The Relationship between the Cognitive and Affective Measures of Physical Literacy and Changes in Physical Activity in a Sample of Children and Adolescents During COVID-19

by

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Abstract

The COVID-19 pandemic has swept across the world and has caused profound impact and worldwide concern. Many countries have imposed measures, such as social distancing protocols and regional lockdowns, to prevent the further spread of the disease. However, those restrictions had the potential to greatly affect health-related behaviours of individuals, especially school-aged children, aged 8–12 years. The aim of the present study was to investigate perceived changes in health-related behaviours of physical activity, sedentary behaviour, and outdoor activity during a COVID-restriction period to the pre-lockdown/pre-restriction period. In addition, I examined the relationships between cognitive and affective measures of physical literacy and selected demographic variables to the perceived changes in COVID-related physical activity. In June 2021, when COVID-19 restrictions were in place in Edmonton, Canada, 211 parents and 79 children were asked to complete a cross-sectional online survey. Questions, posed to both parents and children, focused on perceived changes in physical activity related to the COVID-19 lockdown in children. A regression analysis was performed to understand the correlates of perceived COVID-related changes in physical activity. Results indicated that the COVID-19 lockdown resulted in reductions in physical activity and outdoor activity, and an increase in measures of sedentary behaviour. Moreover, children with physical literacy measures of higher affective levels, motivation, and confidence, were more likely to have

maintained or increased their physical activity during the COVID-19 restrictions. The results indicate the importance of developing the affective domain of physical literacy, motivation, and confidence in children to help ensure future participation in physical activity among school-aged children. Future research is needed to establish the causal relationships and what other factors may also increase these health-related behaviours for future lockdowns or restrictions that might be imposed.

Keywords: COVID-19, physical activity, sedentary behaviour, physical literacy, children

Preface

This thesis is an original work by Liaoyan (Gary) Gan. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, for the project named "The Relationship between the Cognitive and Affective Measures of Physical Literacy and Changes in Physical Activity in a Sample of Children and Adolescents during COVID-19", Pro00110836, May 27, 2021.

As a track-and-field student-athlete and kinesiology student, I am acutely aware of the importance of physical activity and sport experiences to health, both physically and mentally. The outbreak of COVID-19, which caused many negative consequences among children and adolescents, inspired the conception of this thesis. My research question was formulated with my supervisor, Dr. Kerry Mummery. This thesis aims to contribute to the understanding of health-related physical activity behaviour among school-aged children during the COVID-19 pandemic.

This thesis would not have been possible without the support of many people. Special thanks to my supervisor, Kerry Mummery, for his continued guidance through my degree and my committee member, Brian Maraj, for his encouragement and suggestions.

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Table of Contents

List of Tables

List of Figures

Chapter 1. Introduction

1.1 Overview

Physical activity (PA) is defined as any voluntary bodily movement generated by the contraction of skeletal muscle that requires energy expenditure above the resting metabolic rate (Caspersen, Powell & Christenson, 1985). Moderate-to-vigorous PA is associated with numerous physical, psychological/social, and cognitive health benefits in school-aged children and youth (Poitras et al., 2016). According to Canadian 24-hour movement guideline for children and youth (Tremblay et al., 2016), children aged 5–11 years and youth aged 12–17 years should accumulate at least 60 minutes of moderate-to-vigorous intensity physical activity (MVPA) daily and incorporate muscle and bone strengthening activities at least three days per week, which should be as part of play, games, sports, transportation, recreation, physical education, or planned exercise in the context of family, school, and community.

Although the importance of participating in sufficient PA has been well documented, the World Health Organization (WHO) reported that more than 80% of the world's child and adolescent population is insufficiently physically active (WHO, 2020b). In Canada, the 2018 ParticipAction Report Card on Physical Activity for children and youth reported that this population is not active enough with only 35% of 5–17-year-olds are reaching

the recommended physical activity levels. In addition, 51% of them are engaging in more screen time than is recommended by the Canadian 24-Hour Movement Guidelines for recreational screen-based sedentary behaviours (Barnes et al., 2018).

Sometimes an unpredictable life event may suddenly change people's physical activity behaviours. In December 2019, some new cases of pneumonia were reported in Wuhan, China, and the disease soon swept across the world. On January 30, 2020, WHO classified the disease as novel coronavirus disease 2019 (COVID-19), which was then classified as a worldwide pandemic on March 11, 2020 (WHO, 2020a). As of April 30, 2021, global COVID-19 cases had surpassed 150 million, with over 3.1 million related fatalities (Johns Hopkins University, 2021).

