior** | .23 ** (.08 - .36) | 1 | - | - |
| **Motivation and confidence** | .31 ** (.17 - .44) | .29 ** (.15 - .42) | 1 | - |
| **Knowledge and understanding** | .22 ** (.08 - .35) | .03 | .03 | 1 |

*Significant correlation, $p < .05$

**Significant correlation, $p < .01$

## PART 3

### Global Discussion

To date, a small number of studies have examined the results of CAPL assessments, and none have examined the correlations among the four domains of CAPL, or how they differ between healthy weight children and children who are overweight/obese. Thus, the purpose of this thesis was to assess these relationships using data collected in children from the Southeastern Ontario region of Canada. The primary results are contained within Part 2 of the thesis (Tables 1-4), while the results of selected sub-analyses can be found in Part 4 (Tables 5-10).

First, the results of this study illustrate that children who are overweight/obese obtain lower scores than healthy weight children in the physical competence and daily behaviour domains, as well as in the overall CAPL score. The physical competence results concur with the broader literature showing that overweight/obese children tend to perform more poorly in tests of cardiovascular endurance, agility and motor skills, and torso strength/endurance (Brunet et al., 2007; Chatrath et al., 2002; Deforche et al., 2003; Esteban-Cornejo et al., 2014; Graf et al., 2004; Malina et al., 1995; Minck et al., 2000; Pate et al., 1989; Wrotniak et al., 2006). These types of tests, along with waist circumference (lower scores expected for children who are overweight/obese, as $r = 0.91$ with BMI), make up 84.5% of the physical competence score (Bell et al., 2013; Longmuir et al., 2015b).

The scores for daily behaviour are in line with most, but not all, research. For instance, a review of mostly cross-sectional studies found that the majority (79%) of studies reported a negative association between adiposity (determined primarily by BMI or BMI z-score) and habitual PA (Jimenez-Pavon et al., 2010). Similarly, the Canadian Health Measures Survey (CHMS) has found higher numbers of daily pedometer steps in healthy weight boys compared to obese boys (12,584 vs. 10,256, respectively, $p<0.05$). However, it was not the case in girls (11,159 vs. 10,224, respectively, no significant difference) (Colley et al., 2011). The National Health and Nutrition Examination Survey (NHANES) in the USA found that healthy weight children aged 6-11 years registered significantly greater accelerometer counts compared to obese children, although the difference was not significant for 12-15 year-olds (Belcher et al., 2010). Additionally, the data showed that obese children spent more time in sedentary activities and less time in MVPA (Belcher et al., 2010). Pedometer step counts constitute 66% of the daily behaviour domain score, while self-reported MVPA and sedentary behaviour collectively constitute 34% of the daily behaviour score (Longmuir et al., 2015b).

The finding that motivation and confidence scores were similar between the two groups runs counter to research which has shown lower levels of PA self-efficacy in children who are obese, as well as greater perceptions of barriers to PA (De Bourdeaudhuij et al., 2005; Deforche et al., 2006; Trost et al., 2001). Differences are likely due to the fact that these studies did not use the CSAPPA, or Garcia et al.'s (1995) ratio of perceived benefits and barriers of PA, which were used in the CAPL (67% and 22% of the motivation and confidence domain score, respectively). They also did not ask the children to rate their skills or activity levels compared to their peers (11% of the domain score) (Longmuir et al., 2015b).

As mentioned in Part 1, there was little evidence to suggest that healthy weight children would perform better in the knowledge and understanding domain than overweight/obese children. Given that this domain tests participants on topics that are part of the school curriculum, it is not surprising that the two groups performed similarly, given that all of the participants were from Southeastern Ontario, and are likely exposed to the same curriculum.

The most important outcomes from this study are the correlations between physical literacy domains, and the comparison of these correlations between the healthy weight children and those who were overweight/obese. The results for the domains of physical competence, daily behaviour, and motivation and confidence demonstrate that these domains correlate with one another at a low-to-moderate level, and that this does not differ between the two groups of interest.

The correlations identified between physical competence and daily behaviour are in line with the non-CAPL literature, in which primarily low levels of correlation have been found between habitual PA and cardiorespiratory fitness, motor skills, and muscular fitness (Dencker & Andersen, 2011; Holfelder & Schott, 2014; Morrow & Freedson, 1994). The association between PA and cardiorespiratory fitness was 0.10-0.45 in one review, and estimated at 0.17 on average in another (Dencker & Andersen, 2011; Morrow & Freedson, 1994). Literature suggests that this relationship should hold after controlling for body mass (Dencker & Andersen, 2011). Similarly, the association between PA and fundamental movement skills was 0.10-0.33 among studies with similar movement assessments and age groups as the CAPL in the review by Holfelder & Schott (2014), and one study cited in this review suggests that BMI should not influence this relationship (Hume et al., 2008). With respect to the relationship between PA and muscular fitness, some studies have not found that a significant association exists (Blaes et al., 2011). However, among studies that have found significant associations between PA and muscular fitness, the correlation coefficients were low ($r = 0.07 – 0.29$), similar to the results of the current study (Hands et al., 2009; Katzmarzyk et al., 1998; Martínez-Gomez et al., 2011; Sallis et al., 1991).

When looking at studies that have used the CAPL protocol, the results of this study still concur with the literature with respect to the relationship between physical competence and daily behaviour. As mentioned in Part 1, Larouche et al. (2014) found that daily step counts were significantly associated with hand grip strength (r = 0.12), plank time (r = 0.16), and CAMSA time (r = -0.27) and score (r = 0.20) within the context of the CAPL.

The relationships between physical competence and motivation and confidence were the strongest identified in this study. Although there appears to be few studies examining this type of relationship, those that exist have used similar measures to the CAPL, and have found similar results as the current study (Boyer et al., 2013a; Wrotniak et al., 2006). For instance, the CSAPPA (which makes up 66% of the motivation and confidence domain) has been found to correlate moderately with motor skill ability in 8-10 year-olds (Wrotniak et al., 2006). The CSAPPA was also recently found to correlate positively with aerobic fitness (r = 0.40), plank time (r = 0.23), and CAMSA (r = 0.31), which collectively make up 63% of the physical competence domain score (Boyer et al., 2013a; Longmuir et al., 2015b).

With respect to the association between daily behaviour and motivation and confidence, De Bourdeaudhuij et al. (2005) found that associations ranged from 0.20-0.41 between PA and elements of motivation and confidence such as self-efficacy, perceived barriers and benefits, and general attitude towards PA in both healthy weight children and those with overweight/obesity. Conversely to the current study, they found that one of these associations, specifically that between self-efficacy and PA, was higher in healthy weight children compared to overweight/obese children (r = 0.39 vs. r = 0.26, respectively) (De Bourdeaudhuij et al., 2005). However, it is important to note that they did not use the Fisher's r-to-z or any other statistical test to determine if this was a true difference between groups (De Bourdeaudhuij et al., 2005).

No other studies were identified that compared these associations between healthy weight children and those with overweight/obese. However, in the review by Bauman et al. (2012), several elements related to motivation and confidence were found to be correlates or determinants of PA behaviour. Specifically, perceived competence was a correlate in 2/6 studies, self-efficacy was a correlate or determinant in 5/7 studies, and perceived barriers to PA were inversely correlated with PA in 2/6 studies (Bauman et al., 2012). Also, as mentioned in Part 1, the ratio of perceived barriers and benefits to PA used in the CAPL has been previously shown to correlate with exercise behaviour, and the CSAPPA was found to correlate ($r = 0.45$) with self-reported PA in children (Garcia et al., 1995; Hay, 1992).

