10-5-2017

An Investigation of Physical Literacy and Moderate to Vigorous Physical Activity in Children Aged 8-12 Years of Age in Southwestern Ontario

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AN INVESTIGATION OF PHYSICAL LITERACY AND MODERATE TO VIGOROUS PHYSICAL ACTIVITY IN CHILDREN AGED 8-12 YEARS IN SOUTHWESTERN ONTARIO

By

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A Thesis
Submitted to the Faculty of Graduate Studies
through the Department of Kinesiology
in Partial Fulfillment of the Requirements for
the Degree of Master of Human Kinetics
at the University of Windsor

Windsor, Ontario, Canada

2017

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September 6, 2017

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ABSTRACT

Physical literacy has been described as means to achieve an active lifestyle (Physical and Health Education Canada, 2014) and as the building blocks of physical activity, including fundamental movement skills, physical fitness, motor skills, the motivation and confidence (MC), and the knowledge and understanding (KU) to be physically active (Lander et al., 2017; Tremblay & Lloyd, 2010). In Canada, the Canadian Assessment of Physical Literacy (CAPL) was developed as a means to collect and monitor physical literacy in Canadian children 8 to 12 years of age. The aim of the present study was to investigate associations between objectively measured moderate to vigorous physical activity (MVPA), overall CAPL score and the 4 domains: daily behaviour (DB), physical competence (PC), KU, and MC (objective 1). In addition, to evaluate whether objectively measured MVPA could effectively replace the current subjective measure as a means to improve the CAPL tool. The results indicated that only 26.7% of children in southwestern Ontario met the physical literacy requirements to achieve health benefits. The overall CAPL score (except 8 and 12 year old females) and the DB category score (except 12 year old females) were positively associated with MVPA for males and females in all age groups. No differences were observed between the PC and KU categories, yet for MC, positive correlations were observed in 9 year old males and 10 year old male and females. Further, the measure of MVPA was suitable to replace the subjective measure of MVPA, although only contributes 3 points to the total CAPL score. Generally, the CAPL protocol was an effective tool in establishing the relationship between MVPA and physical literacy and is recommended to replace the current subjective MVPA measurement with the objectively measured MVPA collected via the pedometers.

ACKNOWLEDGEMENTS

This thesis would not have been possible without the help of many individuals. Firstly, I would like to thank my supervisor Dr. Sarah Woodruff, for all her tremendous patience and unwaivering support throughout this project and the entirety of my degree. Your kindness and friendship knows no bounds and your leadership is awe-inspiring. You had faith in me when I could not see my own potential and you taught me to never give up and push all boundaries. Thank you for believing me.

I would like to extend many thanks to my committee members, Dr. Marcia Milne and Dr. Jamie Crawley, for your helpful advice. I would like to thank the YMCA of Western Ontario, the Windsor-Essex Catholic District School Board (WECDSB), the Conseil scolaire catholique Providence (CscProvidence), and the University of Windsor, among all other local associations that have granted access for recruitment with the CAPL study. I would also like to thank all my fellow graduate and undergraduate students who have assisted with this project, including my labmates Sara Santarossa, Tré Paton, and the numerous Outstanding Scholar students and research assistants. This research was supported by the Children's Hospital of Eastern Ontario (CHEO) Research Institute through the Royal Bank of Canada (RBC) Learn to Play project, delivered in partnership with ParticipACTION and the Public Health Agency of Canada, the Healthy Active Living and Obesity (HALO) research group and the MITACS Accelerate program. Finally, I would like to thank my family and friends for all their encouragement when I was ready to throw in the towel, your words of clarity and reassurance were very much appreciated. Without you I would have never gotten this far!

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LIST OF ABBREVIATIONS/SYMBOLS

BMI	Body Mass Index
CAMSA	Canadian Agility and Movement Skill Assessment
CAPL	Canadian Assessment of Physical Literacy
CFLRI	Canadian Fitness and Lifestyle Research Institute
CHEO	Children's Hospital of Eastern Ontario
CHMS	Canadian Health Measures Survey
CIBC	Canadian Imperial Bank of Commerce
CSAPPA	Children's Self-Perceptions of Adequacy in and Predilection for Physical Activity
CSEP	Canadian Society for Exercise Physiology
DB	Daily Behaviour
DPA	Daily Physical Activity
EQAO	Education Quality Accountability Office
HALO	Healthy Active Living and Obesity Research Group
KU	Knowledge and Understanding
MC	Motivation and Confidence
MVPA	Moderate to Vigorous Physical Activity
OPASS	Opportunities for Physical Activity at School Survey
PACER	Progressive Aerobic Cardiovascular Endurance Run
PC	Physical Competence
PHE Canada	Physical and Health Education Canada
PLAY	Physical Literacy Assessment for Youth
WC	Waist Circumference

WHO	World Health Organization

CHAPTER 1

RESEARCH ARTICLE

INTRODUCTION

Numerous health benefits are associated with physical activity (Janssen & LeBlanc, 2010) including the physical aspects relating to a decreased risk for cardiovascular and/or metabolic diseases (Hatfield & Chomitz, 2015). Psychosocial aspects are also important, such as increased happiness, increased development of social skills, reduced symptoms of depression among adolescents (Hüttenmoser, 1995; McPhie & Rawana, 2015; Richards et al., 2015) and cognitive health aspects among children (e.g., increased academic performance for memory and ability to learn; Domazet et al., 2015; Becker, McClelland, Loprinzi & Trost, 2014). However, only 14% of Canadian children 5 to 11 years of age and 9% of children 5 to 17 years of age are achieving the recommended physical activity guidelines (Statistics Canada, 2015). The current *Canadian 24-Hour Movement Guidelines* encourages children (aged 5–17 years) to *Sweat, Step*, *Sleep* and *Sit,* with the goal to increase physical activity, decrease sedentary behaviours, and maintain sufficient sleep each day for optimal health benefits (Canadian Society for Exercise Physiology (CSEP), 2016). Under the *Sweat* portion of the guidelines, children should engage in 60 minutes of moderate to vigorous physical activity (MVPA) daily. According to CSEP (2012), MVPA refers to the participation in activities for children that allow them to be working hard, breathing heavily, with increased body temperature, and an increased heart rate. Participation in MVPA is vital for disease prevention and health promotion (Poitras et al., 2016). Under *Step*, participation in several hours of a variety of structured and unstructured light physical activities is recommended. For *Sleep,* the guidelines recommend that children aged 5 to 13 years should engage in 9 to 11 hours of uninterrupted sleep per night while adolescents aged 14 to 17 years, should engage in 8 to 10 hours per night of uninterrupted sleep with consistent bed and wake-up times (CSEP, 2016). Finally, the *Sit* portion indicates that children should be limiting the time spend in sedentary behaviours, such as recreational screen time, to no more than two hours per day, which includes limiting extended sitting periods (CSEP, 2016). Lastly, CSEP (2016) encourages substituting sedentary behaviours with more outdoor activity time and light physical activities with additional MVPA in order to achieve greater health benefits.

It is thought that the low level of MVPA among Canadian children may be attributed to physical literacy (Longmuir & Tremblay, 2016). According to Whitehead (2010), physical literacy has been coined as the motivation, the confidence, the physical competence, the understanding and the knowledge in order to maintain daily physical activity, in addition to having the ability to effectively interact with the physical environment. Essentially, physical literacy is achieving the fundamental movement skills for object control (e.g., catching), locomotor skills (e.g., running), stability skills (e.g., balancing) and possessing motivation and confidence (MC) as well as the knowledge and understanding (KU) of physical activity (Lander et al., 2017; Giblin, Collins, Button, 2014). It is generally thought that the more physical literate a child is, the more likely they will be able to perform a variety of movements confidently, competently, creatively, and strategically across a wide range of health-related physical activities (Longmuir et al., 2015). Children with the knowledge to correctly execute a given task in any form of physical activity will enjoy participating in physical activities with their peers and hopefully continue participation throughout adulthood (Côté & Hancock, 2014). Among a relatively small sample of Canadian children (8-12 years of age), 44% were considered to have reached acceptable requirements for physical literacy, with males demonstrating higher levels (47%) compared to females (41%; ParticipACTION, 2016).

Keeping physical activity and physical literacy rates in Canadian children in mind, there is great importance to explore best practices in order to createa precedent for Canadian children to become more physically active as well as more physically literate. As previously stated, under the *Canadian 24–Hour Movement Guidelines*, children are encouraged to take part in 1 hour of structured and unstructured activities of MVPA and several hours of a variety of structured and unstructured activities to increase their step count (CSEP, 2016).

The Canadian Assessment of Physical Literacy (CAPL) was developed in response to the need for objective data on physical literacy and correspondingly, a reliable and informative tool for monitoring physical literacy in Canadian children (Longmuir et al., 2015). The CAPL uses the core domains of physical literacy, namely MC, physical competence (PC), KU, and habitual engagement in physical activity (characterized as daily behaviour (DB) in CAPL) for examining physical literacy in children 8 to 12 years of age (Longmuir et al., 2015). Furthermore, the four domains (DB, PC, KU, & MC) overlap, highlighting the premise that physical literacy is the result of an interaction between multiple factors (Healthy Active Living and Obesity Research Group (HALO), 216a). However, CAPL only includes a measure of step count (via pedometers) and self-reported MVPA (via questionnaires) to represent the DB domain (along with self-reported sedentary time). Adams, Johnson, and Tudor-Locke (2013) have suggested that 12,000 steps/day is equivalent to 1 hour of MVPA, however, if participants are wearing pedometers, they are also able to estimate time spent in MVPA depending on the type of pedometer used and its capacity to track MVPA (Saunders et al., 2014), which may be a better indicator over self-reported MVPA and/or may provide additional information to better explain DB.

Therefore, the purpose of this thesis was to assess whether objectively measured MVPA (minutes/day collected via pedometers) was associated with physical literacy (the overall score) or any of the 4 domains (DB, PC, KU, and MC). It was hypothesized that the overall CAPL score, in addition to the 4 domains, would be positively associated with the objectively measured MVPA. A secondary objective was to assess the suitability of replacing self-report MVPA currently being used within the CAPL with objectively measured MVPA.

METHODS

All protocols were approved by the University of Windsor Research Ethics Board (REB #14-101) as part of a larger study entitled the Canadian Assessment of Physical Literacy (2014-16).

Participants and Recruitment

Approximately 1,300 children (ages 8-12 years) from southwestern Ontario were recruited via camps (i.e., the Young Men Christians Association (YMCA) of Western Ontario, the University of Windsor, and various community recreation and sports programs) and schools (i.e., the Windsor- Essex Catholic District School Board and the Conseil Scolaire Catholique Providence). All protocols were completed in English or French, depending on the site. Participation in this study was strictly on a voluntary basis, where informed written consent from the parent or guardian, along with verbal assent of the child, was obtained.

Methodology

Under the CAPL protocol, physical literacy is assessed using the 4 domains characterized by physical literacy. Each domain consists of multiple test elements designed to assess PC, MC, KU, and DB, where the DB domain is considered as the behavioral outcome of the separate three domains. The composite physical literacy score is out of 100, with PC and DB each yielding 32 points and the MC and KU scores making up 18 points each. After receiving the overall physical literacy score, the score can be further interpreted under one of the four categories (i.e., beginning, progressing, achieving, or excelling). The four categories were created in order to differentiate the level of physical literacy attained by the participant (i.e., the beginning and progressing phase represent that a participant has not achieved the recommended physical literacy requirements and the achieving and excelling phases represent that a participant has reached the minimum physical literacy requirements). All protocols are fully described in the CAPL Manual (HALO, 2016a) and are briefly described below.

Physical Competence Domain. There were four separate assessments that measured PC: motor competence via the Canadian agility and movement skill assessment (CAMSA), aerobic fitness via the progressive aerobic cardiovascular endurance run (PACER), body composition (including body mass index (BMI) and waist circumference (WC)), and musculoskeletal fitness (including grip strength, torso strength, and flexibility).

Motor Competence. Motor competence was assessed through the CAMSA (Longmuir et al., 2017), which assesses the ability to run, hop (one and two-footed), slide, skip, catch, throw, and kick (Longmuir et al., 2015). Participants were initially given a demonstration where the appraiser moves slowly through the entire course, performing each skill perfectly in order to demonstrate each task followed by a demonstration in real time. During the demonstrations a verbal description of each skill was provided, emphasizing the key words to prompt the child with the next action (i.e., three two-foot jumps, shuffle shuffle shuffle touch, catch the ball, etc.). The appraiser emphasized that the obstacle course should be completed as quickly and accurately as possible. Each participant had two practice trials followed by two timed/scored trials. During the practice trials, verbal corrections for any mistakes were provided. Furthermore, verbal cues or prompts were provided throughout each trial during the test protocol. There were 14 different tasks the participant should have accomplished correctly in order to receive full points (14 points total). Timing began upon movement initiation to start the obstacle course and finished upon contact with the soccer ball (during the kick) and was timed to the nearest 0.1 second.