In the absence of effective treatments and vaccines, one of the best ways to prevent the spread of COVID-19 was to mandate physical distancing or even confinement. Therefore, in almost every country, governments enacted strict measures and restrictions such as closing schools, public services, limiting non-essential travels, or even requiring people to stay at home. Although those measures were necessary to slow the spread of COVID-19, for school-aged children and youth, without any physical education classes at school, organized physical activities in sports clubs, or free play in playgrounds, they had less or even no opportunities to engage in sufficient levels of PA. In addition, as their school classes were delivered online, children had to spend more time in sedentary behaviours and screen time, which may have threatened their health (Meyer et al.,

2020a). A study reported that only 4.8% of children (ages 5–11) and 0.8% of youth (ages 12–17) were meeting 24-hour movement behaviour guidelines during COVID-19 restrictions, which was a significant decline to pre-pandemic movement levels. Moreover, 79% of children and youth were spending more leisure time on screens (Moore et al., 2020a).

The movement behaviour was compromised during the COVID-19 pandemic. Therefore, physical literacy and physical activity gained importance. Physical literacy was initially proposed by Whitehead (2010) and defined as the motivation, confidence, physical competence, knowledge, and understanding to value and engage in physical activity throughout the life course. Together, these domains embody a more holistic perspective of PA and place much emphasis on the mental and physical development of children and youth. Since the COVID-19 pandemic has entered people's lives, it has altered the ways that we work, live, and participate in physical activities. Although the possibility exists that some of these changes may become permanently entrenched, there are no studies related to the affective and cognitive factors associated with physical activity throughout the lockdown period. As for PA related studies, child self-report surveys have many studies but with parent-proxy report, there are not many. Also, physical literacy gained its importance in this decade. People have gradually paid more attention to the cognitive, affective, social, and emotional functions of physical literacy instead of only focusing on the fitness or physical competence portion.

To help increase our understanding of physical activity in school-aged children, this present study examined perceived changes in PA, sedentary behaviour, and outdoor time, related to pandemic control measures in a sample of school-aged children. In addition, the relationships between COVID-related perceived changes in physical activity and measures of physical literacy: affective measure, cognitive measure, and external variables of BMI, age and gender were studied in this sample.

1.2 Statement of the Problem

Physical activity (PA) is a key factor in the prevention and amelioration of noncommunicable diseases such as cardiovascular disease, obesity, or diabetes, and it can improve mental health, quality of life, and well-being (WHO, 2020b). As COVID-19 has become a sustained human viral infection and a global pandemic, strict measures have been enacted by governments such as closing schools, limiting nonessential travel, or even locking down entire cities. One of the unintended consequences of such actions is that school-aged children and adolescents may not engage in sufficient PA (Moore et al., 2020a), which could be detrimental to their health in the long term.

Given the profound and entrenched influence of COVID-19, the socio-ecological model provides a framework for understanding an individual's change in behaviour within the environment context (Martínez-Andrés et al., 2020). At the individual level, one's cognitive and affective factors play an important role in behaviour, such as physical

activity. As it is stressed by Whitehead (2010), one's cognitive (understanding and knowledge) and affective (confidence and motivation) factors are an important part of physical literacy. However, there is a lack of research exploring the relationships between the domains of physical literacy and physical activity, especially during the COVID-19 pandemic. The correlates of the school-aged children's PA participation during COVID-19 were not well investigated.

This research provides insights to developing proper interventions to reduce negative consequences during lockdown periods.

1.3 Hypotheses

1a.

It is hypothesized that parents will perceive that their children did less PA and more sedentary-related behaviour in the time of COVID-19 (Eyler et al., 2021; Moore et al., 2020a).

1b.

It is hypothesized that children will perceive that they did less PA and more sedentary-related behaviour in the time of COVID-19 (Moore et al., 2020a).

2a.

It is hypothesized that there will be a significant relationship between the affective measure, motivation and confidence of physical literacy, and COVID-related changes in physical activity in children (Whitehead, 2010).

2b.

It is hypothesized that there will be a significant relationship between the cognitive measure, knowledge and understanding, of physical literacy, and COVID-related changes in physical activity in children (Whitehead, 2010).

3a.

It is hypothesized that a combination of physical literacy measures, including cognitive and affective domains of physical literacy, and current physical activity level, will reliably predict perceived COVID-related changes in physical activity levels (Whitehead, 2010).

3b.

It is hypothesized that the addition of gender, age, and BMI will not increase the model's predictive ability.

1.4 Objectives

The objectives of this research were to:

1. Explore whether there was COVID-related physical activity change through children's self-report and parental proxy-report.

2. Investigate the relationship between the cognitive and affective measures of physical literacy and external variables of BMI, age and gender and COVID-related changes in physical activity. These investigations were done to understand school-aged children's PA behaviour during the COVID-19 pandemic and what roles the cognitive and affective factors play in the change of children's PA during COVID-19.