The only difference found between healthy weight children and those with overweight/obesity with respect to the associations examined in the current study was that the knowledge and understanding domain did not correlate significantly with any other domain in healthy weight children. Conversely, knowledge and understanding was significantly correlated with physical competence in children with overweight/obesity. A lack of significant association between knowledge and understanding and daily behaviour is not necessarily surprising given that it has been suggested that knowledge alone is not sufficient to drive active behaviour (Morrow et al., 2004). It is unclear from the literature whether one would expect higher levels of knowledge to be associated with greater motivation for active living, although the results of the current study do not support this. Given that associations between domains were assessed in isolation from one another in this study, it could be postulated that knowledge may be playing a mediating role between other domains. In our sub-analyses, correlation coefficients were recalculated without controlling for knowledge scores where applicable, and there was little to no change in the results (Tables 9 and 10), suggesting this may not be the case. However, a more thorough meditation analysis may still be a promising idea for future research. Also of note is the fact that participants in general showed high levels of knowledge. If children with lower levels of knowledge were to show greater variability in other domain scores, it could be possible that more significant associations with the knowledge domain could emerge in this group. This could be the focus of future sub-analyses.

Similarly to the relationship between knowledge and PA, one would not necessarily expect that knowledge alone would be associated with higher levels of fitness and motor skills. However, as mentioned above, this was the case for participants who were overweight/obese (but not those who were healthy weight) in this study. It is unclear why significant associations emerged in this group only, and the finding deserves further investigation. A potential explanation could be that overweight/obese children with higher levels of physical competence may also tend to have higher levels of knowledge due to a common source (e.g., greater levels of participation in physical education). This, however, raises the question as to why a similar trend was not observed in healthy weight children.

The results of the current study help point to several areas for future research. First, as the CAPL protocols are being carried out on children across Canada, the analyses from this study should be carried out using national data when they become available. Comparisons between provinces, and at the national level would help provide further support to the architecture of the CAPL (i.e., show that domains are not measuring the same constructs with a national sample that is more representative of Canadian children). Differences between provinces could also provide some interesting direction for future research to examine, for example, why domains might associate with one another differently in varied populations. Second, longitudinal studies using the CAPL are needed in order to confirm how baseline domain scores predict future changes in other domains. For instance, are children who are more motivated and confident at age 8 more likely to see improvements in physical competence, daily PA behaviour, or overall physical literacy by age 12 than their less motivated and confident counterparts? Can interventions aimed at increasing overall physical literacy be tailored towards one domain in cases of limited resources? The low level of correlations seen among domains in the current study suggests that this is not a good strategy; however, a longitudinal design would help confirm this. Beyond confirming the results of the current cross-sectional study, there are a number of other questions that could be answered using the CAPL in a longitudinal design. For example, what are the predictors of future changes in physical literacy? Such a study would build upon the results of Lizotte et al. (2016). Also, the CAPL could be used to assess any number of interventions as to their effect on physical literacy (e.g., sports programs, summer camps, medical interventions, etc.). It will be important to maintain the current cohort of CAPL participants over time in order to facilitate such studies.

As the CAPL becomes used more widely, it will be important to expand the protocol to a wider age range, to allow for long-term follow up. Currently, some of the assessments, such as the CAMSA, and knowledge and understanding questionnaire would likely show ceiling effects in older children. It will therefore be important to assess how the protocols can be adapted for adolescents, young adults, or even adults. This is an important future step, as the concept of physical literacy continues to become the gold standard outcome of physical education and physical development in general (Roetert & MacDonald, 2015).

One of the benefits of the CAPL is that it allows for a standardized, evidence-based assessment of physical literacy. In that vein, future work needs to be aimed at continuing to promote the widespread use of the CAPL and to refine the tool if needed. Currently, other tools exist for the measurement of physical literacy, although they are not supported by research or by experts like the CAPL (Francis et al., 2015; Longmuir et al., 2015b). One such assessment is the Physical Literacy Assessment for Youth (PLAY) tools. These tools assess similar constructs as the CAPL (e.g., motor skills, motivation, etc.) but are based on the subjective rating of the assessor (e.g., a coach can rate the child's motivation to participate from 'poor' to 'excellent' based on their observations) (Canadian Sport for Life, 2013a; Canadian Sport for Life, 2013b). Evidently such a subjective assessment is not as robust as the CAPL, and the results of studies using these tools would be difficult to compare with results of studies using the CAPL. Thus, the use of a single robust tool across various studies examining physical literacy should be promoted. Another recent study attempted to evaluate the influence of 6 weeks of active video games on physical literacy in 6-12 year old children. This study, instead of using an all-encompassing battery of tests such as the CAPL, used a number of different protocols to assess various elements of physical literacy (George et al., 2016). Their study, however, only examined PA, fitness, motor skills, and knowledge and understanding, missing the important domain of motivation and confidence (they based their assessments on a previous conception of the concept of physical literacy) (George et al., 2016; Lloyd et al., 2010). Again, the use of a standardized, agreed upon, and robust battery of tests for assessing physical literacy helps prevent issues such as not including known important physical literacy domains, or having results from multiple studies that are not easily compared.

As discussed earlier, a major strength of our study is the integrity of the CAPL protocol. Extensive input from many experts in the field was sought in its design, and accordingly, objective measures are weighted more heavily. Also, all of the protocols have been assessed for validity and reliability aside from the knowledge and understanding questionnaire (which was designed based on established curricula), and feasibility of the overall assessment battery has been established (Boyer et al., 2013b; Francis et al., 2015; Longmuir et al., 2015a; Longmuir et al., 2015b). Another strength of the current study is that it includes a relatively large sample size for a study using direct measurements of physical literacy domains. Also, in the statistical analysis, several elements known to influence CAPL domain scores were controlled for, such as age and sex (Longmuir et al., 2015b). Similarly, other domain scores were controlled for in the analysis (i.e., the association between two domains was in isolation from the other domains). Our sub-analyses showed that not controlling for the influence of other domains would have inflated the correlation coefficients (Tables 7 and 8).