Aerobic Fitness. Aerobic fitness was measured with the Fitnessgram 15 meter/20 meter PACER, where participants were instructed to run as long as they can between two pylons placed 15 or 20 meters apart. Pre-recorded audio software (beeps) were used for each stage of the test. Once the first beep sounded, the participants were informed to leave their current position and return to the other side before the next beep. Upon the next beep, the participant must run back to the original start position. Essentially every time the beep sounds, the child should run the other way. If the child reached the line before the beep, they waited until the next beep before running back. They were informed that each beep would gradually get faster so they needed to run faster to keep up. Participants were encouraged to pace themselves in order to not get too tired too quickly. The test concluded when the participant removed him/herself from the test or could not make it to the other side by the time of the beep. The number of completed laps was recorded, and the overall score received was dependent on the number of full laps completed.

Body Composition. Body composition was measured via weight and height (which calculates BMI) and WC in a private area away from other participants. Height and weight were assessed without shoes and wearing lightweight clothing using the Health-O-Meter 500KL electronic stadiometer. Participants stood on the platform in an upright position looking straight ahead. The stadiometer arm came down until it was lightly pressed on the participant's head at which point it was measured to the nearest 0.1 centimeter. Two measurements were taken and averaged to give the final height score. At the same time as the height was being measured, the digital scale measured the participants weight to the nearest 0.1 kilogram. For the assessment of WC, the participant was asked to lift his/her shirt to expose the midsection. WC was measured in the horizontal plane at the top of the iliac crest while they were standing up straight, looking straight ahead, and at the end of a normal exhalation. The measurement was taken twice to the nearest millimeter and averaged to give the final score. If the two trials differed by more than 0.5 centimeter, a third measurement was taken and the closest two scores were averaged.

Musculoskeletal Fitness. Musculoskeletal fitness was measured with grip strength, torso strength, and flexibility. The assessment of grip strength was measured with a handgrip dynamometer. The child was asked to take the apparatus into the palm of the hand and hold it so the scale is facing out. The appraiser ensured that they were gripping the apparatus between the base of the thumb and fingers. The participant held the arm so that it was straight and hanging at each side and was not touching the side of the participant's clothing. Then, the child gradually squeezed the handle as hard as possible while slowly saying the word 'squeeze'. Grip strength was measured twice on each hand (in an alternating fashion) to the nearest 0.5 kilogram. The sum of the highest trial, on each hand, was summed for the overall score. The assessment of torso strength was completed with the plank test. Participants were asked to tuck in their shirt in order to clearly see where the back and body were during the test. Before the assessment began, the appraiser demonstrated proper form. The participant started lying down on the mat with their stomach touching the mat. Upon starting the test, the participant was asked to rise onto their elbows so that their elbows were directly under their shoulders. When the elbows and hands were in position, with the legs straightened so that only the toes were on the floor curled under their feet, the time began. They were then instructed to hold their hands together against the floor and encouraged to look at their hands and make a perfectly straight line with the body. They held this position for as long as possible. The appraiser watched for the hips or shoulders to not sag down or lift their hips too high up in the air. If the body bent out of form they received one warning to straighten the body, on the second time, the test stopped. Torso strength was measured to the nearest 0.1 second. Flexibility was measured via the sit and reach test. Before the test began, each participant completed a five minute warm-up activity to loosen the muscle groups in the legs, including the hurdler stretch (held for 20 seconds, on each leg, twice). The sit and reach test was done without shoes, after a demonstration by the appraiser. The participants were asked to sit on the mat with their legs stretched out in front of them, making sure that the heels were flat against the surface of the sit and reach apparatus and the toes were pointing upward. Participants were instructed to have their knees straight against the mat at all times. Then they placed the arms out straight and stacked the hands together, and gradually moved the body by leaning forward from the hips. They were encouraged to proceed as far as possible with the hands together and knees straight. Once they could no longer bend further forward, the child held the same position for five seconds. In the present study, the flat vertical surface was marked at 26 centimeter. Two trials were completed with the score recorded to the nearest 0.5 centimeter.

Motivation and Confidence and Knowledge and Understanding Domains. All participants completed a Physical Activity Questionnaire that assessed MC and KU. An example of questions that assessed MC included questions such as reasons to be (or not be) physically active, and activity and skill level compared to fellow peers. MC also included the children's self-perceptions of adequacy in and predilection for physical activity (CSAPPA) scale, which was developed to assess children's perception of their own ability to be successful in physical activity and their predilection toward physical activity participation (Hay, 1992). The assessment of KU determined the child's knowledge of physical activity, sedentary behaviour, physical fitness, as well as safety precautions that occur throughout an activity, such as safety equipment that is needed. There were a total of 21 questions that related to MC (with a variety of multiple choice questions, fill in the blank, association, and a form of Likert scale questions) and 17 questions that related to KU. Sedentary behaviour was also assessed via four questions in the Physical Activity Questionnaire, while MVPA was indirectly assessed through one question on the Physical Activity Questionnaire (i.e., 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); HALO, 2016a).

The Physical Activity Questionnaire was administered by a CAPL examiner/appraiser. The questionnaire was taken before or after data were collected for the PC activities (CAMSA, PACER, BMI, WC, sit and reach, plank, and grip strength). Participants were given their own copy of the questionnaire and they completed the questionnaires independently. Before the participants started the questionnaire, it was stated that the child should give their own opinion for each answer, there were no "right" or "wrong" answers, and that if they did not know how to answer a question they should make a best guess. The examiners clarified questions when needed, without divulging the correct answer. The questionnaire took approximately 30 to 45 minutes to complete, depending on the age of the participants. Scoring for each of the domains described (i.e., KU and MC) are separate and range from -0.63 to 18 for KU and -1.5 to 18 for MC.

Daily Behaviour Domain. Daily physical activity behaviour was objectively measured through the use of pedometers and three self-reported questions from the Physical Activity Questionnaire. Participants were instructed to wear the pedometer at all times (during waking hours; with the exception of swimming/bathing) for 7 days. Pedometers were worn on the waistband of their shorts/pants over the right hip. The pedometers used in the present study were PiezoRx (StepsCount, 2016) which measured daily step count, time spent in moderate physical activity (>110 steps/minute), time spent in vigorous physical activity (>130 steps/minute), and total physical activity time (>90 steps/minutes). For the purpose of CAPL, only daily step count (and time worn) were used, however, time spent in moderate physical activity and time spent in vigorous physical activity were recorded for the purpose of the current analyses. The initial day of wearing the pedometer was referred to as the practice day and the official recording days began the subsequent day upon waking. Three days of valid data (i.e., pedometer was worn for at least 10 hours/day and acquired between 1,000 and 30,000 steps/day) were required to calculate a total CAPL score. Prior to receiving their pedometer, participants were instructed on how to properly wear and care for the pedometer. Participants were also given a recording sheet in which they were asked to record when they put the pedometer on and took it off each day (e.g., removing the pedometer for a water related activity).

Materials

Appraiser Training. Appraisers were thoroughly trained under all aspects of the CAPL protocols that were administered. Appraisers were recruited and received the CAPL training manual with the corresponding CAPL training videos prior to in-person training. The in-person training session was a mandatory testing orientation session, where each CAPL protocol was demonstrated by the lead researcher for mastering set-up and the general run through of the individual stations. The in-person training session took approximately 2-3 hours.

Protocol

Upon making contact with each site (e.g., school, recreation site, sports team), the researchers delivered the parent information and consent form to be distributed for each participant. As CAPL was formulated based on physical education curriculum, all children (with verbal assent) participated in the testing sessions, yet only those with parental consent were given a pedometer and remained in the dataset for research purposes.

Depending on the space and time provided for the testing sessions, testing stations were set up within an open space (i.e., usually a school gym). Testing took approximately two hours to complete all protocols (including the survey). Upon completion of the tests, pedometers were handed out and returned 5-7 days later to the testing site for pick up by the research team. Data entry was completed immediately following the testing via the CAPL website (https://www.capl-ecsfp.ca), which calculates all individual and composite scores. An email to parents (if they provided on the consent form) was sent via the CAPL website with their child's individual results. Lastly, upon completion of data entry, 5% of the sample was checked for accuracy by a member of the research team not involved with the initial data entry.

Data Treatment and Statistical Analyses

Statistical Analyses. Data collected from the study (objectives 1 and 2) were analyzed using SPSS version 24.0 for Windows (IBM Corp., 2016), and all tests were deemed significant at $p<0.05$. Only participants that met the inclusion criteria for pedometer usage (acquired 1,000 to 30,000 steps per day, worn for a minimum of ten hours, and had a minimum of three valid days) were included in the present analysis. A Chi-Square Test for Association was performed to determine differences between the participants that were excluded versus those that were included by gender and age. Six individual independent t-test analyses were used to determine differences between gender and age, overall physical literacy, and the four components (DB, PC, KU, and MC). For objective one, to assess whether objectively measured MVPA (minutes/day collected via pedometers) was associated with physical literacy (the overall score) or any of the 4 domains (PC, Kand U, M and C, and DB), for each gender and age combination, 5 one-way

ANOVAs were conducted. For objective 2, to assess the suitability of replacing self-report MVPA with objectively measured MVPA, a Pearson Correlation analysis was conducted to determine the relationship between objectively measured MVPA (via pedometers in minutes/days) and subjectively measured MVPA (via the Physical Activity Questionnaire question 19 in days).

Suitability of Replacing Self-Reported Moderate to Vigorous Physical Activity. To determine whether the objective measure of MVPA could replace the current subjective measure of MVPA, a new scoring system was created and evaluated against the current CAPL scoring. Currently, within the DB domain (i.e., a total of 32 points) there are three sub-sections where points could be allocated; 21 points for average daily step count (via pedometer), 8 points for self-reported sedentary time (via the Physical Activity Questionnaire), and 3 points for self-reported number of days/week they are physically active (at a moderate to vigorous level) for a minimum of 60 minutes daily (via the Physical Activity Questionnaire). For the current CAPL scoring system, participants receive 0 points if they have indicated 0-1 days/week, 1 point for 2-3 days/week, 2 points for 4-5 days/week, and 3 points for 6-7 days/week. An exploratory analysis was conducted to determine a new scoring system based on total minutes/day (as measured by the pedometer). If a participant spent 0-20 minutes/day, they were given 0 points, >20 to 40 minutes/day for 1 point, >40 to 60 minutes for 2 points, and >60 minutes/day for 3 points. Several different models were created and tested and this version was deemed the most appropriate for several reasons. There was consistent time between each interval (i.e., 20 minutes), the highest amount of points is equivalent to meeting the MVPA guidelines, and there was an equal distribution of participants in each of the groups. Multiple paired t-tests were performed to evaluate whether there was a difference in the current scoring system for MVPA (subjective measure in the questionnaire) in the DB domain against the newly created scoring system accounting for the objectively measured MVPA. Lastly, a cross tabulation was used to investigate the variability of the self-perceived (subjective) MVPA scores against the new (objective) MVPA score among males and females. This was completed to evaluate if the objective measure adds to CAPL's ability to discriminate among various levels of physical literacy (e.g., if objective measurement replaces the subjective measure, are the participants receiving the same outcome?).

RESULTS

Across southwestern Ontario, 1,278 children (ages 8-12 years) participated in the CAPL study. In a process of elimination, the data collected for 219 participants were excluded for not meeting the acceptable criteria for pedometer usage (n=219), leaving 1,059 participants for the analysis. There were no differences between those excluded (vs. included) based on gender (p=0.172), however, more 9 and 12 year olds were excluded than 8, 10, and 11 year olds (p=0.004).

Participant demographic information (by gender), along with overall physical literacy categories and across the four domain categories in CAPL (DB, PC, KU, & MC) are presented in Table 1. Approximately, 73% (n=775) of the participants did not meet the acceptable level of physical literacy (i.e., they fell within the beginning or progression phase; HALO, 2016a). Furthermore, 43% (n=237) of males and 28% (n=144) of females met the 60 minutes of MVPA recommended by *the Canadian 24-Hour Movement Guidelines* (CSEP, 2016) with a mean of 60 minutes (SD=27.96) and 50 minutes (SD=21.86) for males and females, respectively. The associations for objectively measured MVPA and the overall CAPL score (and each domain) are presented in Tables 2-6 (by age and gender). With the exception of 8 and 12 year old females, the overall CAPL score was positively associated with MVPA (i.e., the more time spent in MVPA the higher the overall CAPL score). Further, DB was positively associated with MVPA across all age groups (for both males and females), with the exception of 12 year old females. Finally, there was also a positive association observed between the MC domain and MVPA among males 9 years of age and among males and females 10 years of age.

Among all participants, objectively measured MVPA was positively correlated with subjectively measured MVPA (r=0.109, p<0.001), with the exception of males (8 and 9 years) and females (10 years) (see Table 7). The 3-point scale for subjectively measured MVPA and the newly created objectively measured MVPA are presented in Table 8. There were differences observed between the current self-perceived MVPA score (subjectively measured) and the objectively measured MVPA score (through pedometer usage), in males 9 and 11 years of age and in females (all except 10 years of age). As the 3-point scale (out of a potential 100 points) is small (thus not allowing for much movement between CAPL categories), Table 9 indicates participants scores based on the current and newly formed MVPA score. In total, 369 participants (35%) did not change their score, yet 402 participants (38%) decreased their score and 288 (27%) increased their score. In general, the new scoring system does not result in a radical change in a participant's overall CAPL score, varying between an addition of plus three points (maximum) or the subtraction of three points (maximum). However, the results for the new score as depicted in Table 8, demonstrate that the objectively measured MVPA score is lower than the self-reported MVPA score (p<0.001).