1.5 Delimitations

1. The study sample was delimited to healthy school-aged children aged 8–12 years. In addition, this sample was drawn from a database of participants of the Green and Gold Sport System, a sport-school affiliated with the University of Alberta.
2. The domains of physical literacy were delimited to the affective measures of motivation and confidence, the cognitive measures of knowledge and understanding, and of self-reporting on current physical activity. Individual variables were delimited to age, gender, and BMI. The current PA, cognitive and affective factors, were chosen because they are domains of PL. Age and gender are important pieces of information for categorizing a PL score. BMI is one convenient method for collecting health indicators. Also, research has shown that the BMI / weight status will influence the PL score (Delisle Nyström et al., 2018).

1.6 Definition of Key Terms

Physical activity: Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that result in energy expenditure above the resting metabolic rate. Physical activity can be categorized into occupational, leisure, transportation, household, or other activities (Caspersen, Powell, & Christenson, 1985).

Sedentary behaviour: Sedentary behaviour (SB) is defined as any waking behaviour with low energy expenditure (e.g., ≤1.5 metabolic equivalents) occurring in a sitting, reclining, or lying posture (Tremblay et al., 2017).

Movement behaviours: Sleep, sedentary behaviour, and physical activity are collectively referred to as movement behaviours (Tremblay et al., 2016).

COVID-19: COVID-19 is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and was first identified in December 2019 (WHO, 2020a).

Physical literacy: Physical literacy (PL) can be described as the motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for engagement in physical activities for life (Whitehead, 2010).

CAPL-2: CAPL-2 stands for the Canadian Assessment of Physical Literacy – Second Edition. It is a comprehensive protocol for accurately and reliably assessing a broad spectrum of skills and abilities that contribute to and characterize the physical literacy level of a participating child, aged 8–12 years old (Longmuir et al., 2015).

1.7 Operational Definitions

For this research, the following terms were operationally defined as described below:

PA Change: PA change are the perceived changes in physical activity before and during the pandemic reported by the children themselves and their parents.

Motivation & Confidence: In Whitehead's definition, motivation and confidence are one domain of physical literacy (Whitehead, 2010). This domain represents a child's confidence in being physically active and their motivation to participate in physical activity. In our study, the motivation and confidence domain was assessed by using the Canadian Assessments of Physical Literacy – Second Edition (CAPL-2).

Affective Domain of Physical Literacy: The affective domain is defined as the motivation and confidence measure, and it includes developing self-esteem, confidence and motivation, and understanding of the emotional responses linked to movement and physical activity (Australian Sports Commission, 2017).

Knowledge & Understanding: Knowledge and understanding is one domain of physical literacy, in Whitehead's definition (Whitehead, 2010). It represents a child's knowledge about physical activity, skill, and fitness. In the study, knowledge and understanding was assessed using the Canadian Assessments of Physical Literacy – Second Edition (CAPL-2).

Cognitive Domain of Physical Literacy: The cognitive domain is defined as the knowledge and understanding measures, which include the development of a person's understanding of how, when, and why to move in particular ways, as well as the knowledge and awareness of the benefits of movement and physical activity (Australian Sports Commission, 2017).

Sedentary behaviour change: Sedentary behaviour changes in the study represent the estimated changes in daily time spent sitting, and time spent on screen-based activity, before and during the pandemic.

Outdoor time change: Outdoor time change in the study represents the estimated change in time spent outdoors while participating in PA before and during the pandemic.

Parent Proxy Measures: Used as supplementary measures to the children's self-reports and were based on the parent's perceptions of their child's COVID-related changes in physical activity, sedentary behaviour, and outdoor time.

Chapter 2. Literature Review

2.1 Physical Activity and its Benefits

Physical activity refers to all movement and activities, at any intensity level, performed during any time of the day while awake. Extensive research studies have proven that regular physical activity promotes the growth and development of children and has multiple benefits for physical, mental, and cognitive health (Kohl & Cook, 2013). A number of systematic reviews have examined the health benefits of physical activity in school-aged children (Janssen & LeBlanc, 2010; Poitras et al., 2016).

In a 2010 systematic review, Janssen and LeBlanc (2010) examined the relationship between moderate-to-vigorous physical activity (MVPA) and seven health indicators, such as high blood pressure, high blood cholesterol, the metabolic syndrome, obesity, low bone density, depression, and injuries. They found that the higher the quantity and intensity of the physical activity, the greater the health benefits.

A more recent systematic review (Poitras et al., 2016) focused on the relationship between the different intensities of PA, including light-intensity physical activity (LPA), and health indicators among children and youth, including body composition, cardiometabolic biomarkers, physical fitness, social behaviour, cognition/academic achievement, well-being, harms, bone health, motor skill development, psychological

distress, and self-esteem (Poitras et al., 2016). They found all patterns of physical activity provided benefit and the findings continue to support the importance of at least 60 min/day of MVPA for the promotion of health in children and youth (Poitras et al., 2016).