A limitation of the current study includes the fact that it is cross-sectional in nature, which limits the interpretation of the results. Also, as the participants were not randomly chosen (i.e., the sample consists of a convenience sample of children who agreed to participate), the sample may not be representative of the Canadian population; for instance, the proportion of overweight/obese participants was higher than what has been reported for North American adolescents (Ng et al., 2014). Also, there exists the possibility that physically literate children were more likely to participate than less physically literate children (i.e., selection bias). However, the results show that on average, participants' physical literacy scores were interpreted as 'progressing', which is 'similar to [the] typical performance of same-age peers' (Healthy Active Living and Obesity Research Group, 2013). Also, previous studies have found that the large majority of children approached to participate in the CAPL tend to do so (Longmuir et al., 2015b). There are also limitations associated with the use of pedometers to measure daily PA. For instance, they do not provide an indication of activity intensity, or information on water-based or non-ambulatory activity. To complement the pedometer data, participants are also asked to self-report on their MVPA, which could of course be subject to recall or social desirability biases. This self-reported measure is weighted less heavily in the scoring protocol accordingly (based on expert feedback obtained during the Delphi review process) (Francis et al., 2015). Although several important factors were controlled for in our analyses, there are some factors that we were unable to take into account. For instance, the CAPL protocol does not include a measure of developmental stage, which could influence the results. This effect is likely limited, however, due to the fact that all participants were 12 years or younger. Also, a measure of socioeconomic status was not available for participants. However, a recent analysis using a shared dataset (ISCOLE-CAPL) found that measures such as household income and parental education level were not significant correlates of overall physical literacy or CAPL domains in a multivariate model (Lizotte et al., 2016). As a number of the assessments within the physical competence domain (e.g., PACER, CAMSA) are done in groups, there is the possibility that performance could be influenced by social dynamics (Tomkinson et al., 2003). Future research could involve testing a small group of children in a group setting and alone to determine whether this effect exists, although testing each child individually was not possible logistically for the current study. Similarly, the fact that the assessments were not performed in a specific order could potentially influence scores, for instance, if the child performed worse than their peers on the CAMSA, and then subsequently reported their confidence as lower than they would have had they outperformed their peers. One hopes that the constructs of motivation and confidence are stable enough that one performance would not influence the participant's overall conception of PA ability or motivation, but it is impossible to rule out at this point. Another future study could modulate having participants perform the questionnaires before and after the physical competence assessments, each during different visits, to look for potential differences –

differences in scores might suggest that the CAPL should always be performed in the same order. Finally, the Fishers r-to-z transformation used to compare correlation coefficients across groups is a relatively low power test, and thus there is the possibility of type II error (Kenny, 1987). However, the significant correlations were very similar in strength between groups, with the major difference being the lack of statistically significant correlation between physical competence and knowledge and understanding in healthy weight participants.

Overall, although overweight/obese children performed more poorly in the CAPL in this study, the similar associations among domains in children of differing weight category suggest that interventions aimed at improving physical literacy may not need to be tailored based on weight, although longitudinal studies should be used to confirm this. The results also suggest that physical literacy interventions should target multiple domains of physical literacy – unfortunately there does not appear, for example, that there is one domain that could be targeted to improve scores in multiple other domains (providing ‘more bang for the buck’). Also, the fact that the majority of the associations were of low strength helps lend support to the psychometric architecture of the CAPL. Overly strong correlations might suggest that domains are duplicating one another, and that the battery of tests should be revised or shortened. Our results suggest that this is not the case. Beyond the realm of physical literacy, this study helps add to the body of literature looking at the associations between PA and fitness, and their potential correlates, few of which include comparisons by weight status (De Bourdeaudhuij et al., 2005; Dencker & Andersen, 2011; Holfelder & Schott, 2014; Morrow et al., 2004).

**PART 4**

**References**

Active Healthy Kids Canada. (2014). *Is Canada in the running? The 2014 active healthy kids Canada report card on PA for children and youth.* Toronto, ON.

American Diabetes Association. (2000). Type 2 diabetes in children and adolescents. *Diabetes Care,* 23(3), 381-389.

Barfield, J. P., Rowe, D. A., Michael, T. J. (2004). Interinstrument consistency of the Yamax Digi-walker pedometer in elementary school-aged children. *Measurement in Physical Education and Exercise Science,* 8(2), 109-116.

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R., Martin, B., Lancet PA Series Working Group. (2012). Correlates of PA: Why are some people physically active and others not? *Lancet*, 380(9838), 258-271.

Belcher, B. R., Berrigan, D., Dodd, K. W., Emken, B. A., Chou, C. P., Spuijt-Metz, D. (2010). Physical activity in US youth: Impact of race/ethnicity, age, gender, & weight status. *Medicine and Science in Sports and Exercise*, 42(12), 2211-2221.

Bell, L., Hung, J., Knuiman, M., Divitini, M., Beilby, J., Hunter, M., Mollison, L., Thompson, P., McQuillan, B., Davis, E. (2013). Body mass index and waist circumference: Relationship to cardiometabolic risk factors in children - Busselton health study 2005-2007. *Journal of Paediatrics and Child Health,* 49(11), 955-962.

Berrington de Gonzalez, A., Hartge, P., Cerhan, J.R., Flint, A.J., Hannan, L., MacInnis, R.J., Moore, S.C., Tobias, G.S., Anton-Culver, H., Freeman, L.B., Beeson, W.L., Clipp, S.L., English, D.R., Folsom, A.R., Freedman, D.M., Giles, G., Hakansson, N., Henderson, K.D., Hoffman-Bolton, J., Hoppin, J.A., Koenig, K.L., Lee, I., Linet, M.S., Park, Y., Pocobelli, G., Schatzkin, A., Sesso, H.D., Weiderpass, E., Willcox, B.J., Wolk, A., Zeleniuch-Jacquotte, A., Willett, W.C., Thun, M.J. (2010). Body-mass index and mortality among 1.46 million white adults. *New England Journal of Medicine*, 363, 2211-2219.

Blaes, A., Baquet, G., Van Praagh, E., Berthoin, S. (2011). Is there any relationship between PA level and patterns, and physical performance in children? *International Journal of Behavioral Nutrition and Physical Activity*, 4(8), 122.

Bohannon, R. W. (2008). Is it legitimate to characterize muscle strength using a limited number of measures? *The Journal of Strength & Conditioning Research,* 22(1), 166-173.

Bounajm, F., Dihn, T., Theriault, L. (2014). *Moving ahead: The economic impact of reducing physical inactivity and sedentary behaviour*. Ottawa: The Conference Board of Canada.

Boyer, C., McFarlane, A., McClelland, K., Barnes, J., Borghese, M., Larouche, R., Saunders, T., LeBlanc, A., Hospod, A., Tremblay, M., Longmuir, P. (2013a). Children's physical activity self-efficacy is related to physical fitness, motor skill and perceived social support. *Pediatric Exercise Science,* 25(Supp.), S3.

Boyer, C., Tremblay, M., Saunders, T. J., McFarlane, A., Borghese, M., Lloyd, M., Longmuir, P. (2013b). Feasibility, validity and reliability of the plank isometric hold as a field-based assessment of torso muscular endurance for children 8-12 years of age. *Pediatric Exercise Science,* 25, 407-422.

Brunet, M., Chaput, J. P., Tremblay, A. (2007). The association between low physical fitness and high body mass index or waist circumference is increasing with age in children: The 'Quebec en Forme' project. *International Journal of Obesity,* 31, 637-643.

Canadian Society for Exercise Physiology. (2013). *Canadian Society for Exercise Physiology-Physical Activity Training for Health (CSEP-PATH)*. Ottawa, Ontario: Canadian Society for Exercise Physiology.

Canadian Sport for Life. (2013a). *Physical literacy assessment for youth: Basic.* Victoria, BC: Canadian Sport Institutes.

Canadian Sport for Life. (2013b). *Physical literacy assessment for youth: Coach.* Victoria, BC: Canadian Sport Institutes.

Carson, V., Rinaldi, R., Torrance, B., Maximova, K., Ball, G., Majumdar, S., Plotnikoff, R.C., Veugelers, P., Boule, N.G., Wozny, P., McCargar, L., Downs, S., Daymont, C., Lewanczuk, R., McGavock, J. (2014a). Vigorous PA and longitudinal associations with cardiometabolic risk factors in youth. *International Journal of Obesity*, 38(1), 16-21.