DISCUSSION

The present study investigated whether there was a relationship between physical literacy and time spent in MVPA (minutes/days) and if there was a possibility of replacing the self-reported MVPA with the objectively measured MVPA among males and females 8 to 12 years of age. According to Longmuir and colleagues (2016), physical literacy and physical activity behaviours are intertwined, however, not to the extent where one does not exist without the other. Rather, physical literacy can be viewed as an umbrella term that includes physical activity as well as the desires and commitments to attain a healthy and active lifestyle (Francis et al., 2016). It was predicted that the levels of physical literacy would be associated with physical activity behaviour; therefore, physical literacy rates would be relatively low given the poor physical activity levels among Canadian Children (Colley et al., 2011). In the current study, only 37% of children in southwestern Ontario 8 to 12 years of age reached the sufficient level of physical literacy in order to obtain the associated health benefits. This rate is slightly lower in comparison to the 44% of children 8 to 12 years of age that were physically literate nationally (ParticipACTION, 2016). However, southwesten Ontario is known for having slightly worse health outcomes. For example, 44% of 10-14 year olds from Windsor-Essex County were considered overweight/obese (Woodruff & Fryer, 2011) versus 32% nationally as collected via the Canadian Health Measures Survey (CHMS; Statistics Canada, 2012). Southwestern Ontario is often described as being an automotive town (Dimatulac & Maoh, 2017) with 91.8% of Windsor Essex-County residents indicating their main mode for transportation to work was with an automobile (Windsor-Essex County Health Unit, 2016). Furthermore, with the limited walkability or bike lanes available for active transportation (Kornas, Bornbaum, Bushey, & Rosella, 2017), only 5% of males and 4.6% of females in Windsor-Essex County reported walking or biking compared to the provincial (Ontatio) reports at 6% in males and 6.7% in females (Windsor-Essex County Health Unit, 2016). Although the higher preference for automobiles has been observed in adults in southwestern Ontario, it is important to note that the behaviour of children tends to be reflective of their parents (Gustafson & Rhodes, 2006). Parents can directly influence their children's physical activity behaviour through role modeling (Bauman et al., 2012), therefore, the lack of participation in active transportation in adults may predict the behaviour of children in southwestern Ontario. For example, Garriguet, Colley, and Bushnik (2017), suggested that for every 20 minute increase in a parent's MVPA, their child's MVPA increased by 5-10 minutes.

Objective 1. The first objective of this study aimed to determine if objectively measured MVPA (minutes/days collected via pedometers) was associated with physical literacy (the overall score) or any of the four domains (DB, PC, KU, and MC). Generally, a positive association was observed for total time spent in MVPA (collected via pedometers) and the overall CAPL score, DB, and MC (yet not across all age groups in the MC domain). It was somewhat expected and not surprising that the MVPA score was positively associated with the DB score, as both were being measured using the same device. As mentioned earlier, the DB score is primarily made up of the step count (21 out of the 36 total points), and those generally with higher step rate would have had a greater chance at acquiring MVPA (greater number of steps/minutes). Gu and colleagues (2017) suggested that children can become more self-aware of their physical activity levels when wearing a pedometer, thus increasing step rate (or MVPA) as they become more motivated. Using pedometers as a means to motivate children to become more physically active (Gu et al., 2017) can also, potentially, explain the positive association between time spent in MVPA and MC among certain age groups (males 9 and 10 years and females 10 years). The motivation to be physically active and the confidence in one's physical abilities are important factors to an individual's likelihood to be physically active throughout their life (Tremblay & Lloyd, 2010). Results in the present study show a mixed association across all age groups for MC, therefore, more research should be implemented to explore how MC is associated MVPA.

PC (associated with motor skills and physical fitness), along with the ability and implementation of fundamental movement skills, are strong predictors of children's ability to be physically active and literate throughout their life course (Longmuir et al., 2015). According to Simpson et al. (2017), fundamental movement skills are key predictors of children's ability to be physically active. More so that it will allow for children to learn about their individual abilities which motivate children to enjoy physical activity. Contrary to the majority of previous research, which suggested a positive association between competency for motor skills (PC) and in physical activity (MVPA) behaviour (Simpson et al., 2017), there is no evidence to suggest a relationship between PC and MVPA in the present study. The non-significant association could potentially be explained with the PC assessment with the CAMSA, because the CAMSA protocol assesses a child's ability to transfer from one fundamental movement skill to another fundamental skill in a sequence to complete the assessment. In total, under the PC domain score, just over one quarter (26%) of the total PC score can be accumulated strictly for the CAMSA portion. According to Hulteen and colleagues (2017), fundamental movement skills (e.g., running and kicking; Physical and Health Education Canada (PHE Canada), 2017b) are important for physically active pursuits but are not enough to provide additional pathways to a lifetime of physical activity skills. The CAPL protocol for PC with the CAMSA relies on a child's ability to transfer from one fundamental skill to another to complete the assessment. Hulteen and colleagues (2017) suggested that foundational physical activity skills (e.g., cycling, swimming or resistance training skills) may potentially allow an individual to become more physically active while providing the individual the ability to apply those skills to context related applications (e.g., mountain biking, ocean swimming). Conversely, Júdice and colleagues (2017) identified that MVPA was positively associated with PC in children, more specifically through flexibility (sit and reach), the PACER, and BMI (with an inverse correlation to MVPA). Each of the measurements and assessments previously listed are also measured in the PC domain in CAPL, yet the current analysis did not investigate the associations between MVPA and the individual tests. The findings reported in the present study against the current research, can possibly equate to the notion that PC is a more comprehensive indication of physical fitness and capabilities as it measured musculoskeletal fitness, body composition, aerobic fitness, and motor competence. Moreover, all domains (including PC) in CAPL overlap with one another, meaning that a score obtained from one domain may be related to the performance in another domain (e.g., the performance during the PACER is interrelated with the MC; HALO, 2016a). Which essentially is the premise for physical literacy (i.e., the greater the MC, PC, and KU, the greater likelihood to maintain physical activity throughout an individual's life; Whitehead, 2010). Potentially the findings illustrate that children simply do not exhibit the adequate PC levels that can be translated into the MVPA behaviours (as it was observed in the DB domain). Alternatively, the results could be indicative of the mixed positive associations that were observed in the MC (only in males 9 years of age and males and females 10 years of age), because score obtained on certain of the test items (within a given domain) may be influenced by scores obtained in another domain (HALO, 2016a).

Starting at the age of 6 years, KU of physical activity is a strong determinant of children's physical activity levels later in life (DiLorenzo, Stucky-Ropp, Vander Wal, & Gotham, 1998). However, the current findings indicated that there was no relationship between KU and time spent in MVPA. The observation of no realtonship between KU and MVPA may result in children not having the proper awareness of the benefits of daily physical activity that carry out later in life. A potential solution can be directed towards further developing the physical education curriculum in schools, which would be tailored to increasing motor competence and overall physical fitness, along with the development of competence for motivation to engage in physical activity (Gu et al., 2017). More physical education specialists should be hired in Canadian schools, as only 43% of Canadian schools indicated the use of physical education specialist for the delivery of physical education (Canadian Fitness and Lifestyle Research Institute (CFLRI), 2015). Perhaps the inclusion of physical education specialists within the schools would better promote the appropriate developmental physical activity skills and sport programs for children to develop proper forms and/or skills needed for the KU of physical activities (CFLRI, 2015).

Lastly, the current findings could perhaps be explained through the notion that the physical literacy score and the DB score are reflective of MVPA (and not in PC and KU), because the DB domain is considered the behavioural outcome of the other three domains (HALO, 2016a). Therefore, a physically literate individual will engage in MVPA because there is an understanding of the importance of physical activity because they are confident in their knowledge of their skills and abilities in any environment (Whitehead, 2010). Essentially physical activity is one of the many aspects of the multifaceted term of physical literacy. Physical literacy is demonstrated in PC, KU, and MC and can contribute to the promotion of the involvement in physical activity through the lifecourse (Lloyd, Colley, & Tremblay, 2010). The concept of physical literacy, however, is to create the ability, the willingness, and the desire to engage in physical activity (Tremblay & Lloyd, 2010), which was not expressed in any relationship between PC and KU and MVPA, nor was it observed for MC among several of the age/gender categories.

Objective 2. The second objective aimed to assess the suitability of replacing self-reported MVPA with objectively measured MVPA (minutes/days) through pedometer usage. Similar to previous research (James et al., 2016), objectively measured MVPA via pedometers is thought to provide a more accurate assessment of movement compared to self-report, in addition to having the capability of recording the intensity. The current data (Tables 8 and 9) suggested that participants overreported their physical activity behaviour, compared to the objectively measured pedometer intensity. As it was previously mentioned, the pedometers used in the current study was the PiezoRx (StepsCount, 2017), which has the ability to differentiate between various intensities (sedentary, light, moderate, and vigorous). Saunders et al., (2014) validated the various intensities against indirect calorimetry among 10-17 year old children and adolescents and reported that the PiezoRx had the highest combined sensitivity (92.9%) and specificity (96.5%) for correctly identifying a bout of MVPA (against other pedometers and accelerometers).

Commonly used subjective methods for measuring physical activity include questionnaires/surveys, diaries, logs, and/or recalls (Warren et al., 2010). This method may be cost effective and can be used on a large scale (James et al., 2016), however, may pose numerous problems, including reliability and accuracy (James et al., 2016; Hoeboer, Krijger & Savelsbergh, 2017). For instance, a study conducted by Sprengeler and colleagues (2017), reported that self-reported light physical activity and MVPA in children 6 to 17 years of age during school were enormously underestimated compared to the objectively measured light physical activity and MVPA, except for MVPA during organized sports activities. Furthermore, in a review conducted by Demetriou, Gillison and McKenzie (2017), studies that used subjective measures to assess physical activity behaviour reported relatively higher outcomes compared with objectively measured MVPA. Nevertheless, self-reported physical activity provides information on context and type of physical activity and may consequently be a useful complement to objective measurements (Sprengeler et al., 2017). While it may be clear that using pedometers as an objective measure is the more ideal solution, it does not necessarily ascertain a feasible approach (in terms of cost, interpretation, and/or data collection) (Van Camp & Hayes, 2017), especially considering who is administering the CAPL (i.e., coaches, parents, and teachers) (Garriguet, Colley, and Bushnik, 2017). The current CAPL research study may have used pedometers to measure DB and MVPA among the participants, however, the pedometers proved to be quite challenging at times with regards to participants returning the pedometers after the study period and/or compliance with wearing them. Nevertheless, the results in the current study suggest that in order to ensure that the CAPL tool is the gold standard tool for the assessment of physical literacy, CAPL should adopt the objectively measured MVPA method through pedometers along with the current daily step count to monitor DB among children.

Limitations

This study is not without limitations. There are numerous factors that can be attributed to a child's participation in physical activity, such as socioeconomic status (Canadian Imperial Bank of Commerce (CIBC) & KidSport, 2014), school board funding for development of physical education in schools (CFLRI, 2015), safety attributed to outdoor play (Veitch, Salmon, & Ball, 2008), active transportation (Tremblay et al., 2015), and through sports (Marquesa, Ekelund, & Sardinhaa, 2016). Although location of the data collection (urban, rural, and suburban) was collected, it was not entered into the CAPL score and it is suggested that a measure of socioeconomic status be incorporated in the future. Secondly, the participants of this study were obtained via a convenience sample. The participants were recruited from summer/day camps, in various community recreation and sports programs, and from schools. The children that were recruited from the previously mentioned location could have been predisposed to the participation in physical activities because of the availability to become active was encouraged through organized programming. Perhaps a more randomized sample could provide a better representation of physical activity and physical literacy in southwestern Ontario. Furthermore, within the convenience sample, there were some participants that were not included based on active parental consent procedures, which may have resulted in not capturing all children from a given location. Thirdly, within objective one, 50 one-way ANOVAs were conducted to evaluate the relationship between objectively measured MVPA and the CAPL score and the 4 domains (DB, PC, KU, and MC) by age and gender. This may have increased the chance of observing a type I error. However, O'Keefe (2003) argues that employing such alpha adjustments is unjustified and undesirable, thus the adjustments were not undertaken. Lastly, in relation to the PiezoRx pedometer model used to collect daily steps and MVPA, there were some challenges that arose with respect to the functionality. Some of the pedometers malfunctioned or the battery died while the participant used the pedometer. Additionally, as MVPA was measured with step frequency (per minute), some non-weight bearing activities (e.g., riding a bike) and/or water-related activities (e.g., swimming) were not accounted for. This may pose a problem for females because they tend to prefer participating in non-weight bearing activities such as yoga, Pilates, and swimming, which would not have registered with the increased step frequency needed to measure MVPA.