In addition, PA can also improve psychosocial outcomes such as mental health, cognitive function, and self-esteem. Biddle and Asare's (2011) review showed that physical activity has potential effects for reducing depression and anxiety, and improving cognitive performance, academic achievements, and self-esteem in children and adolescents. Recently, Biddle et al. (2019), updated these findings, noting that higher or improved fitness and physical activity are associated with better mental health. Moreover, they found some causal relationship between physical activity and mental health, specifically, the strongest evidence for causal relationship appears to be for cognitive function and there is partial evidence for depression (Biddle et al., 2019).

The accumulation of evidence supporting the benefits of physical activity have led to several guidelines in Canada and around the world. According to the Canadian Physical Activity Guidelines, in order to gain those health benefits for children, an accumulation of at least 60 minutes per day of moderate-to-vigorous physical activity (MVPA) and muscle and bone strengthening activities should be completed at least three days per week (Tremblay et al., 2011). Another Canadian 24-hour movement guideline for children and youth stated that for optimal health benefits, they should experience high levels of physical activity, low levels of sedentary behaviour, and sufficient sleep each

day, specifically, they should achieve at least 60 minutes per day of MVPA and incorporate muscle and bone strengthening activities at least three days per week, and get uninterrupted 9–11 hours of sleep per night with consistent bedtimes and wake-up times, additionally sitting for extended periods should be limited with no more than two hours per day of recreational screen time (Tremblay et al., 2016).

Given that children are in school for many hours of the day, organized physical activities and free play during school time are ways to provide children with sufficient PA opportunities to meet the PA guidelines.

2.2 Physical Activity Before the COVID-19 Pandemic

The electronic revolution has fundamentally changed people's movement patterns. People now tend to sleep less, sit more, walk less, drive more, and do less physical activity than before (Guthold et al., 2020). Physical inactivity has become a worldwide concern and promoting adequate PA in children remains a major public health issue (WHO, 2020c).

Globally, 75% of adults do not meet the recommended levels of physical activity and 80% of the world's adolescent population is insufficiently physically active (WHO, 2020b). A recent study looked at the global trends of physical activity levels for more than a decade and reported that children's physical activity participation is a universal problem and has not improved over time. Internationally, between 2001 and 2016,

physical inactivity among boys fell from 80% to 78%, while for girls it stayed at 85% (Guthold et al., 2020). In Canada, the Canadian Health Measures Survey (CHMS) regularly collects objective measures of moderate-to-vigorous physical activity (MVPA) from a representative national sample using accelerometers. To date, the CHMS has collected data over six cycles from 2007 through to 2019. The first cycle of the data, collected between 2007 and 2009, reported that only 7% of Canadian children and youth met the recommended physical activity guidelines of 60 minutes MVPA per day (Colley et al., 2011). Subsequent cycles reported that boys accumulated more MVPA than girls, and 6- to 11-year-old children accumulated more MVPA than 12- to 17-year-old youth. In addition, the MVPA levels among Canadian children and youth did not change over the nine-year period from 2007 to 2015 (Colley et al., 2017). Nevertheless, before we can clearly determine the percentage of children and youth who meet PA guidelines, we should reconcile the difference between various PA guidelines. Based on an alternative definition, the percentage of children and youth meeting the MVPA recommendation can differ from 7% to 33% based on the CHMS collected in 2014/2015 (Roberts et al., 2017). The previous MVPA recommendation has been operationalized as an accumulation of 60 minutes of MVPA on at least six out of seven days per week. Recently, a more well-accepted operational definition was adopted in the Canadian 24-Hour Movement Guidelines, released in 2016, suggesting that children and youth be classified as adherent if their average daily MVPA is at least 60 minutes per day. However, no matter which

definition is applied, the surveys show that Canadian children and youth meeting MVPA recommendations remains low and has not changed to any extent since 2007 (Colley et al., 2017).

2.3 Physical Activity During the COVID-19 Pandemic

The COVID-19 pandemic has presented several challenges with respect to physical activity in children worldwide. For instance, in the case of parents and guardians of school-aged children, it has been difficult to maintain the norms of daily life. The lockdown has resulted in closures of school, gym, and recreational facilities. Hence, school-aged children accustomed to outdoor play, organized sport, active travel, and school physical education classes have been compelled to seek a new "normal". A systematic review of 66 studies indicated that PA declined and SB increased during the COVID-19 pandemic lockdown (Stockwell et al., 2021).