Carson, V., Rodgers, N., Howard, B., Winkler, E., Healy, G., Owen, N., Dunstan, D.W., Salmon, J. (2013). Light-intensity physical activity and cardiometabolic biomarkers in US adolescents. *PLoS One*, 8(8), e71417.

Carson, V., Stone, M., & Faulkner, G. (2014b). Patterns of sedentary behavior and weight status among children. *Pediatric Exercise Science*, 26(1), 95-102.

Chaput, J., Klingenberg, L., Astrup, A., Sjodin, A. M. (2011). Modern sedentary activities promote overconsumption of food in our current obesogenic environment. *Obesity Reviews*, 12, e12-e20.

Chaput, J., Lambert, M., Mathieu M., Tremblay, M., O'Loughlin, J., Tremblay, A. (2012). PA vs. sedentary time: Independent associations with adiposity in children. *Pediatric Obesity*, 7(3), 251-258.

Chaput, J. P., Ferraro, Z. M., Prud'homme, D., Sharma, A. M. (2014a). Widespread misconceptions about obesity. *Canadian Family Physician*, 60(11), 973-975.

Chaput, J. P., Leduc, G., Boyer, C., Belanger, P., LeBlanc, A. G., Borghese, M. M., Tremblay, M.S. (2014b). Objectively measured physical activity, sedentary time and sleep duration: Independent and combined associations with adiposity in Canadian children. *Nutrition & Diabetes*, 4, e117.

Chatrath, R., Shenoy, R., Serratto, M., Thoele, D. G. (2002). Physical fitness of urban American children. *Pediatric Cardiology,* 23(6), 608-612.

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., Tremblay, M. S. (2011). Physical activity of Canadian children and youth: Accelerometer results from the 2007 to 2009 Canadian health measures survey. *Health Reports,* 22(1), 15-23.

Committee on Fitness Measures and Health Outcomes in Youth, Food and Nutrition Board, & Institute of Medicine. (2012). *Fitness measures and health outcomes in youth.* Washington, DC: National Academies Press.

De Bourdeaudhuij, I., Lefevre, J., Deforche, B., Wijndaele, K., Matton, L., Philippaerts, R. (2005). Physical activity and psychosocial correlates in healthy weight and overweight 11 to 19 year olds. *Obesity Research,* 13(6), 1097-1105.

Deforche, B. I., De Bourdeaudhuij, I. M., Tanghe, A. P. (2006) Attitude toward physical activity in normal-weight, overweight and obese adolescents. *Journal of Adolescent Health,* 38(5), 560-568.

Deforche, B., Lefevre, J., De Bourdeaudhuij, I., Hills, A. P., Duquet, W., Bouckaert, J. (2003). Physical fitness and physical activity in obese and nonobese Flemish youth. *Obesity Research,* 11(3), 434-441.

Dencker, M., Andersen, L. (2011). Accelerometer-measured daily PA related to aerobic fitness in children and adolescents. *Journal of Sports Sciences*, 29(9), 887-895.

De Onis M, Lobstein T. (2010) Defining obesity risk status in the general childhood population: Which cut-offs should we use? *International Journal of Pediatric Obesity,* 5, 458-460.

De Onis M, Onyango A, Borghi E, Siyam A, Nishida C, Siekmann J. (2007) Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization,* 85,660-667.

Dobbins, M., Husson, H., DeCorby, K., LaRocca, R. (2013). School-based PA programs for promoting PA and fitness in children and adolescents aged 6 to 18. *Cochrane Database of Systematic Reviews*, 2, CD007651.

Esteban-Cornejo, I., Tejero-Gonzalez, C. M., Martinez-Gomez, D., del-Campo, J., Gonzalez-Galo, A., Padilla-Moledo, C., Sallis, J., Veiga, O. (2014). Independent and combined influence of the components of physical fitness on academic performance in youth. *The Journal of Pediatrics,* 165(2), 306-312.

Fisher, R. (1921). On the probable error of a coefficient of correlation deduced from a small sample. *Metron,* 1, 3-32.

Francis, C. E., Longmuir, P. E., Boyer, C., Andersen, L. B., Barnes, J. D., Boiarskaia, E., Cairney, J., Faigenbaum, A.D., Faulkner, G., Hands, B.P., Hay, J.A., Janssen, I., Katzmarzyk, P.T., Kemper, H.C., Knudson, D., Lloyd, M., McKenzie, T.L., Olds, T.S., Sacheck, J.M., Shephard, R.J., Zhu, W., Tremblay, M. S. (2015). The Canadian Assessment of Physical Literacy: Development of a model of children's capacity for a healthy, active lifestyle through a Delphi process. *Journal of Physical Activity & Health,* 13(2), 214-22.

Garcia, A. W., Broda, M. A. N., Frenn, M., Coviak, C., Pender, N. J., Ronis, D. L. (1995). Gender and developmental differences in exercise beliefs among youth and prediction of their exercise behavior. *Journal of School Health*, 65(6), 213-219.

George, A., Rohr, L., Byrne, J. (2016). Impact of Nintendo Wii games on physical literacy in children: Motor skills, physical fitness, activity behaviors, and knowledge. *Sports,* 4(1), 3.

Graf, C., Koch, B., Kretschmann-Kandel, E., Falkowski, G., Christ, H., Coburger, S., Lehmacher, W., Bjarnason-Wehrens, B., Platen, P., Tokarski, W., Predel, H.G., Dordel, S. (2003). Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-project). *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity,* 28(1), 22-26.

Haapala, E. A. (2013). Cardiorespiratory fitness and motor skills in relation to cognition and academic performance in children: A review. *Journal of Human Kinetics,* 36, 55-68.

Hamilton, A., Balnave, R., Adams, R. (1994). Grip strength testing reliability. *Journal of Hand Therapy: Official Journal of the American Society of Hand Therapists,* 7(3), 163-170.

Hands, B., Larkin, D., Parker, H., Straker, L., Perry, M. (2009). The relationship among PA, motor competence and health-related fitness in 14-year-old adolescents. *Scandinavian Journal of Medicine & Science in Sports*, 19(5), 655-663.

Hay, J. A. (1992). Adequacy in and prediliction for physical activity in children. *Clinical Journal of Sport Medicine,* 2(3), 192-201.

Healthy Active Living and Obesity Research Group. (2013). *Canadian Assessment of Physical Literacy - Manual for test administration*. Ottawa, ON: Healthy Active Living and Obesity Research Group (HALO).

Herman, K., Craig, C., Gauvin, L., Katzmarzyk, P. (2009). Tracking of obesity and PA from childhood to adulthood: The PA longitudinal study. *International Journal of Pediatric Obesity*, 4(4), 281-288.

Hill, J. O., Wyatt, H. R., Reed, G. W., Peters, J. C. (2003). Obesity and the environment: Where do we go from here? *Science (New York, N.Y.),* 299(5608), 853-855.

Hjorth, M. F., Chaput, J. P., Ritz, C., Dalskov, S. M., Andersen, R., Astrup, A., Tetens, I., Michaelsen, K.F., Sjodin, A. (2014). Fatness predicts decreased physical activity and increased sedentary time, but not vice versa: Support from a longitudinal study in 8- to 11-year-old children. *International Journal of Obesity,* 38(7), 959-965.