Implications & Conclusions

Overall, the main objective of this study was to determine whether physical literacy was associated with MVPA among children 8 to 12 years of age in southwestern Ontario. Children in southwestern Ontario are not physically literate, with the majority of participants falling under the progressing phase for the overall CAPL score. Generally, the overall physical literacy scores were associated with MVPA accumulated through pedometer usage (minutes/day), in addition to DB. The CAPL protocol was an effective tool in establishing the relationship between MVPA and physical literacy. However, like most assessments, the CAPL protocol can be improved. As it was previously discussed, the CAPL protocol relied on self-reported MVPA as part of the Physical Activity Questionnaire. As part of this project, the pedometers that were used to measure average daily step count were also used to measure total time spent in MPVA for all participants. A new scoring system was adopted in order to replace the self-reported MVPA with objectively measured MVPA. When considering an assessment for MVPA, pedometers should be the preferred choice in order to accurately assess a participant's amount and intensity of physical activity, as the participants are already wearing the pedometers for step count. Consequently, the Children's Hospital of Eastern Ontario (CHEO) should consider adopting the new scoring system (with the objective measure for MVPA) in order to continue to be the gold standard for the assessment of physical literacy.

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Table 1
Physical literacy (and components) categories by gender (n=1059)

	Males (n=546) n (%)	Females (n=513) n (%)	Significance *p*-value
Age (years)			0.311
8	56 (10.3)	39 (7.6)	
9	147 (26.9)	145 (28.2)	
10	180 (33.0)	161 (31.4)	
11	129 (23.6)	142 (27.7)	
12	34 (6.2)	26 (5.1)	
Physical Literacy (score; 0-100)			0.380
Beginning (<43.8)	81 (14.9)	92 (18.0)	
Progressing (43.8 to 63.8)	311 (57.0)	291 (56.8)	
Achieving (> 63.8 to 74.0)	103 (18.9)	87 (17.0)	
Excelling (> 74.0)	50 (9.2)	42 (8.2)	
Daily Behaviour (score; 0-32)			0.115
Beginning (<7.5)	68 (12.5)	109 (21.2)	
Progressing (7.5 to 19.2)	399 (73.0)	316 (61.6)	
Achieving (> 19.3 to 25.2)	49 (9.0)	65 (12.7)	
Excelling (>25.2)	30 (5.5)	23 (4.5)	
Physical Competence (score; 0-32)			0.190
Beginning (<14.1)	85 (16.0)	60 (11.9)	
Progressing (14.1 to 21.5)	292 (54.9)	277 (55.0)	
Achieving (>21.6 to 25.3)	97 (18.2)	99 (19.6)	
Excelling (>25.3)	58 (10.9)	68 (13.5)	
Knowledge & Understanding (score; 0-18)			0.907
Beginning (<6.8)	66 (12.2)	69 (13.7)	
Progressing (6.8 to 11.5)	232 (43.0)	229 (45.5)	
Achieving (>11.6 to 14.1)	123 (22.8)	100 (19.8)	
Excelling (>14.1)	119 (22.0)	106 (21.0)	
Motivation & Confidence (score; 0-18)			0.353
Beginning (<8.1)	84 (15.5)	82 (16.1)	
Progressing (8.1 to 13.7)	273 (50.6)	243 (47.6)	
Achieving (>13.8 to 16.6)	104 (19.3)	106 (20.8)	
Excelling (>16.6)	79 (14.6)	79 (15.5)	

Note. Total amount of n's may not add up to total population due to missing data.

Table 2
Objectively measured time spent in moderate to vigorous physical activity (minutes) by physical literacy categories (and components) among males and females 8 years of age

		Males (n=56) Mean (SD)	Significance *p*-value	Females (n=39) Mean (SD)	Significance *p*-value
Physical Literacy					
	Beginning	41.95 (24.39)	0.025	39.83 (24.08)	0.697
	Progressing	57.66 (25.61)		43.74 (18.95)	
	Achieving	78.88 (26.47)		50.93 (9.46)	
	Excelling	56.03 (50.58)		N/A*	
Daily Behaviour					
	Beginning	23.77 (6.49)	0.001	28.55 (8.40)	0.025
	Progressing	59.27 (23.58)		46.21 (19.75)	
	Achieving	81.24 (42.29)		61.85 (19.38)	
	Excelling	79.58 (13.88)		N/A*	
Physical Competence					
	Beginning	58.06 (29.84)	0.953	30.53 (12.56)	0.319
	Progressing	56. 94 (34.37)		44.46 (19.35)	
	Achieving	63.96 (14.59)		52.67 (14.69)	
	Excelling	57.52 (81.35)		40.78 (N/A*)	
Knowledge & Understanding					
	Beginning	57.80 (26.74)	0.451	50.94 (17.36)	0.346
	Progressing	61.95 (32.10)		39.48 (21.06)	
	Achieving	44.08 (19.81)		37.02 (26.55)	
	Excelling	62.94 (25.77)		40.59 (9.01)	
Motivation & Confidence					
	Beginning	43.75 (21.06)	0.174	34.40 (20.69)	0.450
	Progressing	57.82 (32.10)		48.06 (24.29)	
	Achieving	72.44 (34.66)		41.83 (11.45)	
	Excelling	66.83 (19.36)		45.25 (10.24)	

Note. N/A signifies that at least one group has fewer than two cases.

Table 3
Objectively measured time spent in moderate to vigorous physical activity (minutes) by physical literacy categories (and components) among males and females 9 years of age

		Males (n=147) Mean (SD)	Significance *p*-value	Females (n=145) Mean (SD)	Significance *p*-value
Physical Literacy					
	Beginning	40.63 (18.30)	<0.001	37.30 (12.39)	<0.001
	Progressing	63.61 (23.36)		47.91 (21.17)	
	Achieving	77.37 (31.78)		71.66 (26.83)	
	Excelling	97.81 (22.60)		81.00 (22.69)	
Daily Behaviour					
	Beginning	33.64 (6.80)	< 0.001	32.09 (11.53)	<0.001
	Progressing	63.98 (23.08)		49.53 (21.17)	
	Achieving	98.35 (30.29)		76.82 (15.32)	
	Excelling	95.73 (33.24)		105.56 (17.98)	
Physical Competence					
	Beginning	58.71 (24.55)	0.106	48. 33 (20.83)	0.725
	Progressing	68.54 (30.99)		54.52 (25.84)	
	Achieving	77.49 (29.12)		56.89 (25.87)	
	Excelling	74.32 (20.46)		53.70 (24.17)	
Knowledge & Understanding					
	Beginning	66.08 (26.05)	0.960	52.23 (23.75)	0.312
	Progressing	69.21 (30.46)		50.72 (22.78)	
	Achieving	70.89 (30.16)		60.20 (32.38)	
	Excelling	68.84 (28.04)		58.12 (21.65)	
Motivation & Confidence					
	Beginning	53.06 (24.88)	0.001	56.88 (27.27)	0.920
	Progressing	62.85 (24.55)		52.55 (23.45)	
	Achieving	75.67 (30.90)		54.65 (28.87)	
	Excelling	84.43 (32.89)		52.89 (24.90)	

Table 4
Objectively measured time spent in moderate to vigorous physical activity (minutes) by physical literacy categories (and components) among males and females 10 years of age

		Males (n=180) Mean (SD)	Significance *p*-value	Females (n=161) Mean (SD)	Significance *p*-value
Physical Literacy					
	Beginning	45.02 (31.15)	<0.001	36.47 (13.67)	<0.001
	Progressing	55.42 (25.03)		49.32 (16.69)	
	Achieving	69.41 (23.15)		63.03 (18.61)	
	Excelling	85.02 (23.25)		75.39 (26.27)	
Daily Behaviour					
	Beginning	41.71 (32.10)	<0.001	35.44 (12.39)	<0.001
	Progressing	56.48 (22.11)		51.82 (16.68)	
	Achieving	82.36 (24.99)		67.75 (18.61)	
	Excelling	103.62 (28.46)		84.84 (26.27)	
Physical Competence					
	Beginning	56.38 (32.67)	0.926	53.34 (23.58)	0.077
	Progressing	58.89 (28.40)		48.30 (17.93)	
	Achieving	59.92 (25.57)		51.37 (23.71)	
	Excelling	61.83 (21.11)		60.04 (21.81)	
Knowledge & Understanding					
	Beginning	61.94 (44.76)	0.924	50.89 (15.84)	0.843
	Progressing	59.14 (25.87)		49.76 (17.83)	
	Achieving	57.17 (28.04)		51.57 (25.26)	
	Excelling	57.13 (23.55)		53.56 (22.58)	
Motivation & Confidence					
	Beginning	58.91 (29.91)	<0.001	44.15 (20.43)	0.017
	Progressing	52.71 (24.01)		49.00 (18.50)	
	Achieving	75.91 (31.83)		54.81 (21.97)	
	Excelling	55.09 (22.90)		60.97 (21.27)	

Table 5
Objectively measured time spent in moderate to vigorous physical activity (minutes) by physical literacy categories (and components) among males and females 11 years of age

		Males (n=129) Mean (SD)	Significance *p*-value	Females (n=142) Mean (SD)	Significance *p*-value
Physical Literacy					
	Beginning	48.27 (35.44)	0.002	37.26 (75.87)	<0.001
	Progressing	46.87 (20.15)		45.60 (59.97)	
	Achieving	62.21 (28.97)		60.10 (68.64)	
	Excelling	72.85 (14.47)		58.46 (59.53)	
Daily Behaviour					
	Beginning	36.92 (13.88)	<0.001	32.44 (54.01)	<0.001
	Progressing	49.77 (23.47)		48.94 (64.95)	
	Achieving	84.12 (21.35)		63.55 (55.33)	
	Excelling	82.39 (21.34)		67.95 (40.29)	
Physical Competence					
	Beginning	49.52 (34.89)	0.762	41.01 (61.82)	0.439
	Progressing	52.36 (22.98)		48.00 (69.01)	
	Achieving	49.55 (24.09)		51.45 (64.81)	
	Excelling	57.52 (26.84)		49.53 (73.61)	
Knowledge & Understanding					
	Beginning	40.56 (16.81)	0.067	53.74 (90.52)	0.369
	Progressing	55.26 (28.33)		48.78 (60.77)	
	Achieving	56.02 (25.44)		42.11 (77.44)	
	Excelling	48.68 (19.12)		49.19 (62.08)	
Motivation & Confidence					
	Beginning	58.39 (38.81)	0.232	48.19 (79.48)	0.817
	Progressing	47.54 (23.10)		46.66 (57.84)	
	Achieving	51.45 (22.45)		50.08 (73.78)	
	Excelling	58.30 (21.61)		50.98 (70.63)	

Table 6

Objectively measured time spent in moderate to vigorous physical activity (minutes) by physical literacy categories (and components) among males and females 12 years of age

		Males (n=34) Mean (SD)	Significance *p*-value	Females (n=26) Mean (SD)	Significance *p*-value
Physical Literacy					
	Beginning	38.73 (20.99)	<0.001	43.38 (16.17)	0.116
	Progressing	58.21 (21.53)		42.15 (18.47)	
	Achieving	58.06 (8.90)		38.34 (11.03)	
	Excelling	111.70 (3.69)		64.04 (14.49)	
Daily Behaviour					
	Beginning	28.03 (16.86)	<0.001	43.27 (19.53)	0.118
	Progressing	57.98 (17.47)		40.05 (14.70)	
	Achieving	111.70 (3.69)		50.26 (14.92)	
	Excelling	N/A*		71.94 (N/A*)	
Physical Competence					
	Beginning	47.03 (17.36)	0.586	49.33 (22.53)	0.305
	Progressing	61.92 (31.66)		48.16 (16.82)	
	Achieving	56.54 (11.88)		28.82 (4.35)	
	Excelling	55.69 (9.15)		38.75 (16.23)	
Knowledge & Understanding					
	Beginning	42.99 (21.16)	0.302	36.57 (N/A*)	0.784
	Progressing	58.05 (23.04)		48.06 (18.25)	
	Achieving	64.41 (29.26)		39.47 (21.49)	
	Excelling	62.50 (22.37)		47.20 (15.83)	
Motivation & Confidence					
	Beginning	40.15 (17.67)	0.092	48.48 (34.57)	0.988
	Progressing	60.36 (23.05)		44.28 (17.39)	
	Achieving	68.89 (19.85)		43.88 (16.85)	
	Excelling	62.23 (35.15)		46.23 (20.06)	

Note. N/A signifies that at least one group has fewer than two cases.

Table 7
The correlation between objectively measured moderate to vigorous physical activity (via pedometers in minutes/days) and subjectively measured moderate to vigorous physical activity (via the Physical Activity Questionnaire in days) among males and females

	Pearson's r correlation
Males (n=546)	
8 years of age (n=56)	0.285*
9 years of age (n=147)	0.227**
10 years of age (n=180)	0.067
11 years of age (n=129)	0.071
12 years of age (n=34)	0.138
Females (n=513)	
8 years of age (n=39)	0.141
9 years of age (n=145)	-0.047
10 years of age (n=161)	0.205**
11 years of age (n=142)	-0.039
12 years of age (n=26)	0.28
Total participants (n=1059)	0.109*

Note. * Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level.