Studies also found that people's regular PA routines were difficult to continue during the lockdown and the modes of PA changed. Studies found that all types of PA decreased except for PA such as housework and yard work, which increased during the lockdown. Regardless, total PA levels decreased despite increases in these specific modes of PA (Biviá-Roig et al., 2020; Schlichtiger et al., 2020).

In a comparison of Google's community mobility data from before the WHO pandemic announcement and after the pandemic was declared, across 15 countries,

showed physical activity time spent in parks and community gardens was down by 31% and active public transportation was down by 59% (Guan et al., 2020). On the contrary, time spent in places of residence increased by an average of 17%. A parent-report study, representing 35 states in the United States, reported that children (aged 5–13) performed less PA and engaged in more SB during the early COVID-19 period as compared with before the pandemic (Dunton et al., 2020). Also, the locations of children's PA changed greatly between the pre- and early COVID-19 periods. A significant increase in children's PA occurring on the sidewalks and roads in their neighborhoods represents a unique trend during the pandemic (Dunton et al., 2020). In addition, a study in Portugal suggested that the time children allocated for PA during the COVID-19 confinement was reduced compared with normal pre-pandemic days (Pombo et al., 2020). The study also indicated that being younger, having bigger outdoor spaces, and having at least one adult working from home were significant positive predictors of children's PA.

Moreover, a scoping review provided evidence indicating consistent decreases in PA time and other measures, such as energy expenditure and MVPA, in children and youth in both cross-sectional and longitudinal designs (Paterson et al., 2021). The study used subjective measures of PA that were consistent with self and proxy-report studies, which showed that children with medical conditions spent less time in LPA and MVPA and had decreased step counts following the onset of the pandemic (Hemphill et al., 2020). The modes and locations of PA were also influenced by the pandemic. Studies found that PA

shifted from occurring outdoors and at school to being home based and community based. The studies also reported PA declines in outdoor time and active transport (Jia et al., 2021; McCormack et al., 2020).

In Canada, Moore et al., (2020b) reported that only 4.8% of children and 0.6% of youth met combined movement behaviour guidelines, including physical activity, sedentary behaviour, and sleep, during COVID-19 restrictions. The study also showed that children and adolescents had poor movement behaviours, such as lower PA levels, less outdoor time, higher sedentary behaviour, and longer sleep during the outbreak. Mitra et al. (2020) examined the changes in 11 movement behaviours during COVID-19. Their results indicated that 56% of Canadian children and youth decreased their outdoor activities and increased their screen time and other sedentary behaviours (Mitra et al., 2020).

Given the strong association between optimal physical activity and health benefits, those decreases in PA time are likely to be compromising children's health during the pandemic.

2.4 Physical Activity Assessment

In order to understand people's PA behaviour, identifying the frequency, duration, intensity, and types of PA performed during a period of time is important. The tools used

to measure PA and energy expenditure can generally be categorized into two parts: self-report and direct measure PA assessment tools.

Self-report PA assessment tools such as questionnaires, activity logs, and detailed diaries, are some of the most common methods used in epidemiological and surveillance studies. They are cost-effective and are a relatively low burden to the respondents. However, the trade-off when compared to direct measures is questionable reliability and validity (Shephard, 2003). Direct measures are believed to offer more precise estimates of energy expenditure and physical activity behaviour, since they remove some of the self-report limitations such as recall and social desirability error (Prince et al., 2008). Direct measures of PA include motion sensors and monitors such as pedometers and accelerometers, which can objectively record one's movement behaviour. Despite the advantages of these direct measures, they are usually time-consuming and costly, making it difficult to apply to larger epidemiology studies (Prince et al., 2008). Therefore, the selection of an optimal PA assessment tool can be challenging based on the many factors that need to be considered, such as cost, time and personnel availability, participant considerations, etc.

As the outbreak of the COVID-19 pandemic led to government-issued social-distancing protocols and restrictions, it is not surprising that online-based surveys have been used in the majority of PA studies (Guerrero et al., 2020; Jia et al., 2021; Meyer et al., 2020b; Moore et al., 2020a; Schmidt et al., 2020). The most widely used surveys

include validated self-report measures of PA, such as the International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003), Physical Activity Questionnaire for Older Children (PAQ-C) (Kowalski et al., 2004), and the Physical Activity Questionnaire for Adolescents (PAQ-A) (Kowalski et al., 2004). Some non-validated measures of PA have been used and constructed by researchers themselves based on face validity. These surveys include questions asking for the daily duration of PA (Zhou et al., 2020), number of days per week with at least 60 min of MVPA (Moore et al., 2020a), and the frequency of weekly PA (Dragun et al., 2020).