Holfelder, B., Schott, N. (2014). Relationship of fundamental movement skills and physical activity in children and adolescents: A systematic review. *Psychology of Sport and Exercise,* 15, 382-391.

Hume, C., Okely, A., Bagley, S., Telford, A., Booth, M., Crawford, D., Salmon, J. (2008). Does weight status influence associations between children's fundamental movement skills and physical activity*? Research Quarterly for Exercise and Sport,* 79, 158-165.

Janssen, I., Leblanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity,* 7, 40.

Jimenez-Pavon, D., Kelly, J., Reilly, J. J. (2010). Associations between objectively measured habitual physical activity and adiposity in children and adolescents: Systematic review. *International Journal of Pediatric Obesity,* 5(1), 3-18.

Katzmarzyk, P., Malina, R., Song, T., Bouchard, C. (1998). PA and health-related fitness in youth: A multivariate analysis. *Medicine and Science in Sports and Exercise*, 30(5), 709-714.

Kenny, D. A. (1987). *Statistics for the social and behavioral science*s. Canada: Little, Brown and Company.

Kroeze, W., Werkman, A., Brug, J. (2006). A systematic review of randomized trials on the effectiveness of computer-tailored education on PA and dietary behaviors. *Annals of Behavioral Medicine*, 31(3), 205-223.

Larouche, R., Boyer, C., Tremblay, M., Longmuir, P. (2014). Physical fitness, motor skill, and PA relationships in grade 4 to 6 children. *Applied Physiology, Nutrition, and Metabolism*, 39, 553-559.

Lizotte, C., Larouche, R., LeBlanc, A. G., Longmuir, P. E., Tremblay, M. S., Chaput, J. (2016). Investigation of new correlates of physical literacy in children. *Health Behavior and Policy Review, 3*(2), 110-122.

Lloyd, M., Colley, R. C., Tremblay, M. S. (2010). Advancing the debate on 'fitness testing' for children: Perhaps we're riding the wrong animal. *Pediatric Exercise Science*, 22, 176-182.

Longmuir, P. (2013). Understanding the physical literacy journey of children: The Canadian Assessment of Physical Literacy. *Bulletin of the International Council of Sport Science and Physical Education ICSSPE*, 65, 1-6.

Longmuir, P., Boyer, C., Barnes, J., LeBlanc, A.G., Borghese, M., Larouche, R. (2013). Canadian Assessment of Physical Literacy reliability and validity: Plank torso strength and motor skill obstacle course protocols. *Pediatric Exercise Science*, 25(Supp.), S11-S12.

Longmuir, P.E., Boyer, C., Lloyd, M., Borghese, M.M., Knight, E., Saunders, T.J., Tremblay, M.S. (2015a). Canadian Agility and Movement Skill Assessment of motor skill: Validity, objectivity and reliability evidence for children 8 to 12 years of age. *Journal of Sport and Health Science,* (in press).

Longmuir P.E., Boyer, C., Lloyd, M., Yang, Y., Boiarskaia E., Zhu W., Tremblay M.S. (2015b). The Canadian Assessment of Physical Literacy: methods for children in grades 4 to 6 (8 to 12 years). *BMC Public Health,* 15(1), 767.

Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., Okely, A. D. (2010). Fundamental movement skills in children and adolescents: Review of associated health benefits. *Sports Medicine*, 40(12), 1019-1035.

Malina, R. M., Beunen, G. P., Claessens, A. L., Lefevre, J., Eynde, B. V., Renson, R., Vanreusel, B., Simons, J. (1995). Fatness and physical fitness of girls 7 to 17 years. *Obesity Research,* 3(3), 221-231.

Mandigo, J., Francis, N., Lodeqyk, K., Lopez, R. (2009). *Position paper: Physical literacy for educators*. Brock University: Physical & Health Education Canada.

Matrínez-Gómez, D., Welk, G., Puertollano, M., Del-Campo, J., Moya, J., Marcos, A., Veiga, O.L., AFINOS Study Group. (2011). Associations of PA with muscular fitness in adolescents. *Scandinavian Journal of Medicine & Science in Sports*, 21(2), 310-307.

McNamara, E., Hudson, Z., Taylor, S. J. C. (2010). Measuring activity levels of young people: The validity of pedometers. *British Medical Bulletin*, 95(1), 121-137.

Mehdad, S., Hamrani, A., El Kari, K., El Hamdouchi, A., Barakat, A., El Mzibri, M., Mokhtar, N., Aguenaou, H. (2012). Body mass index, waist circumference, body fat, fasting blood glucose in a sample of Moroccan adolescents aged 11–17 years. *Journal of Nutrition and Metabolism,* 2012, 510458.

Milliken, L. A., Faigenbaum, A. D., Loud, R. L., & Westcott, W. L. (2008). Correlates of upper and lower body muscular strength in children. *The Journal of Strength & Conditioning Research,* 22(4), 1339-1346

Minck, M. R., Ruiter, L. M., Van Mechelen, W., Kemper, H. C. G., Twisk, J. W. R. (2000). Physical fitness, body fatness, and physical activity: The Amsterdam growth and health study. *American Journal of Human Biology,* 12(5), 593-599.

Molenaar, H. M., Zuidam, J. M., Selles, R. W., Stam, H. J., Hovius, S. E. (2008). Age-specific reliability of two grip-strength dynamometers when used by children. *The Journal of Bone and Joint Surgery. American Volume*, 90(5), 1053-1059.

Morano, M., Colella, D., Robazza, C., Bortoli, L., Capranica, L. (2011). Physical self-perception and motor performance in normal-weight, overweight and obese children. *Scandinavian Journal of Medicine & Science in Sports,* 21(3), 465-473.

Morrow, J., Freedson, P. S. (1994). Relationship between-habitual physical activity and aerobic fitness in adolescents*. Pediatric Exercise Science,* 6, 315-315.

Morrow, J., Krzeqinski-Malone, J., Jackson, A., Bungum, T., FitzGerald, S. (2004). American adults' knowledge of exercise recommendations. *Research Quarterly for Exercise and Sport*, 75(3), 231-237.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E.C., Biryukov, S., Abbafati, C., et al. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the global burden of disease study 2013. *Lancet*, 384(9945), 766-781.

ParticipACTION. (2015). *The biggest risk is keeping kids indoors. The 2015 ParticipACTION report card on physical activity for children and youth*. Toronto, Canada: ParticipACTION.

ParticipACTION, Sport for Life Society, Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute, Physical and Health Education Canada, Canadian Parks and Recreation Association, Ontario Society of Physical Activity Promoters in Public Health. (2015). *Canada's physical literacy consensus statement*. Canada.

Pate, R. R., Slentz, C. A., Katz, D. P. (1989). Relationships between skinfold thickness and performance of health related fitness test items. *Research Quarterly for Exercise and Sport,* 60(2), 183-189.

Penney, D., Chandler, T. (2000). Physical education: What future? *Sport, Education and Society*, 5(1), 71-87.

Plowman, S. A., Sterling, C. L., Corbin, C. B., Meredith, M. D., Welk, G. J., Morrow, J. R. J. (2006). The history of FITNESSGRAM. *Journal of Physical Activity & Health,* 3(Suppl. 2), S5-S20.