Table 8
Self- perceived (subjectively) measured moderate to vigorous physical activity score (via the Physical Activity Questionnaire, 0-3) with a generated new score (objectively) measured moderate to vigorous physical activity (via pedometers in minutes/days, 0-3) among males and females

	Self-Perceived Score M (SD)	New Score M (SD)	Significance *p*-value
Males (n=546)			
8 years of age (n=56)	2.09 (0.95)	2.13 (0.92)	0.816
9 years of age (n=147)	2.20 (0.96)	2.42 (0.78)	0.017
10 years of age (n=180)	2.30 (0.87)	2.13 (0.88)	0.055
11 years of age (n=129)	2.19 (0.89)	1.88 (0.89)	0.004
12 years of age (n=34)	2.26 (1.08)	2.15 (0.89)	0.600
Females (n=513)			
8 years of age (n=39)	2.15 (0.98)	1.51 (0.85)	0.002
9 years of age (n=145)	2.17 (0.86)	1.96 (0.93)	0.045
10 years of age (n=161)	2.09 (0.93)	1.94 (0.79)	0.100
11 years of age (n=142)	2.08 (0.86)	1.83 (0.91)	0.019
12 years of age (n=26)	2.50 (0.76)	1.73 (0.82)	0.003
Total participants (n=1059)	2.18 (0.91)	2.02(0.88)	<0.001

Table 9

The crosstabulation of the self-perceived (subjective) moderate to vigorous physical activity score (0-3) against the new (objective) moderate to vigorous physical activity score (0-3) among males and females 8 to 12 years of age

		New moderate to vigorous physical activity score				
	Score	0	1	2	3	Total
Self-perceived moderate to vigorous score	0	4	18	26	13	61
	1	10	51	66	51	178
	2	14	91	111	113	329
	3	17	114	156	204	491
Total		45	274	359	381	1059

CHAPTER 2

REVIEW OF LITERATURE

Among children, many benefits have been associated with physical activity such as improving overall health (Janssen & LeBlanc, 2010), decreased risk for cardiovascular and/or metabolic diseases (Hatfield & Chomitz, 2015), increased happiness (McPhie & Rawana, 2015; Richards et al., 2015), increased academic performance relating to performance at school (Domazet et al., 2016; Becker, McClelland, Loprinzi & Trost, 2014), and increased development of social skills (Hüttenmoser, 1995). Further, physical activity can prevent as well as reduce symptoms of depression among adolescents (Larun, Nordheim, Ekeland, Hagen, & Heian, 2006; McPhie & Rawana, 2015). Tremblay, Shields, Laviolette, Craig, Janssen, and Connor Gorber (2010), suggested that it has become clear that Canadian children are not meeting the physical activity guidelines (Tremblay et al., 2010). In fact, a report from Statistics Canada (2015), determined that girls aged 12 to 17 years were the least likely to achieve the recommended amount of physical activity (at 3%), whereas boys aged 5 to 11 age were most likely to meet the guidelines for moderate-to-vigorous physical activity (at only 18%). Furthermore, children and adolescents aged 12 to 17 were significantly more sedentary (9 hours and 16 minutes) and significantly less active (only 50 minutes of moderate to vigorous physical activity) than children aged 5 to 11 years (i.e., 7 hours and 38 minutes of sedentary behaviour and 67 minutes of moderate to vigorous physical activity; Statistics Canada, 2015). In order to provide a comprehensive background on physical activity in children, this review of literature will assess the current guidelines set by the Canadian Society for Exercise Physiology (CSEP), physical activity rates, sedentary behaviours, and physical literacy among Canadian children.

The Guidelines

In 1998, CSEP and Heath Canada released the original set of guidelines for physical activity for Canadians, entitled *Canada's Physical Activity Guide to Healthy Active Living*. The guide introduced four categories oriented towards physical activity, presented in the form of a rainbow, to Canadians (CSEP, 1998a). The guide presented an array of physical activity options for Canadians to become more physically active with information on how to get started; the categories included increasing flexibility, strength, and endurance, while aiming to decrease long sitting periods (CSEP, 1998b). *Canada's Physical Activity Guide to Healthy Active Living* was designed to introduce Canadians of all ages to different forms of physical activity ranging from activities that require very light to maximal effort while promoting assistance and encouragement for healthy living for the general public (Tremblay et al., 2011a). After the release of *Canada's Physical Activity Guide to Healthy Active Living,* Health Canada decided it was important to release separate guidelines oriented towards children, therefore, in 2002 a separate guide titled the *Canadian Physical Activity Guide for Children and Youth* was released (Health Canada & CSEP, 2002a, 2002b).

Approximately 10 years later, due to the alarming rate of comorbidities associated with overweight and obesity, CSEP (2011) developed a new set of guidelines with detailed information focusing on both physical activity and sedentary behaviours (Colley et al., 2011). With the decline of physical activity and fitness of Canadians within the past decades (Colley et al., 2011), CSEP developed and published the *Canadian Physical Activity Guidelines* (2012) to promote healthy active living in the Canadian population (Tremblay, Shephard, & Brawley, 2007). Specific to children and youth, the guidelines were divided into: the *Canadian Physical Activity Guidelines* and the *Canadian Sedentary Behaviour Guidelines*. CSEP, in collaboration with the Healthy Active Living and Obesity Research Group (HALO) and ParticipACTION, developed the guidelines with the goal of increasing physical activity and decreasing sedentary behaviour among the Canadian population (Tremblay et al., 2011a, 2011b). The *Canadian Physical Activity Guidelines* (2012) advocated that children aged 5 to 17 years should accumulate 60 minutes of daily moderate to vigorous physical activity (MVPA) and perform vigorous physical activities and muscle and bone strengthening activities for a minimum of 3 days/week. The *Canadian Sedentary Behaviour Guidelines* from CSEP (2012) suggested that children aged 5 to 17 years of age should limit recreational screen time to 2 hours a day and limit sitting for long periods.

More recently (June, 2016), the *Canadian 24-Hour Movement Guidelines* were released in order to instil the importance of understanding total movement behaviour within an entire day (Tremblay et al., 2016). The *Canadian 24–Hour Movement Guidelines* for children and youth encourage youth to *Sweat*, *Step*, *Sleep*, and *Sit* (CSEP, 2016). The *Canadian 24–Hour Movement Guidelines* for children and youth incorporate the previous guidelines of physical activity (60 minutes of MVPA) and sedentary behaviour (no more than sitting for 2 hours/day), as well as two new categories: steps and sleep (CSEP, 2016). According the *Canadian 24–Hour Movement Guidelines,* children aged 5-13 and 14-17 years should be receiving approximately 9 to 11 and 8 to 10 hours of uninterrupted sleep, respectively. Further, children are encouraged to take part in several hours of structured and unstructured activities of light physical activity in order to increase their step count, which should reach a minimum of 12,000 steps/day (CSEP, 2016a). As the various guidelines have been in effect for almost 20 years, it has been a useful tool to determine activity (or sedentary) behaviours in children and youth.

Physical Activity

Physical activity is crucial for the development of movement skills for children, which should promote a healthy active lifestyle that will carry out into adulthood (MacNamara, Collins & Giblin, 2015). However, in order to achieve an active lifestyle there are numerous factors involved in long lasting healthy behaviours (Francis et al., 2016). According to the Global Health Observatory data from the World Health Organization (WHO; 2016), children aged 11 to 17 years living among upper and middle class income countries, such as Canada, are more likely to attain the appropriate levels of physical activity due to the access of programmes available to the general public. With the many health benefits associated with physical activity, Canadian officials realize the importance of multiple levels of governments and nongovernmental funded built community environments developments (Trans Canada Trail, 2016), for the re-introduction of active outdoor play (Smith, Gardner, Aggio, & Hamer, 2015), to participate in organized sport (Canadian Fitness and Lifestyle Research Institute (CFLRI), 2015; Canadian Imperial Bank of Commerce (CIBC) & KidSport Report, 2014), as well as participation of school based activities including structured physical education (Opportunities for Physical Activity at School Survey (OPASS), 2015). Although, there may be numerous opportunities available in Canada, ~90% of Canadian children are not meeting the guidelines with regards to MVPA (Colley et al., 2011). Possible reasons can be due to socioeconomic status or funding for programs (CIBC & KidSport Report, 2014), internal desire for participation (Allison, 1999), and lack of familial or friend support (Gómez-López, Gallegos, & Extremera, 2010).

According to Warren et al., (2010) there are 2 types of methods for assessing physical activity, typically measured through energy expenditure. The first method for measuring physical activity, which is the most common form used among researchers is through self-reports in the forms of questionnaires, diaries, logs, and/or recalls (Warren et al., 2010). This method is cost effective, and can be used on a larger scale (James et al., 2016). However, this method poses many problems, including reliability and accuracy (James et al., 2016). Also, logs and diaries may capture more detailed and frequent physical activity behaviour than reports based on questionnaires, although studies have shown that logs tend to over-report higher intensity activities (James et al., 2016). The second method of measurement collection is through objective measures such as heart rate monitors, accelerometers, pedometers, motion sensors, direct observation, and/or through global positioning systems (GPS; Warren et al., 2010). This method allows for accurate assessment of each participant's location and speed. More specifically, accelerometery and pedometers provide information on the amount and intensity of physical activity (James et al, 2016). However, these tools are costly and may cause the researcher to rely on the self-report method (Warren et al., 2010).

Participation Rates. Through the measurement of accelorometry, Canadian research suggests, that males (13%) tend to be more active (i.e., reaching 60 minutes of daily MVPA) than females (6%; Colley et al., 2001; WHO, 2015; Statistics Canada, 2015). Similarly, the Canadian Health Measures Survey (CHMS; Statistics Canada, 2014) suggested that only 14% of children aged 5 to 11 years and 9% of children 5 to 17 years are active enough (i.e., as measured with accelerometers). Even with this alarmingly low rate, it has been reported that physical activity tends to decline with increasing age (Colley et al., 2011). Furthermore, children are spending 62% of their day participating in sedentary activities, such as playing video games and watching television (Tremblay et al., 2010). The CHMS reported that only 24% of children aged 5 to 17 years are meeting the Canadian sedentary guidelines (Statistic Canada, 2015). Therefore, it has become evident that Canadian children are not as active compared to the current recommendations.

Barriers. With all the opportunities available for children to engage in physical activity, the question arises as to why children are not meeting the *Canadian 24-hour Movement Guidelines* (CSEP, 2016). It is believed that there are some obstacles that may pose as direct barriers to engage in physical activity; such as parents being concerned for the safety and well-being for their children when it comes to participating in active outdoor play and active transportation (Tremblay et al., 2015). In addition, even though organized sport may be widely available throughout communities, sport has increasingly become costly for parents for enrollment and equipment costs (CIBC & KidSport, 2014) due to socioeconomic status. Finally, with limited funding available for physical education within the school boards, schools tend not to allocate resources for physical education specialists or enough time in the day to allow children to learn proper forms and skills to participate in sport and physical activities (CFLRI, 2015).

Another possible reason why children are not meeting the guidelines can be attributed to internal and external motives (Gómez-López, Gallegos, & Extremera, 2010); such as lack of time, lack of interest or enjoyment, lack of social support (including sibling support; Gómez-López, Gallegos, & Extremera, 2010), lack of motivation (Allison, 1999), not seeing the practicality or usefulness of physical activities in general, and finally having the belief that they are incapable of performing the physical activities (Sallis, Prochaska, & Taylor, 2000). Children and adolescents aged 3 to 18 years have reported that perceived competence, and intention to be active, may also play a role in the participation in physical activities and sport. Further, among university students, it has been reported that the main factor related to external barriers is associated with lack of time to devote to physical activities (Sallis et al., 2000). Lastly, some internal barriers consist of wanting to be inactive during their spare time and lack of support of family and friends (Gómez-López et al., 2010).

Motivation and confidence is essential in order to maintain engagement in physical activity, especially in children and adolescents (Litt, Iannostti, & Wang, 2011). There are numerous internal and external motivations, such as making new friends, becoming more physically fit, and/or having fun (Deci & Ryan, 1985; Lee, Nigg , DiClemente, & Courneya, 2001; Litt et al., 2011). According to Litt and colleagues (2011), adolescent males and females frequently report that having fun is a major reason for engaging in sports and other physical activities. The benefits assocatiated with physical activity extend far beyond physiology and includes psychological and social well-being that may carry through into adulthood (Litt et al., 2011). However, some barriers associated with internal and external motivations include barriers associated with body image and having an understanding of one's behaviours (Campbell, MacAuley, McCrum & Evans, 2001).