2.5 Physical Literacy

Over the past 20 years, the concept of physical literacy (PL) has gained popularity internationally. Some countries, such as Australia, UK, and Canada, have incorporated PL, or its components, into policies and programs to develop and enhance lifelong physical activity participation in children (Spengler & Cohen, 2015). Canada, as one of the leading countries in terms of physical literacy development, has promoted PL at the grassroots level across education, sport, recreation, and public health sectors (Spengler & Cohen, 2015).

Despite the substantial interest, ongoing ambiguity and debate prevail concerning the definition of PL across different organizations and countries. This ambiguity undermines the understanding and measurement of physical literacy, the understanding of

discoveries, and it forestalls any significant build-up of research findings (Edwards et al., 2018). Therefore, a clear understanding and a unification of the concept of physical literacy is important. According to a systematic review conducted by Edwards et al. (2017), 70% of papers related to definitions and associations of physical literacy (PL) adopted the "Whitehead" version. The International Physical Literacy Association (IPLA) also adopts this definition, which describes PL as "the motivation, confidence, physical competence, knowledge, and understanding to maintain physical activity throughout the life course." (Whitehead, 2010, p. 12). The popularity of the "Whitehead" version is likely related to the extensive scope of its physical movement and psychosocial properties, as it develops PL in children beyond competitive sports participation as the primary vehicle for deliberate physical movements (Edwards et al., 2017). In addition, Whitehead proposed that new ways of thinking about the body and mind, relying on the philosophical foundations of monism, existentialism, and phenomenology (Whitehead, 2010). *Monism* is the belief that the body and mind are integrated entities that work together in harmony; *existentialist belief* is that individuals create themselves as they live and interact with their surroundings and the world, and *phenomenology* is the belief that every individual will perceive the world from their perspectives or previous experiences (Whitehead, 2010). In summary, based on the philosophical groundings mentioned above, physical literacy is a disposition to use experience, understanding, and abilities to

interact effectively with the world, which shows a holistic approach to the concept of PL (Whitehead, 2013).

Although PA and PL are related, they are independent of each other. As a multidimensional concept, PL encompasses four domains, including the affective (confidence and motivation), cognitive (understanding and knowledge), behavioural, and physical domains that have a mutually beneficial relationship with motor skills and forms of physical activity (Tremblay et al., 2018). More importantly, physical literacy does not necessarily result in or from physical activity, and it needs to be developed as a life skill, ideally before adolescence (Shahidi et al., 2020).

The cognitive domain of physical literacy focuses on developing the requisite understanding and knowledge of physical activity and movement. This framework enables individuals to understand how to develop on cognitive, social, psychological, and physical levels besides engaging in lifelong physical activity and healthy movement behaviours (Longmuir et al., 2015). Thus, this domain encompasses developing an individual's understanding of why, when, and how to assume precise movements and the awareness and knowledge of the benefits associated with physical activity and movement.

The affective domain of physical literacy represents the motivation and confidence of physical activity and movement. It refers to an individual's enthusiasm for, enjoyment of, and self-assurance in treating PA as an integral part of life (Sport for Life, n.d.).

2.6 Canadian Assessment of Physical Literacy

Canada is one of the world leaders in promoting physical literacy and developing assessment tools (Sport for Life, n.d.). The Canadian Assessment of Physical Literacy (CAPL), one of the most used physical literacy measurements worldwide, was developed by the Healthy Active Living and Obesity Research Group (HALO) in 2013 (HALO, 2013). It is considered the first comprehensive tool to accurately and reliably evaluate a broad spectrum of skills and abilities that characterize a participating child's physical literacy level (HALO, 2013).

CAPL measures the four domains of physical literacy, consistent with Whitehead's globally accepted definition. The four domains are physical competence, motivation and confidence (affective domain), knowledge and understanding (cognitive domain), and physical activity behaviour. The physical competence domain consists of motor performance tests (obstacle course) and physical fitness (aerobic fitness and musculoskeletal endurance). Physical activity behaviour is assessed across seven days of pedometer data. Self-report questionnaires are used to evaluate the affective domain of motivation and confidence as well as the cognitive domain of knowledge and understanding. The maximum PL score in CAPL-2, which is the second version of CAPL, is 100 points and can be further divided into four categories: beginning, progressing, achieving, or excelling. The beginning and progressing stages indicate that

participants have not reached the optimal level of physical literacy, while the achieving and excelling stages represent those participants that have met the recommended level of physical literacy with the expected gain of health benefits associated with a physically active lifestyle.

2.7 Cognitive and Affective Measures of Physical Literacy and Physical Activity

In physical literacy, the cognitive and affective domains play an important role in lifelong participation in physical activity (Sport for Life, n.d.). The affective domain of physical literacy includes motivation and confidence, and the cognitive domain includes measures of knowledge and understanding.