Public Health Agency of Canada. (2011). *Obesity in Canada: A joint report from the Public Health Agency of Canada and the Canadian Institute for Health Information*. Canada: Public Health Agency of Canada.

Roberts, K., Shields, M., de Groh, M., Aziz, A., Gilbert, J. (2012). Overweight and obesity in children and adolescents: Results from the 2009-2011 Canadian health measures survey. *Health Reports*, 23(3), 37-41.

Roetert EP, MacDonald LC. (2015) Unpacking the physical literacy concept for K-12 physical education: What should we expect the learner to master? *Journal of Sport and Health Science*, 4(2), 108-112.

Sallis, J., McKenzie, T., Alcaraz, J. (1993). Habitual PA and health-related physical fitness in fourth-grade children. *American Journal of Diseases of Children*, 147(8), 890-896.

Saunders, T., Tremblay, M., Mathieu, M., Henderson, M., O'Loughlin, J., Tremblay, A., Chaput, J. (2013). Associations of sedentary behavior, sedentary bouts and breaks in sedentary time with cardiometabolic risk in children with a family history of obesity. *PLoS One*, 8(11), e79143.

Savva, S. C., Tornaritis, M., Savva, M. E., Kourides, Y., Panagi, A., Silikiotou, N., Kafatos, A. (2000). Waist circumference and waist-to-height ratio are better predictors of cardiovascular disease risk factors in children than body mass index. *International Journal of Obesity,* 24(11), 1453-1458.

Scott, S. N., Thompson, D. L., Coe, D. P. (2013). The ability of the PACER to elicit peak exercise response in youth. *Medicine and Science in Sports and Exercise*, 45(6), 1139-1143.

Sorof, J., Lai, D., Turner, J., Poffenbarger, T., Portman, R. (2004). Overweight, ethnicity and the prevalence of hypertension in school-aged children. *Pediatrics*, 113(3), 475-482.

Taylor, R. W., Jones, I. E., Williams, S. M., Goulding, A. (2000). Evaluation of waist circumference, waist-to-hip ratio, and the conicity index as screening tools for high trunk fat mass, as measured by dual-energy X-ray absorptiometry, in children aged 3-19 y. *American Journal of Clinical Nutrition,* 72(2), 490-495.

Telama, R. (2009). Tracking of physical activity from childhood to adulthood: A review. *Obesity Facts,* 2(3), 187-195.

Tomkinson, G. R., Leger, L. A., Olds, T. S., Cazorla, G. (2003). Secular trends in the performance of children and adolescents (1980-2000): An analysis of 55 studies of the 20m shuttle run test in 11 countries. *Sports Medicine,* 33, 285-300.

Tremblay, M. S., LeBlanc, A. G., Janssen, I., Kho, M. E., Hicks, A., Murumets, K., Colley, R.C., Duggan, M. (2011a). Canadian sedentary behaviour guidelines for children and youth. *Applied Physiology, Nutrition, and Metabolism,* 36(1), 59-64.

Tremblay, M. S., LeBlanc, A. G., Kho, M. E., Saunders, T. J., Larouche, R., Colley, R. C., Goldfield, G., Connor Gorber, S. (2011b). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *The International Journal of Behavioral Nutrition and Physical Activity,* 8, 98.

Tremblay, M. S., & Lloyd, M. (2010). Physical literacy measurement - the missing piece. *Physical and Health Education*, Spring, 26-30.

Tremblay, M. S., Warburton, D. E. R., Janssen, I., Paterson, D. H., Latimer, A. E., Rhodes, R. E., Kho, M.E., Hicks, A., Leblanc, A.G., Zehr, L., Murumets, K., Duggan, M. (2011c). New Canadian physical activity guidelines. *Applied Physiology, Nutrition, and Metabolism,* 36(1), 36-46.

Trost, S. G., Kerr, L. M., Ward, D. S., Pate, R. R. (2001). Physical activity and determinants of physical activity in obese and non-obese children. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity,* 25(6), 822-829.

van Sluijs, E., McMinn, A., Griffin, S. (2007). Effectiveness of interventions to promote PA in children and adolescents: Systematic review of controlled trials. *BMJ*, 335(7622), 703.

Wang, J. J., Wang, H. J., Liu, J. S., Ma, J. (2013). The association between body mass index, waist circumference with body fat percent, and abdominal fat rate in overweight and obese pupils. *Zhonghua Yu Fang Yi Xue Za Zhi [Chinese Journal of Preventive Medicine],* 47(7), 603-607.

Weaver, B., Wuensch, K. (2013). SPSS and SAS programs for comparing pearson correlations and OLS regression coefficients. *Behavior Research Methods,* 45(3), 880-895.

Whitehead, M. (2001). The concept of physical literacy. *European Journal of Physical Education*, 6(2), 127-138.

Whitehead, M. (Ed.). (2010). *Physical literacy: Throughout the lifecourse*. New York, NY: Routeledge.

Wind, A., Takken, T., Helders, P. M., Engelbert, R. H. (2010). Is grip strength a predictor for total muscle strength in healthy children, adolescents, and young adults? *European Journal of Pediatrics,* 169(3), 281-287.

Wrotniak, B. H., Epstein, L. H., Dorn, J. M., Jones, K. E., Kondilis, V. A. (2006). The relationship between motor proficiency and physical activity in children. *Pediatrics,* 118(6), e1758-e1765.

Zabinski, M. F., Saelens, B. E., Stein, R. I., Hayden-Wade, H. A., Wilfley, D. E. (2003). Overweight children's barriers to and support for physical activity. *Obesity Research,* 11(2), 238-246.

## Appendices

Additional Tables

**Table 5**.
Partial correlations between scores in domains of physical literacy in **overweight children only**, controlling for age, sex, and other domain scores. 95% confidence intervals are indicated in parentheses for significant correlations.

| | Physical competence | Daily behaviour | Motivation and confidence | Knowledge and understanding |
|---|---|---|---|---|
| **Physical competence** | 1 | - | - | - |
| **Daily behaviour** | 0.29**<br>(0.10- 0..46) | 1 | - | - |
| **Motivation and confidence** | 0.26**<br>(0.07- 0.43) | 0.29**<br>(0.10- 0.46) | 1 | - |
| **Knowledge and understanding** | 0.20<br>(0.01- 0.38)<br>(p=0.05) | <0.01 | 0.04 | 1 |

**Significant correlation, $p<0.01$
N = 104

**Table 6**.
Partial correlations between scores in domains of physical literacy in **obese children only**, controlling for age, sex, and other domain scores. 95% confidence intervals are indicated in parentheses for significant correlations.

| | Physical competence | Daily behaviour | Motivation and confidence | Knowledge and understanding |
|---|---|---|---|---|
| **Physical competence** | 1 | - | - | - |
| **Daily behaviour** | 0.16**<br>(-0.07- 0.37) | 1 | - | - |
| **Motivation and confidence** | 0.30**<br>(0.08- 0.49) | 0.32**<br>(0.10- 0.51) | 1 | - |
| **Knowledge and understanding** | 0.25*<br>(0.03- 0.45) | 0.06 | -0.02 | 1 |