Active Play. While there may be no conclusive definition of active play (Luchs & Fikus, 2013), active play can be classified as an unstructured and/or unorganized activity for several hours a day, is generally moving at an intensity that is above resting and sedentary levels, and is being done freely and often without the direct guidance or supervision of adults (Working Group of the All-Party Parliamentary Group, 2015). Thus, play is considered fun, freely chosen, and personally directed physical activities, where the amount of energy expenditure differs across each of the activities listed above (Bergen, 2009). The Active Healthy Kids Canada Report Card (Active Healthy Kids Canada (AHKC), 2012) suggested that active play involves the pursuit of an activity with no defined outcome or purpose other than having fun. Furthermore, it was defined as learning opportunities associated to physical activity as a whole. Active play is thought to foster learning and development for children (Piaget, 2007), as well as improve children's creativity skills, motor functions, and conflict resolutions (Brockman, Fox, & Jago, 2011; Gray, 2011). Also, play is important for children's mental health as Gray (2011) reported that it stimulates children to (a) develop personal interests and competencies, (b) make decisions, solve problems, practice self-control, and follow rules, (c) learn how to manage their emotions, (d) create friendships and behaviour in a corporative manner, and (e) experience joy. It has been suggested that children engage in play for intrinsic reasons rather than to receive external rewards separate from the activity itself (Witherspoon & Manning, 2012). Some intrinsic goals include making friends, learning about their environment, and developing competencies at an activity (Gray, Prapavessis, & McGowan, 2009). Furthermore, active play can contribute to improved physical, emotional, social and cognitive development (Brussoni et al., 2015; Wolley & Lowe, 2013).

Outdoor play is also attributed to active play, where outdoor play occurs during a child's free time (Veitch, Salmon, and Ball, 2008). Overall, according to the Health Behaviour in School Aged Children Study (HBSC; 2013- 2014), 62% of children aged 11 to 15 years engage in more than or equal to one hour of outdoor active play; whereas 42% spent two or more hours; 25% at three or more hours; and 15% at four hours a day engaging in outdoor active play. Although, current rates suggest that Canadian children are increasingly participating in outdoor active play, research has demonstrated a consistent and significant decline in children's outdoor play dating back to 1955 (Gray, 2011). Over a 16-year period (1981-1997), American children (6-8 years) were surveyed to monitor how they spent their free time (Hofferth & Sandberg, 2001). Parents were instructed to keep records of their children's activities on random days selected by the researchers. The results demonstrated that children played less and had less opportunity for self-selected activities in 1997 than in 1981. More specifically, the researchers found that children decreased their play time (by 25%) and time spent communicating with others in their home (by 55%). On the other hand, children increased their time spent in school (by 18%), at home working on schoolwork (by 45%), and shopping with their parents (by 68%).

The decline in children's free play was further examined by Clements (2004) who compared free play experiences among children and their mothers (for when they were children). The findings indicated that the mothers reported playing outdoors significantly more often and for greater time lengths than their children; however, the retrospective nature of assessing play may not be the best methodology for assessing behaviours associated with play. The continual decline of children's play, especially outdoor play, is believed to be a consequence of over-protective and controlling parents (Gray, 2011). A study conducted by Inter IKEA Systems (2015) revealed that 51% of parents would prefer their children to play more outdoors (yet fear of their child's safety is stronger), whereas, 39% of parents prevent their children to play outdoors for fear of safety. Parents are concerned about their child being abducted or becoming a victim of youth violence (Mintz, 2011). Although, the Uniform Crime Reporting Survey from Statistics Canada (2016) reported that in Canada the child abduction rate is 27% lower in 2014 than in 2011, the rate of violence against children has risen 13% since 2011 due to children being lured via a computer. In the future, programs to increase parents' and caregivers' awareness and understanding of the benefits versus the risks of outdoor play should be implemented throughout local communities across Canada.

The Natural Environment. The built environment can include parks, playgrounds, sport facilities, infrastructure, and the natural environment (Wheeler, Cooper, Page, & Jago, 2010).

According to the CFLRI, municipal recreation departments are continuously working with federal, provincial, and several third party agencies to enhance policies and programming for physical activity in communities across Canada (CFLRI, 2015). Furthermore, the built environment can play a crucial role in promoting active behaviour (Tremblay et al., 2015) through access of trails, sidewalks, and bike lane paths (Trans Canada Trail, 2014). According to the Physical Activity Opportunities in Canadian Communities survey, 81% of municipalities across Canada have agreements with local school boards for use of facilities and resources and 88% have agreements with certain sport organizations and physical activity clubs for use of facilities and resources (CFLRI, 2015).

Through the use of greenspaces and built environments, children are more likely to adhere to active outdoor play (Wheeler et al., 2010) which is considered valuable play experiences for children (Herrington & Brussoni, 2015). The built environment initiative encourages children to participate in active play, for several hours a day, allowing children to develop essential movement skills, self–determination, and improve motor and physical skills (MacNamara et al, 2015). Côté and Hancock (2014) suggested that deliberate play promotes enjoyment for physical activity. Enjoyment for play is important because physical activity behaviours that occur during childhood are likely to continue into adulthood (Côté & Hancock, 2014). Interestingly, research has suggested that levels of physical activity are directly proportional to the amount of space devoted to open tree areas and playgrounds in their neighbourhoods resulting in an increase in free-time physical activity outside of school hours (Janssen & Rosu, 2015). That being said, children will play longer in natural playgrounds areas, such as open areas with movable equipment typically made of wood and ropes over playgrounds with structural equipment with swings, seesaws, and slides added (Luchs & Fikus, 2013).

Organized Sport. Organized sport is widely used across Canada as a means to maintain an active lifestyle among children, as children who participate in organized sport are more likely to achieve their daily MVPA recommendations (Marquesa, Ekelund & Sardinhaa, 2016). With frequent participation, physical activity behaviours will carry out into adulthood (Bélanger et al., 2015). Social support from family and peers is essential for continuous participation in sport (Hebert, Møller, Andersen & Wedderkopp, 2015; Johnson, Kubik & McMorris, 2011). Sport can foster the development of motor skills and communication skills (CIBC & KidsSport, 2014), as well as teach the importance of having fun, building team play, behaving in sportsmanship like behaviour, and learning how to succeed and fail (Côté & Hancock, 2016; CIBC & KidsSport, 2014). Participation in sport is also a great indicator of higher self-confidence and mental health into adulthood (Jewett et al., 2014). According to the CANPLAY study, 77% of Canadian children aged 5 to 19 years of age participate in some form of organized sports and physical activities (CFLRI, 2015).

With the high rate of Canadian children participating in some form of organized sport (77%; CFLRI, 2015), there is a strong belief that children will achieve the recommended physical activity guidelines through sport. However, research suggests that children only reach approximately 20 minutes of the recommended MVPA, which equates to achieving one third of the physical activity guidelines from a one-hour organized sport session (Sacheck, Nelson, Ficker, Kafka, Kuder J, & Economos, 2011; Guagliano, Rosenkranz, Kolt, 2013). The reason behind the lack of time spent in MVPA during organized sport can be attributed to time spent in activities associated in light physical activities such as learning a skill or in sedentary behaviour such as listening to their coach or waiting for their turn to practice the drills and skills (Sacheck et al., 2011). Other factors associated to less time spent in MVPA can be attributed to actual playing time during practice and game day, teaching and coaching methods applied, as well as the position the child may hold on a team (Wickel & Eisenmann, 2007). In fact, in a recent research study conducted by Van Den Berg and Kolen (2015), found that children who had participated in a regularly scheduled ice hockey practice for a duration of 70 minutes, had only engaged in moderate physical activity for 43.1% of the total time, which amounts to approximately 30.2 ± 10.8 minutes. Further, they spent 50.1% (35.1 ± 9.1 minutes) of time participating in light activities and 7.4% (5.2 ± 2.8 minutes) in sedentary behaviour. Within this same sample, games (80 minutes in duration) resulted in even lower amounts of moderate physical activity (27.4%; 21.9 ±6.3 minutes), light physical activity (41.6%; 33.3 ± 12.9 minutes), and more time spent being sedentary (29.7%; 23.7 ± 10.6 minutes) (Van Den Berg & Kolen 2015).

Although organized sport may appear to be a the ideal area for children to initiate in physical activity (CFLRI, 2015; Dunn, Dorsch, King, & Rothlisberger, 2016), except for the actual duration of MVPA, parental pressure may also play a significant role in the child's enjoyment for the sport as well as the commitment to continue within the sport (Dunn et al, 2016). Furthermore, intrapersonal beliefs, including knowledge, skills, and age, are attributed to the decline of participation in sport mainly within the transition from elementary school to secondary school as the competitive nature, and/or bullying behaviour, of sports takes over (Basterfield et al., 2016). Moreover, Canadian parents of children (9 and 12 years) have reported that competing demands, such as money, travel, equipment and competeviness, as well as time are key elements in participation rates (CFLRI, 2013).

Schools. With children spending approximately 8 to 9 hours at school, it is ideal for schools to incorporate physical activities throughout the school day (Castelli, Centeio, &

Nicksic, 2013). It has been suggested that the physical education program should be the foundation of physical activity yet movement can also be extended throughout activities during the entire school day (Castelli et al., 2013). There is evidence to suggest that physical activity and physical fitness can enhance cognitive performance (Hillman et al., 2009; Lees & Hopkins, 2013). Yet, testing for knowledge and understanding for physical activity are not taken into consideration when children reach the grades integral for proper development (Hillman et al., 2009). In Ontario, when children reach the grades of 3, 6, 9 and 10, they must undergo provincial testing from the Education Quality and Accountability Office (EQAO) that test for reading, writing, and mathematics (EQAO, 2015a) and not physical education. Based on the EQAO provincial testing, the Ontario curriculum is designed to allow children to succeed at the greatest level (EQAO, 2015b). However, with the increased demands for classes/schools to succeed, more class time gets allocated to learning literacy and developing mathematics skills compared to other subjects (Patton, 2012).

According to the OPASS (2015) in Canada, school boards and ministries indicated that 73% of schools provided various forms of physical activities for students, which include physical education and recess. Similarly, 69% of school boards have mandated a policy for daily physical education for all students; whereas 62% of school boards and ministries have university graduated teachers with the proper education to teach and implement physical activity; 59% make funds available for physical activity and sport equipment; and 25% of school boards ensure opportunities for children to part take in active transportation throughout the school year (e.g., such as bike racks; CFLRI, 2015). Hatfield and Chomitz (2015) recommend that in order to increase physical activity throughout the school day, school boards and educators should take into consideration of three important factors including (1) implementation of policies aimed toward building quality physical education, (2) taking into consideration student factors, such as prior physical activity experience, age, gender, and/or ethnicity, and (3) incorporating involvement of familial/parental factors.

In 2015, the Ontario Ministry of Education implemented policy No. 138 entitled Daily Physical Activity (DPA) to all elementary schools in Ontario (Policy/Program Memorandum (PPM) No. 138; Ontario Ministry of Education, 2005). The DPA policy requires schools to provide all children (including those with special needs) in grades 1 to 8, with opportunities to participate in a minimum of twenty minutes of daily MVPA during instructional class time (Policy/Program Memorandum No. 138, para. 4, 2005). While limited evidence exists as to the success/failure of DPA, Patton (2012) reported that 64% of 145 teachers surveyed in London, Ontario suggested that their administrators rarely or never monitored classroom DPA. Possible contributors to the lack of PPM 138 could be time availability throughout the school day or lack of leadership (Ontario Ministry of Education, 2005). Under all education policies, there needs to be procedures implemented in order to ensure schools are indeed abiding to the policy (Olstad, Campbell, Raine, & Nykiforuk, 2015). Furthermore, it was concluded that due to the Ontario education policy that requires secondary students to complete only one physical education credit for graduation, there is a large amount of students that do not part take in physical education after the initial credit is obtained (Hobin, Leatherdale, Manske, Burkhalter, & Woodruff, 2010). As Hobin and colleagues (2010) reported, secondary school students who take physical education tend to be: male, in a younger grade, be a non-smoker, have stronger parental support, have more active friends, have a lower body mass index (BMI), have higher physical activity levels, and be less sedentary. However, it has been suggested that enrollment for physical education at the secondary level, is directly related to the amount of time the elementary school has provided for daily physical education occurring five days a week (Hobin et al., 2010).

Sedentary Behaviour

Sedentary Behaviour Rates in Canadian Children

Contrary to the belief, sedentary behaviour is not solely related to physical inactivity; rather it is associated with low energy expenditure throughout the day that takes place while being seated for long periods of time or placed in a reclining posture (Sedentary Behaviour Research Network, 2012). Related to children, some examples include, watching television, reading books, playing video games, using a computer to browse the internet or watching videos, using social media websites, and doing homework on a computer (including readings online and completed assignments) (Tremblay et al., 2011). Furthermore, sedentary lifestyles in children are associated with negative outcomes that are associated to physiological health which include overall physical fitness (Tremblay et al., 2011), cognitive development (Carson et al., 2015), mental health (Jewett et al., 2014), and obesity (Tremblay et al., 2011). In fact, 76% of children aged 5 to 19 years in Canada have reported that watching television, playing computer or video games, or reading books are primary afterschool activities (CFLRI, 2015). Furthermore, while a child is at school, they spend most of their time seated for periods of time, such as sitting in class listening to the teacher, doing homework, and traveling to/from school in a vehicle (Larouche, Saunders, Faulkner, Colley, & Tremblay, 2014). Currently, only 24% of Canadian children aged 5 to 17 years meet the sedentary behaviour recommendations in the *Canadian 24-Hour Movement Guidelines for Children and Youth* (Statistics Canada, 2014).