The four domains are all important: cognitive, affective, behaviour, and physical, however, due to the COVID-19 pandemic, the physical domain could not be measured. Also, the cognitive and affective domains were less studied than others. This study is solely focused on how focused on how the cognitive and affective domain impacts the PA behaviour domain.

2.7.1 Affective Domain—Motivation and Confidence

Motivation is what moves us to act. According to Cognitive Evaluation Theory (CET), a sub-theory of the Self-Determination Theory (SDT), all individuals have three fundamental psychological needs that determine a human's behaviour: the need for competence, the need for relatedness, and the need for autonomy (Deci & Ryan, 2000). Respectively, competence is defined as mastery experiences and interaction effects with the environments. Relatedness refers to the desire to feel connected with other people. Finally, autonomy implies the choice and freedom in one's behaviour (Deci & Ryan, 2000). Numerous research studies have supported SDT in physical activity. Rutten, Boen, and Seghers (2012) revealed that the achievement of competence and autonomy were closely related to physical activity participation in Grade 6 children. Deci and Ryan (2000) also showed that in SDT, competence and autonomy were identified as the most important contributors to physical activity engagement.

At the heart of physical literacy is a desire to be active, to improve physical competence, and to try new activities (Whitehead, 2010). A physically literate individual will be confident in their physical abilities to enjoy a challenge and to be regularly involved in all kinds of physical activities, and to engender positive self-esteem and self-confidence (Whitehead, 2010). However, measures of motivation can be very diverse, even in different physical literacy measurements. For example, one commonly used physical literacy measurement tool, the Physical Literacy Assessment in Youth program

(PLAY) developed by the Canadian organization Sport for Life (2014), assesses children's motivation via parental reports and coaches reports based on their performance and daily behaviours using a 5-point Likert scale. Conversely, in CAPL, the child's motivation and confidence questionnaire is answered and assessed using four items: predilection, adequacy, intrinsic motivation, and physical activity competence. In this study, the motivation and confidence questionnaire of the CAPL has been utilized to measure a child's motivation and confidence.

2.7.2 Cognitive Domain—Knowledge and Understanding

Health-related fitness knowledge is an essential component of health and physical education to nurture physically literate individuals capable of independent physical activity and fitness planning, and positively promote PA behaviour (Zhu et al., 2020). Having appropriate health-related fitness knowledge might be critical for people to understand and apply principles of exercise to their daily lives, especially for children. If a child does not possess adequate knowledge related to the importance of physical activity, they may be more likely to discontinue physical activity as adults (Ferkel & Judge, 2014). In addition, Whitehead (2010) stated that physically literate individuals have an understanding of the principles of embodied health with respect to basic aspects such as exercise, sleep, and nutrition.

Research shows that some children may undertake more physical activity than others because they know the benefits of exercise, and the recommended amount of physical activity (Roth & Stamatakis, 2010). This indicates that knowing more information about physical activity could enable activity in some children. However, numerous studies have reported that children have limited knowledge and understanding of health, fitness, and physical activity (Desmond et al., 1990; Ferkel & Judge, 2014; Fredriksson et al., 2018; Harris et al., 2018; Placek et al., 2001).

Since 1990, research studies have emerged regarding young people's knowledge and understanding of health, fitness, and physical activity. In the USA, Desmond et al. (1990) found that a high proportion of the students held misconceptions about fitness. For example, many students either incorrectly believed or were unsure if wearing extra layers of clothes while exercising will help the body lose more fat.

Since the turn of the century, many research studies reported that children had difficulty defining foundational physical activity and fitness knowledge. Placek et al. (2001) stated that a group of Grade 6 children showed a lack of knowledge or an incomplete understanding of health-related fitness. For example, they thought that fitness equaled looking good, which equaled being thin. They had little knowledge about the types of fitness, the purpose of specific exercises, or Frequency, Intensity, Time, and Type (FITT) principles. A health survey in England examined 1,954 children aged 11–15 and found familiarity with physical activity guidelines to be low, and an association

between knowing the guidelines and an increased possibility of meeting them (Roth & Stamatakis, 2010). Even more recently, studies have continued to report a limited knowledge and understanding of health, fitness, and physical activity concepts among young students. One study reported that Native American children had a minimal understanding of basic PA and healthy behaviour concepts, with only 7% of students able to answer why physical activity was important and only half able to explain why PA was good for them (Brusseau et al., 2011). Powell and Fitzpatrick (2015) examined a group of primary school children in New Zealand and found children's understanding of fitness might be problematic. Many children perceived that fitness meant thinness and fitness lessons were connected with the avoidance of being fat.

Those findings revealed that the children's understanding of health, fitness, and PA were still limited and have not improved noticeably over the past three decades. It has been proven that PA participation is positively related to PA-related knowledge. Therefore, more attention should be paid to the importance of the knowledge and understanding of PA.