*Significant correlation, $p<0.05$
**Significant correlation, $p<0.01$
N = 77

**Table 7**.
Partial correlations between scores in domains of physical literacy in healthy weight children, controlling for age and sex (**no control for other domain scores**). 95% confidence intervals are indicated in parentheses for significant correlations.

| | **Physical competence** | **Daily behaviour** | **Motivation and confidence** | **Knowledge and understanding** |
|---|---|---|---|---|
| **Physical competence** | 1 | - | - | - |
| **Daily behaviour** | 0.24** (0.13- 0.35) | 1 | - | - |
| **Motivation and confidence** | 0.43** (0.33- 0.52) | 0.29** (0.18- 0.39) | 1 | - |
| **Knowledge and understanding** | 0.12 (p=0.05) | -0.05 | 0.07 | 1 |

**Significant correlation, p<0.01
N = 275

**Table 8**.
Partial correlations between scores in domains of physical literacy in overweight/obese children, controlling for age and sex (**no control for other domain scores**). 95% confidence intervals are indicated in parentheses for significant correlations.

| | **Physical competence** | **Daily behaviour** | **Motivation and confidence** | **Knowledge and understanding** |
|---|---|---|---|---|
| **Physical competence** | 1 | - | - | - |
| **Daily behaviour** | 0.37** (0.24- 0.49) | 1 | - | - |
| **Motivation and confidence** | 0.43** (0.30- 0.54) | 0.40** (0.27- 0.52) | 1 | - |
| **Knowledge and understanding** | 0.27** (0.13- 0.40) | 0.13 (p=0.08) | 0.14 (p=0.06) | 1 |

**Significant correlation, p<0.01
N = 181

**Table 9**.
Partial correlations between scores in domains of physical literacy in healthy weight children, controlling for age, sex and other domains, **except for knowledge/understanding where applicable**. 95% confidence intervals are indicated in parentheses for significant correlations.

| | **Physical competence** | **Daily behaviour** | **Motivation and confidence** | **Knowledge and understanding** |
|---|---|---|---|---|
| **Physical competence** | 1 | - | - | - |
| **Daily behaviour** | 0.15*<br>(0.03- 0.26) | 1 | - | - |
| **Motivation and confidence** | 0.36**<br>(0.25- 0.46) | 0.23**<br>(0.12- 0.34) | 1 | - |
| **Knowledge and understanding** | 0.09 | -0.11 | 0.09 | 1 |

*Significant correlation, $p<0.05$
**Significant correlation, $p<0.01$
N = 275

**Table 10**.
Partial correlations between scores in domains of physical literacy in overweight/obese children, controlling for age, sex and other domains**, except for knowledge/understanding where applicable**. 95% confidence intervals are indicated in parentheses for significant correlations.

| | **Physical competence** | **Daily behaviour** | **Motivation and confidence** | **Knowledge and understanding** |
|---|---|---|---|---|
| **Physical competence** | 1 | - | - | - |
| **Daily behaviour** | 0.17*<br>(0.03- 0.31) | 1 | - | - |
| **Motivation and confidence** | 0.37**<br>(0.24- 0.49) | 0.29**<br>(0.15- 0.42) | 1 | - |
| **Knowledge and understanding** | 0.22**<br>(0.08- 0.35) | 0.01 | <0.01 | 1 |

*Significant correlation, $p<0.05$
**Significant correlation, $p<0.01$
N = 181

Ethics Approval Documents

*CHEO Research Institute*

# Research Ethics Board
# 2015 Annual Renewal (Delegated)

**Principal Investigator:** Dr. Patricia Longmuir
**REB Protocol No:** 08/32E
**Romeo File No:** 10000157
**Project Title:** CHEOREB#08/32E - Canadian Assessment of Physical Literacy: Feasibility and Pilot Study
**Primary Affiliation:** HALO\HALO
**Protocol Status:** Active
**Approval Date: January 14, 2015Approval Valid Until:** January 15, 2016
**Annual Renewal Submission Deadline: December 15, 2015**

This is to notify you that the CHEO REB has granted approval to the renewal for the above named research study for a period of one year. The renewal was reviewed and approved by the Chair only. Decisions made by the Chair under delegated review are ratified by the full Board at its subsequent meeting.

In fulfilling its mandate, the CHEO REB is guided by: Tri-Council Policy Statement; ICH Good Clinical Practice Practices: Consolidated Guideline; Applicable laws and regulations of Ontario and Canada (e.g., Health Canada Division 5 of the Food and Drug Regulations & the Food and Drugs Act - Medical Devices Regulations).

Approval is granted with the understanding that the investigator agrees to comply with the following requirements:

1 The investigator must conduct the study in compliance with the protocol and any additional conditions set out by the Board.

2 The investigator must not implement any deviation from, or changes to, the protocol without the appval of the REB except where necessary to eliminate an immediate hazard to the research subject, or when the change involves only logistical or administrative aspects of the study (e.g., change of telephone number or research staff). As soon as possible, however, the implemented deviation or change, the reasons for it and, if appropriate, the proposed protocal amendment(s) should be submitted to the Board for review.

3 The investigator must, prior to use, submit to the Board changes to the study documentation, e.g., changes to the informed consent letters, recruitment materials. Should major revisions to the consent form be made, the investigator agrees to re-consent those subjects who have originally consented to the study and who wish to continue on the study.

4 For clinical drug or device trials, investigators must promptly report to the REB all adverse events that are both serious and unexpected (SAEs). For SAE reports on CHEO patients, the investigator must also comply with the hospital-wide Policy regarding, Procedures For Considering Medical Error In The Differential Diagnosis of Severe Adverse Events

(SAE) Associated with the Drugs Administered in a Clinical Trial (see http://cheonet/data/1/rec_docs/3792_Medical%20Error%20Policy%20revised%20january%2020061.doc.

5 For all other research studies, investigators must promptly report to the REB all unexpected and untoward occurrences (including the loss or theft of study data and other such privacy breaches).

6 Investigators must promptly report to the REB any new information reagarind the safety or research subject (e.g., changes to the product monograph or investigator's brochure of drug trials). Where available, any reports produced by Data Safety Monitoring Board should be submitted to the REB.

7 Investigators must notify the REB of any study closures (temporary, premature or permanent), in writing along with an explanation of the rationale for such action.

8 Investigators must submit an annual renewal report to the REB 30 days prior to the expiration date stated on the final approval letter.

9 Investigators must submit a final report at the conclusion of the study.

10 Investigators must provide the Board with French version of the consent form, unless a waiver has been granted.

If you have any questions, pertaining to this letter, please contact Natalie Anderson, Research Ethics Board office at [redacted] .

Regards,

**Dr. Carole Gentile**
**Chair, Research Ethics Board**
**Présidente, Comitéd'éthique de la recherche**
[redacted]

*Upper Canada District School Board*

**From:** Dawes, Phil [redacted]
**Sent:** Tuesday, October 08, 2013 9:50 AM
**To:** Boyer, Charles
**Cc:** Ruttan, Randy
**Subject:** RE: CHEO - Health Through Physical Literacy for Ontario Children - Research Application

Hi Charles,

On Thursday September 26th the UCDSB External Research Committee reviewed and approved the research application from Dr. Pat Longmuir entitled “Health through physical literacy for Ontario children.”