Sedentary Behaviour and Health Outcomes

The sedentary behaviour rates among children in Canada is particularly disconcerting for children because, although a child may be physically fit (and/or meeting the current physical activity guidelines), being sedentary still poses a threat for developing cardiometabolic diseases such as coronary heart disease or type II diabetes (Stierlin et al., 2015). A four year longitudinal study that measured fat mass, lean mass, bone mass, height, weight, activity rates, and diet among children aged 3 to 7 years of age, concluded that spending more than two hours a day of watching television/computer use was associated with decreased musculoskeletal fitness (Wosje et al., 2009). Additionally, an increased time spent being sedentary was associated with decreased physical fitness (Albarwani, Al-Hashmi, Al-Abri, Jaju, & Hassan, 2009; Dollman & Ridley, 2006) including VO_2 max (Albarwani et al., 2009).

It has been suggested that there is a relationship between sedentary activity and overweight/obesity status among children (Salmon, Dunstan, & Owen, 2008). However, a recent comparison of normal-weight and obese children and youth in Canada found no differences in sedentary time (Adamo, Colley, Hadjiyannakis, & Goldfield, 2015). Further, participants within the Built Environment and Active Transport project, which measured physical activity and sedentary behaviour using accelerometers, spent on average 630 minutes/day in sedentary behaviours and 69 minutes/day in MVPA, where sedentary behaviour time was not associated with BMI scores (Carson, Stone, & Faulkner, 2014). Therefore, mixed results with weight status suggests that there is great importance to target all children for sedentary behaviour interventions.

Is Sleep a Contributor? Perhaps the most sedentary of activities is sleep. Sleep is a new component associated with the *Canadian 24- Hour Movement Guidelines*, as it plays a crucial role in healthy development among children (Gruber et al., 2014) in order to foster a healthy active lifestyle. Particularly, the total amount of sleep has been associated with the overall sedentary behaviour time (Gomes et al., 2014; McNeil et al., 2015). According to the HBSC study (2013-2014), only 68% of children aged 10 to 13 years in Canada meet the sleep recommendations for school-aged children. Children who slept less than 9 hours per night had greater sedentary time than children who slept 9 to 11 hours per night (McNeil et al., 2015). Additionally, according to the CHMS (Statistics Canada, 2014), 33% of children aged 5 to 13 years in Canada have difficulty going to sleep or staying asleep at least some of the time (Statistics Canada, 2014). Recent data suggested that insufficient sleep can reduce physical activity levels (Schmid et al., 2009), thereby increasing the amount of screen time in children (Chaput, 2016). The findings suggest that children are then too tired to participate in physical activity and organized sport (Schmid et al., 2009) creating a vicious cycle. Children and adolescents sleep less now compared to children and youth in the past (Matricciani, Olds, & Petkov, 2012). Sleep rates recorded among this age group is alarming because chronic sleep deprivation poses a serious threat to academic success, and the overall health and well-being that is attributed to becoming physically fit (Gruber et al., 2014). Sleep offers numerous benefits and is an essential component of healthy development for physical and mental health. Ideally, families should place more emphasis to ensure sleep is taken more seriously and developing a household bedtime system with consistent wake up and bed times during the entire week (including weekends), in order to further prevent children from attaining sleep deprivation.

Physical Literacy

What is Physical Literacy and How to Define it?

Physical and Health Education Canada (PHE Canada) suggests that physical literacy is the means to attain an active lifestyle (PHE Canada, 2014). Physical literacy is a term that has been coined as the motivation and confidence that are associated with physical competence, knowledge, and understanding of physical activity throughout a lifetime (Whitehead, 2010). It has been argued that physical competence is related to motor skills, however, fitness and fundamental movement skills in conjunction with physical activity behaviour are important building blocks associated with physical literacy (Tremblay & Lloyd, 2010). A physically literate person can perform a variety of movements confidently, competently, creatively, and strategically across a wide range of health-related physical activities (Longmuir et al., 2015). As opposed to simply being physically active, physical literacy can be viewed as a broader term that encompasses the desire and commitment of a healthy and active lifestyle, as well as attaining the necessary characteristics, skills, and behaviour outcomes attributed to physical activity (Francis et al., 2016).

According to Lloyd, Colley, and Tremblay (2010), there are four pillars associated with physical literacy: physical fitness, motor behaviour, physical activity behaviours, and psycho-social/cognitive factors. Further, physical activity behaviours, development of fundamental motor skills, and attitudes and understanding are essential to the physical development and health and well-being of children (Lloyd et al., 2010). Physical literacy is currently gaining greater insight as a part of the necessary tools for teaching and encouraging children to have the desire to participate in physical activities and organized sport (Tremblay & Lloyd, 2010; Francis et al., 2016; Cardinal, 2014). Teaching and encouraging children are important because children have a perception of their individual abilities that fosters self-determination within to allow them to deliberately continue their involvement in lifelong physical activity (MacNamara et al., 2015).

How to Measure Physical Literacy?

To assess and understand the concept of physical literacy and its capacity to develop fundamental movement skills among children (Tremblay & Lloyd, 2010), programs and tools have been developed to assess and measure physical literacy in Canadian children (PHE Canada, 2014). Educators, parents, and coaches can use physical literacy information to help monitor current physical literacy among children (Francis et al., 2016), gain further insight into physical movement skills that can be translated into everyday activities (Tremblay & Lloyd, 2010), and while understanding the mechanics of physical literacy, encourage children to maintain a healthy lifestyle into adulthood (Smith et al., 2015).

In Canada, there are predominantly four known tools that have been developed in order to measure and assess physical literacy among children (PHE Canada, 2014). These physical literacy tools include the *Passport for Life* developed by PHE Canada (2013a), *the Physical Literacy Assessment for Youth* (PLAY) tools developed by the Canadian Sport for Life (2016b), the *Fundamental Movement Skills Assessment Tool* developed by the 60 Minute Kids' Club (2015), and the Canadian Assessment of Physical Literacy (CAPL) developed by the Children's Hospital of Eastern Ontario (CHEO; HALO, 2016b). Originally, the Passport for Life and Fundamental Movement Skills Assessment Tool was developed with intentions of providing the general public with basic tools that enable educators, coaches, parents, and children to assess physical literacy for daily usage (PHE Canada, 2014). The Passport for Life and the Fundamental Movement Skills Assessment Tool were developed for non research purposes and for the use of individual needs for parents and educators in order to improve knowledge, understanding, and participation in physical literacy. Whereas, the PLAY and CAPL tools were developed to assess physical literacy in communities across the nation and on a larger scale to expand research in programs and sports across the country (PHE Canada, 2014). The PLAY and CAPL tool are research tools developed with the intention of gathering research data on a larger scale in order to assess physical literacy in children in Canada. Subsequently, each tool differentiates from one another and individually serves its own purpose depending on the needs of the user and/or population (coach, parent, teacher, and researcher; PHE Canada, 2014). Each tool was created for the promotion and usage through researchers, educators, coaches, and parents, with a common purpose to bring awareness of physical literacy to the general public through the school system (O'Sullivan, 2013). Physical literacy is a key component in encouraging children to lead and maintain an active lifestyle through motivation, confidence, knowledge, and understanding of movement skills (Francis et al., 2016). Dr. Kriellaars is a leading expert in physical literacy, and believes that promotion of physical literacy has become ineffective (Canadian Sport for Life Society, 2016a) because rates of physical activity remain low, with a low percentage of Canadian children reaching the recommended 60 minutes of daily MVPA. He further argues that the average child spends at least six hours a day in front of the screen (The Canadian Sport for Life Society, 2016a). Dr. Kriellaars is an advocate for the physical literacy movement in Canada and hopes to create a culture where Canada takes action towards building a healthy active lifestyle approach to daily living (The Canadian Sport for Life Society, 2016a). Implementation and application of physical literacy is crucial in order to understand where Canadian children stand on the national scale (Francis et al., 2016) in order to identify which areas of physical literacy need improvement.

Physical literacy is a relatively new term and only recently gained traction among clinicians, practitioners, and researchers, and limited research exists (Longmuir & Tremblay, 2016). Using the CAPL tool, HALO reported that 44% of 5,700 Canadian children (8-12 years of age) were physically literate (ParticipACTION, 2016). Within each domain, 28%, 44%, 37%, and 62% of children met the minimum requirements for physical competence, daily behaviour, motivation and confidence, and knowledge and understanding, respectively, with boys (47%) more physically literate than girls (41%; ParticipACTION, 2016).

Passport for Life. The Passport for Life assessment tool is currently available for students in grades 3 to 12. It was originally developed with the purpose of emulating the four pillars of physical literacy into physical education classes (via curriculum materials) with the teachers as the facilitators to improve physical literacy rates in children (PHE Canada, 2013). As was previously mentioned, this physical literacy tool was not been created to collect research on current rates of physical literacy in Canada, but rather with the intent of increasing awareness and rates of physical literacy for individual purposes (i.e., personal growth, educational use; PHE Canada, 2013). The Passport for Life is comprised of four components associated with the tool: active participation, living skills, fitness skills, and movement skills (PHE Canada, 2017a). The active participation component allows for children to think about their physical activity behaviours through involvement in activities at school and at home, whether it be in a organized and/or unorganized form. The living skills portion evaluates the decisions children make in order to sustain healthy active choices beneficial to themselves, others and the environment they live in. The fitness skills include the assessment for balance, muscle endurance and cardiovascular fitness. Whereas, movement skills evaluate a child’s ability for throwing, jumping, and running which are the building blocks to develop complex skills which can be translated in games, activities, sports and other leisure pursuits (PHE Canada, 2017b). The active participation and living skills assessments of the tool is assessed through an online questionnaire filled out by the student, whereas, the fitness and movement skills are assessed through the teacher during physical education class (PHE Canada, 2013). Cardiovascular endurance, core strength, and dynamic balance are assessed to establish the physical fitness component. The Passport for Life measures fitness skills through activities related cardiovascular tasks, such as a four-station circuit that provides a sustained sub-maximal exertion workout. Dynamic balance is assessed using a lateral bound movement, where dynamic balance has been incorporated for the greater chance for skills to apply and transfer into everyday activities such as walking, running, climbing, to real world activities. Finally, core or trunk strength is assessed by performing a front plank. Each of the components addressed are measured using the provided four-point criterion-based rubric (PHE Canada, 2014). With the Passport for Life tools, movement skills are assessed through locomotor skill testing, upper limb movement, and lower limb movement. Locomotor skills can be defined as running, jumping, hopping, skipping, etc., and children are assessed by performing a running task which consists of the child having to run from a mark position to the indicated area (running from point A to point B). While the child is running toward the end position, he or she must successfully change direction once they arrive at the second indicated point and run back to the start position. This task assesses the ability to accelerate and decelerate with appropriate timing, the ability to control movement within a set space, as well as the ability to change direction are all important factors associated with physical literacy. Upper limb movement is assessed through object control and manipulation task (i.e., children must throw a ball) and lower limb movement is assessed through performing two forms of kicking (PHE Canada, 2014).

According to PHE Canada (2014), Passport for Life is used for gathering information that will motivate children to become more physically active, and guide teachers to utilize resources in their community for improving goals towards health and physical fitness. No score is given to the student/parent, as the objective is to provide a target for the future where feedback can be used by the students/parents as a means to improve their skills for physical literacy. The Passport for Life tool was developed to reduce discouragement from physical inactivity and introduce an active lifestyle through goal setting (PHE Canada, 2013a).

Passport for Life has launched a pilot initiative for elementary schools (kindergarten to grade 3) across Canada (PHE Canada, 2013c). This program ran from October 2016 to May 2017, with the intent of increasing lifelong participation in physical activity and sport (PHE Canada, 2013c). As it was previously discussed, the Passport for Life assessment tool was designed for the incorporation of physical literacy within the school environment, where it targets educators to evaluate students' current state and progression with physical literacy (PHE Canada, 2013b). Further, the intentions for Passport for Life are to allow teachers to gain competency through a formative online survey assessment of student's physical literacy as a means to stimulate and maintain growth and learning (through criteria under active participation, living skills, fitness skills, and movement skills; Canadian Sport for Life Society, 2016b; PHE Canada, 2015). Most importantly, the four categories used to evaluate a child's physical literacy competency (active participation, living skills, fitness skills, and movement skills), are widely used to further develop the physical education curriculum (Giblin, Collins, & Button, 2014) where physical education is deemed as integral to influencing stronger national standards relating to public health (Sallis et al., 2012). In order to fully comprehend physical literacy, physical education is deemed as a primary source for interventions in order for children to gain motor skill development (Castelli, Centeio, Beighle, Carson, & Nicksic, 2014), granted that physical education is provided by a physical education specialist (OPASS, 2015). In fact, the Ministry of Education in Ontario has launched a new health and physical education curriculum that incorporates the fundamentals of physical literacy with the goal of attaining physically literate students (Ontario Ministry of Education, 2015). Using school as a means to encourage physical activity is a great opportunity for educators to take advantage of and would allow children to achieve maximal MVPA (Erwin, Beighle, Morgan, & Noland, 2011). Ideally, the Passport for Life tool was designed for educators to implement throughout the school day, where numerous physical activity opportunities arise (Castelli et al., 2014) in the course of structured activities (e.g., physical education, classroom time, and school assemblies oriented towards physical activity), and unstructured opportunities (e.g., field trips and recess). However, there is no governing body in place to ensure that schools implement physical activies throughout the day (Ontario Ministry of Education, 2005).