Normally, as a next step, I would email the principals of the participating schools to inform them of the research proposal and to give them advance notice that they will hearing from you or Pat.
However, with Randy’s involvement, I sense that this probably isn’t necessary.

I will try to connect with Randy to clarify next steps and whether there is anything else required from me.

Thanks.

Phil.

Phil Dawes
Planning and Research Officer
Upper Canada District School Board
[redacted]

[redacted]

*University of Ottawa*

**File Number:** H06-15-25 **Date (mm/dd/yyyy):** 07/14/2015

Université d'Ottawa University of Ottawa
Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

## Ethics Approval Notice

### Health Sciences and Science REB

**Principal Investigator / Supervisor / Co-investigator(s) / Student(s)**

| First Name | Last Name | Affiliation | Role |
|---|---|---|---|
| Jean-Philippe | Chaput | Medicine / Medicine | Supervisor |
| Gregory | Traversy | Health Sciences / Human Kinetics | Student Researcher |

**File Number:** H06-15-25

**Type of Project:** Secondary use of data

**Title:** Associations between Domains of Physical Literacy in 8-12 year-old Children, by Weight Status

| Approval Date (mm/dd/yyyy) | Expiry Date (mm/dd/yyyy) | Approval Type |
|---|---|---|
| 07/14/2015 | 07/13/2016 | Ia |

**(Ia: Approval, Ib: Approval for initial stage only)**

**Special Conditions / Comments:**
N/A



[redacted]

**File Number:** H06-15-25 **Date (mm/dd/yyyy):** 07/14/2015

Université d'Ottawa University of Ottawa
Bureau d'éthique et d'intégrité de la recherche Office of Research Ethics and Integrity

This is to confirm that the University of Ottawa Research Ethics Board identified above, which operates in accordance with the Tri-Council Policy Statement (2010) and other applicable laws and regulations in Ontario, has examined and approved the ethics application for the above named research project. Ethics approval is valid for the period indicated above and subject to the conditions listed in the section entitled "Special Conditions / Comments".

During the course of the project, the protocol may not be modified without prior written approval from the REB except when necessary to remove participants from immediate endangerment or when the modification(s) pertain to only administrative or logistical components of the project (e.g., change of telephone number). Investigators must also promptly alert the REB of any changes which increase the risk to participant(s), any changes which considerably affect the conduct of the project, all unanticipated and harmful events that occur, and new information that may negatively affect the conduct of the project and safety of the participant(s). Modifications to the project, including consent and recruitment documentation, should be submitted to the Ethics Office for approval using the "Modification to research project" form available at: http://research.uottawa.ca/ethics/submissions-and-reviews.

Please submit an annual report to the Ethics Office four weeks before the above-referenced expiry date to request a renewal of this ethics approval. To close the file, a final report must be submitted. These documents can be found at: http://research.uottawa.ca/ethics/submissions-and-reviews.

If you have any questions, please do not hesitate to contact the Ethics Office at extension 5387 or by e-mail at: ethics@uOttawa.ca.

**Signature:**

[redacted]

Catherine Paquet
Director
For Daniel Lagarec, Chair of the Health Sciences and Sciences REB

[redacted]

Permissions

Permission to reproduce Figures 1-4 and questionnaires from the *Canadian Assessment of Physical Literacy – Manual for Test Administration* (Healthy Active Living and Obesity Research Group, 2013) was obtained from Dr. Mark Tremblay, Director of the Healthy Active Living and Obesity research group on April 12, 2016 via personal communication.

Questionnaires

# **Appendix F:** CAPL Questionnaires

## Physical Activity Questionnaire
**(Canadian Assessment of Physical Literacy)**

**What school grade are you in:** (please circle one)

1 2 3 4 5 6 7 8

**Are you a:** (please circle one) boy girl

**What month is your birthday:** (please circle one)

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

**How old are you:** (please circle one)

5 6 7 8 9 10 11 12 13 14 15

**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 not 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 |
| …I didn't like to be active | 1 | 2 | 3 | 4 | 5 |

4. **Compared to other kids your age, how active are you? (circle one number)**

A lot less active — Same — A lot more active

1 2 3 4 5 6 7 8 9 10

5. **Compared to other kids your age, how good are you at sports or skills? (circle one number)**

Others are better — Same — I'm a lot better

1 2 3 4 5 6 7 8 9 10

**6. Sometimes children watch television, play video games or play on the computer or on a smart phone. What is the most time that children should look at a screen each day? Do not count the time that you have to look at a screen to do your homework.**

a) 30 minutes
b) 60 minutes or 1 hour
c) 2 hours
d) 4 hours

**7. There are many different kinds of fitness. One type is called endurance fitness or aerobic fitness or cardiorespiratory fitness. Cardiorespiratory fitness means… (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.

**8. Muscular strength or muscular endurance means… (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.**

**Being skinny**

**Looking good**

**Healthy**

**Eating well**

**Feeling good**

**Not being sick**

**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 <u>always</u> or <u>almost always</u> wear safety gear (like helmet or shin pads) when you do the activity, add a check mark inside the circle.**


**Snowmobiling**


**Swinging**


**Baseball**


**Sledding**


**Monkey Bars**


**Skipping**


**Swimming**


**Inline Skating**


**Skiing**


**Biking**


**Ice Skating**

**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 did not 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 <u>school day</u> 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 <u>school days</u>

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

**21. On a <u>weekend day</u> 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 <u>weekend day</u>

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

## Thank you for your help!

# What's Most **Like Me**

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 | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for 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 EACH PAGE!**

## What's most like me

| | | | | |
|---|---|---|---|---|
| Some kids can't wait to play active games after school | | **BUT** | Other kids would rather do something else after school | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |
| Some kids don't like playing active games | | **BUT** | Other kids really like playing active games | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |
| Some kids don't have much fun playing sports | | **BUT** | Other kids have a good time playing sports | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |
| Some kids are good at active games | | **BUT** | Other kids find active games hard to play | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |
| Some kids don't like playing sports | | **BUT** | Other kids really enjoy playing sports | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |
| Some kids always hurt themselves when they play sports | | **BUT** | Other kids never hurt themselves playing sports | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |
| Some kids like to play active games outside | | **BUT** | Other kids would rather read or play video games | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids are among the last to be chosen for active games. | | **BUT** | Other kids are usually picked to play first. | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids do well in most sports | | **BUT** | Other kids feel they aren't good at sports | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for mee | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids learn to play active games easily | | **BUT** | Other kids find it hard learning to play active games | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for mee | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids think they are the best at sports | | **BUT** | Other kids think they aren't good at sports | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids find games in physical education hard to play | | **BUT** | Other kids are good at games in physical education | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids like to watch games being played outside | | **BUT** | Other kids would rather play active games outside | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids like to take it easy during recess | | **BUT** | Other kids would rather play active games at recess | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids aren't good enough for sports teams | | **BUT** | Other kids do well on sports teams | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids like to read or play quiet games | | **BUT** | Other kids like to play active games | |
| ☐ REALLY TRUE for mee | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |

| | | | | |
|---|---|---|---|---|
| Some kids like to play active games outside on weekends | | **BUT** | Other kids like to relax and watch TV on weekends | |
| ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me | | ☐ REALLY TRUE for me | ☐ SORT OF TRUE for me |

## Thank you for your help!