Fundamental Movement Skills Assessment Tool. The Fundamental Movement Skills Assessment Tool was designed with parents, educators, coaches, and the overall general public in mind (i.e., easy usage for individuals with no prior knowledge or experience of movement skills), with the objective to empower families with the knowledge and skills to live a healthy and active lifestyle, and be positive role models for their children and community (Info for parents, n.d.). The Fundamental Movement Skills Assessment tool can easily be used by a parent or the public. The Fundamental Movement Skills Assessment Tool was developed with the intent for the lay person (i.e. parents, coaches, and educators) to have access to the necessary physical literacy tool should they wish to assess physical literacy at a smaller scale (i.e. not for research purposes) and to assess a child's motor competence (Physical Literacy Assessment in Canada, 2014). The 60 Minute Kids Club, along with Active for Life and the Heart and Stroke Foundation, have created a series of short, simple videos that identify and demonstrate the mechanics of a select number of fundamental movement skills portrayed through the assessment tool. The tool uses visual comparisons of four different levels of performance for each skill:

emerging, developing, acquired, and accomplished (Physical Literacy Assessment in Canada, 2014). The assessor determines which video matches the current performance of the child and places the corresponding identification in the chart (Physical Literacy Assessment in Canada, 2014). The purpose of using this tool is to provide background of a child's motor and physical competence of physical literacy while increasing the motivation for children to engage in physical activity (PHE Canada, 2014). A document is provided with each fundamental movement skill video, which explains each skill and provides games and activities for developing the skill. The assessment is completed through guided learning and visual comparison, where a video is presented with a model performing 15 movements, which include executing throwing, catching and kicking a ball. Once the fundamental movement skill has been demonstrated, the child must then mirror the movements as correctly as possible (PHE Canada, 2014). In-person demonstrations for the participant can also be provided through physical education teachers, making this a suitable tool for the use with the general public. This tool focuses on encouraging healthy habits and physical literacy into children's lifestyles (Tremblay, Prince, Ham & Barnes, 2016).

There are four levels (i.e., emerging, developing, acquired, and accomplished) of performances available for each movement skill and the examiner must indicate on the chart provided which level the child matched (PHE Canada, 2014). The results are used for informational purposes and introduce awareness and activation for physical literacy (60 Minute Kids Club, 2014).

In order to obtain the Fundamental Movement Skills Assessment Tool, schools and educators are challenged through the community and neighbouring schools. Once the Fundamental Movement Skills Assessment Tool is provided to a given school, there are three, 30 day challenges that occur throughout the school year and the entire school is encouraged to participate. School participation is dependent upon selected school champions (i.e., students) that are nominated, where the champions are responsible to launch the program and introduce the necessary tools provided. When the 60 day challenge is complete, schools receive a percentage of participation rates and total physical literacy score reports (60 Minute Kids Club, 2014). The children that participate are given incentives for their participation and the top school receives a grand prize. In order to become eligible to win the grand prize, the schools must participate in all three challenges (Fall, Winter, and Spring) throughout the school year (60 Minute Kids Club, 2014).

The Fundamental Movement Skills Assessment Tool by the 60 Minute Kids Club was initially launched in 2010, with a participation rate of 13 schools from British Columbia, Ontario, and Nova Scotia. More recently, the 2015-2016 school year has generated a participation rate of 81,500 students, with 326 schools involved in nine provinces in the 60 Minute Kids Club school-wide program, with an average participation rate of 87.6% within the school level (Canadian Sport for Life, 2016).

Physical Literacy Assessment for Youth (PLAY). PLAY was developed for research purposes, with the goal of expanding the current state of physical literacy among the population and to provide a means of increasing knowledge and understanding in communities (Canadian Sport for Life Society, 2016b). PLAY was designed for children seven years of age and above (Canadian Sport for Life Society, 2016b). There are six PLAY tools used for assessment (PLAYbasic, PLAYcoach, PLAYfun, PLAYinventory, PLAYparent, and PLAYself), where each tool is directed for building towards movement vocabulary, competence, confidence, and comprehension through the specified facilitators indicated above (Canadian Sport for Life

Society, 2016). The PLAYfun tool is most commonly used where the children must perform running, locomotor, object control for upper body and lower body, balance, stability, and body control (Canadian Sport for Life Society, 2014b). Scores are calculated based on performance and can be used for further research (Canadian Sport for Life Society, 2016c).

The Canadian Sport for Life Society and the Centre for Healthy Development through Sport and Physical Activity (CHDSPA) at Brock University have joined in partnership with the intention of using the PLAY tools (Brock University, 2014) to monitor levels of physical literacy among children and youth aged 7 to 17 years (Brock University, 2014). The PLAY tools were developed for children and youth to become more physically literate in the sport, recreation and health sectors (Canadian Sport for Life, 2016b), and to increase opportunities and participation in physical activity in Canada. Lead investigators for the youth physical literacy assessment project at Brock University (2014), Mandigo and Lodewyk, will evaluate the overall efficiency of the PLAY tools currently in use under coaches, recreation leaders, and other community practitioners. The youth physical literacy assessment project will also entail creating a database of over 3000 children between the ages of 7 and 17 years, evaluated under the PLAY tools in various communities throughout Ontario.

Canadian Assessment of Physical Literacy (CAPL). The CAPL is an assessment tool that was designed for research with a goal to augment physical literacy among Canadian children (HALO, 2016a). This comprehensive tool assesses and monitors fitness, physical activity behaviour, knowledge, and motor skills in children ages 8-12 years of age (Francis et al., 2016). The four pillars of physical literacy are assessed through the following activities: direct assessment of daily behaviour (via pedometers), a Canadian agility and movement skill assessment (CAMSA), an aerobic fitness FitnessGram 15/20 meter progressive aerobic cardiovascular endurance run (PACER), body composition (i.e., height, weight, and waist circumference (WC)), musculoskeletal fitness (i.e., grip strength, plank assessment for torso strength, and sit and reach for flexibility strength), and completion of a questionnaire (HALO, 2016b). Scores are gathered collectively by trained examiners and interpreted with feedback provided to parents (Francis et al., 2016).

Under the CAPL protocols, children are assessed within four domains identified as daily behaviour (DB), physical competence (PC), motivation and confidence (MC), and knowledge and understanding (KU). Within each of these domains, children are rated as beginning, progressing, achieving, and excelling and an overall physical literacy score (out of 100) is calculated (Longmuir et al, 2015). The beginning phase indicates that the child is beginning to develop physical literacy skills, however is not meeting the recommended physical literacy requirements; the progressing stage indicates that the child is progressing on the physical literacy journey and is performing at a level similar to peers, and not meeting the physical literacy requirements; the achieving phase indicates the child is achieving recommended scores indicative of the physical literacy needed to obtain health benefits from a physically active lifestyle; while the excelling phase indicates that the child is exceeding recommended physical literacy levels associated with physical activity health benefits (Longmuir et al, 2015). The CAPL has been deemed appropriate and relevant in terms of reliability and validity through a Delphi process with experts and leaders in the field (Francis et al., 2016) and through a cross-sectional sample of children attending local schools in Eastern Ontario, Canada (Longmuir et al., 2015).

Similar to the various physical literacy tools available in Canada previously discussed, the CAPL tool was designed to monitor and address physical literacy levels, as well as develop a program that has an objective instrument encompassing comprehensive, valid, and reliable measures for Canadian children in grades 4 to 6 (Francis et al., 2016). A recently released study of 9-11 year olds from Ottawa, Ontario indicated that physical literacy, as assessed using the CAPL, was positively correlated with time spent outdoors on weekends and active transportation to/from school (Lizotte et al., 2016). At present, a national research study is currently undergoing, to capture physical literacy rates among ~10,000 children across 7 provinces. This will be the largest dataset of information collected within Canada and will eventually form a database to which smaller scale studies can be compared.

A Comparison of Physical Literacy Tools

With regards to the four physical literacy tools available in Canada, there are many advantages and disadvantages associated with each tool. First, the Passport for Life and The Fundamental Movement Skills Assessment Tool are tools that are easily accessible to the general public through websites with user friendly instructional videos provided. The tools have been developed comprehensively and can be performed and analyzed for all individuals such as parents, teachers, and coaches (PHE Canada, 2015; Canadian Sport for Life Society, 2014a). Furthermore, both tools are inexpensive and require minimal or no training involved to perform the assessment, in addition to being developed for small scale samples, such as within schools, community/individual sport teams, and/or interested parents. However, when considering the application of the four physical literacy tools stated above, there has been no conclusive research oriented in verifying its function and ability to properly address the aspects of physical literacy (including knowledge and understanding for movement skills and/or motivation and confidence).

The PLAY and CAPL assessment tools were designed to assess physical literacy on a large scale as a primary means and to collect research on the status of physical literacy among

Canadian children. Additionally, the PLAY and CAPL tools were designed to ensure that physical literacy rates were collected through objective measures, to create comparisons across individuals and groups and track sedentary and physical activity behaviours. Training is provided for all testers and investigators to ensure consistency across data collections (Brock University, 2014; Longmuir et al., 2015). Additional equipment is necessary (e.g., pylons, scales, hoops) in order to measure physical literacy using PLAY and CAPL (Canadian Sport for Life Society, 2016c; Longmuir et al., 2015). Both assessment tools use subjective evaluations under certain testing sessions, however, the CAPL tool uses more objective measurements in the protocols (Longmuir et al., 2015). In comparison, the PLAY tools are judged based on the qualifications of the tester; for instance, for an assessment using PLAYfun which assesses key movement skills, the investigator makes a judgement of what proper form should be considered (Canadian Sport for Life Society, 2014b).

The CAPL protocol is currently being used across Canada for research to monitor physical literacy rates among children across Canada (Longmuir et al, 2015), making the CAPL protocol an ideal physical literacy tool to use for future studies. Other tools such as the Passport for Life, the Fundamental Movement Skills Assessment Tool, and the PLAY are beginning to gain traction as physical literacy assessment tools across the world (Canadian Sport for Life, 2016; Aspen Institute, 2015). The CAPL, the Passport for Life, the Fundamental Movement Skills Assessment Tool, and the PLAY programs and tools are successful, were developed based on research, and vary on objectivity or subjectivity measures when assessing physical literacy. In general, sectors involved in physical activity, organized sport, and within the health promotion field with children and youth should work in unity to promote and assess physical literacy among all Canadian children.

Generally, the CAPL seems to be a superior assessment tool in comparison to the others for many reasons. Firstly, CAPL is more objective than the other tools. Training is required by those that implement the CAPL to ensure reliable and valid data collection. To ensure consistency, HALO (2014), provides an extensive and comprehensive user friendly training manual with accompanying training videos for each protocol assessment. Opposingly, those using the PLAY tool are provided with training, however testers are told to use personal judgement to assess whether the participants are performing the assessment correctly.The Canadian Sport for Life (2014a), provides a *PLAYfun* workbook with a basic description of what to look for during the assessment. For the evaluation of a skill, the tester is informed to imagine how an expert athlete would perform said skill and rate the skill on a scale of 0 to 100, a rather large range which is open to interpretation.

Furthermore, the assessment for physical literacy in the CAPL tool is represented under four components; DB, PC, MC and KU. Through the CAPL tool, these components are referred to as the four domains of physical literacy. In comparison to the Passport for Life, the Fundamentals Movement Assessment Tool, and the PLAY tools, the CAPL's components not only assess physical activity and sedentary behaviours, but knowledge and motivation regarding participation in physical activity/sedentary behaviours and safety skills practiced during an activity. Whereas, other programs and tools emphasize the evaluation of physical abilities and fitness. Further, under CAPL, the PC domain evaluates the ability for a child to engage in physical activity, incorporating physical fitness and motor performance, which evaluates a child's ability to make the necessary transitions between specific movements under one test. For example, through the CAMSA, the children take part into an obstacle course which forces the participant to have to transition from various skills throughout the test (e.g., jumping, shuffling, catching, throwing, skipping, hopping and kicking together). The CAMSA recognizes the importance of mimicking the motor skills essential for the participation in physical activities (including organized and unorganized) in different environments (e.g. on land, on ice and snow, in water and in air) and with physically active peer play that requires skill variation and stimulates typical movement patterns (HALO, 2016a). Therefore, with CAMSA, the children must participate in a sequence of discrete movements. Meanwhile, the PLAY tool assesses 18 individual discrete movement skills (divided into five subsections; running, locomotor, object control – upper body, object control – lower body, balance, stability & body control) separately to evaluate physical literacy. Also, the Passport for Life and the Fundamental Movement Skills Assessment Tool highlight the importance for physical ability and the development of physical fitness through discrete movement skills. Additionally, each time the CAPL protocol is used, the time requirement to complete the assessment does not vary, while the time used to complete the full PLAY assessment varies depending on the evaluator's preference and abilities. Therefore, based on the information provided, it is clear that the CAPL research based tool is ideal to use based on the information previously discussed because it is an objective tool that is consistent and reliable and the best indicator for measurement and assessment of physical literacy.

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