In this study, CAPL was used to measure a child's knowledge and understanding of physical activity. In CAPL, the knowledge and understanding domain assesses a child's knowledge about physical activity, skill, and fitness. Specifically, the questions include guidelines for daily physical activity, the definition of cardiorespiratory fitness, muscular

strength and muscular endurance, ways to improve movement skills, and ways to improve understanding of fitness and physical activity.

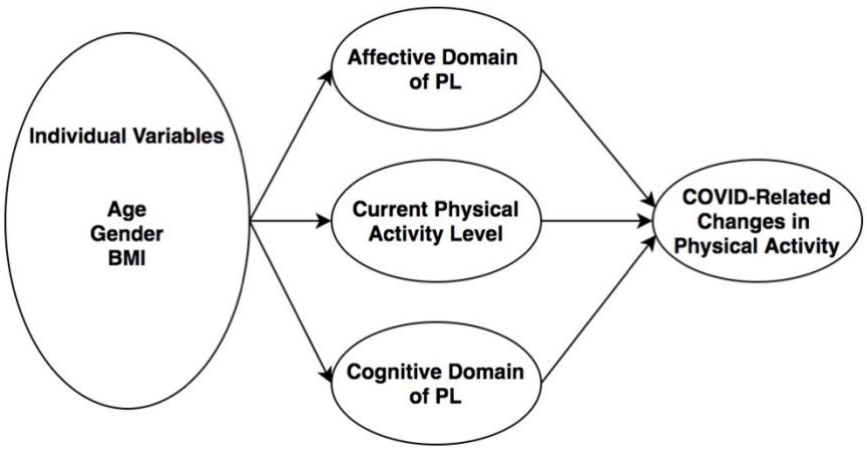
Chapter 3. Method

3.1 Study Design

This study is a cross-sectional study conducted in the spring/summer of 2021 with a sample of 8–12 year-old children recruited from the Green and Gold Sports System at the University of Alberta in Edmonton, Alberta, Canada. Along with demographic information, children's physical activity level, COVID-related perceived changes in physical activity, and cognitive and affective measures of physical literacy, were collected to better understand the relationship between selected measures of physical literacy and COVID-related changes in physical activity.

Figure 1

Model of the Relationships among Individual Variables, Cognitive and Affective Measures of Physical Literacy, and COVID-related Changes in Physical Activity Behaviours



3.2 Participants

A sample of children aged 8–12 years old was randomly selected from participants of the Green and Gold Sports System at the University of Alberta in Edmonton.

A prior power analysis indicated that a sample size of 143 would be sufficient to detect a significant effect with a power of 0.8 and an alpha of 0.05.

A goal to have 143 children and their parents complete the online survey was established. Based on recruitment experience for previous studies (Nulty, 2008), we expected a 35% response rate from parents and then from their children.

Parents were also required to provide perceived changes in their children's COVID-related behaviour, such as their changes in physical activity, in sedentary behaviour, and in outdoor time. Parents were approached to provide informed consent for the researcher to contact their children to complete the study. Once parental informed consent and the child's email address were received, children were contacted via separate email messages to obtain their assent to participate. A more detailed recruiting process is in section 4.1. The recruiting material, including the parental consent form and children's assent form, can be seen in Appendix A.

3.3 Instruments

All the data were collected and managed via the REDCap electronic data capture tool hosted at the University of Alberta. Research Electronic Data Capture (REDCap) is a secure web application for building and managing online surveys and databases. A survey was constructed in REDCap assessing demographics (e.g., age, gender, BMI), cognitive and affective measures of PL, current physical activity, and perceptions of COVID-related changes in physical activity (see Appendix B).

3.3.1 Demographics

Demographic information was collected via the child's self-report questionnaire, including age, gender, height, and weight, and BMI was calculated afterwards.

3.3.2 Domains of Physical Literacy

Physical literacy domains were assessed via the Canadian Assessment of Physical Literacy – Second Edition (CAPL-2) Questionnaire (HALO, 2017). It comprises three physical competence protocols, two daily behaviour protocols (pedometer and self-report questionnaire), and a questionnaire, assessing the affective domain of motivation and confidence and the cognitive domain of knowledge and understanding. Each domain has numerical scores and is assigned to one of four categories: beginning, progressing,

achieving, and excelling. Additionally, the actual domain scores and categories of physical literacy are adjusted by age and gender.

Due to COVID-19 restrictions, only CAPL information that could be collected via online survey was included. This study did not include the physical competence domain or objective assessed physical activity behaviour, those require close interaction with a group of people. Therefore, in the present study, we only focused on the daily behaviour (self-report) and specifically on the cognitive and affective domains of PL. Detailed information about each domain follows.

3.3.3 Affective Domain—Motivation & Confidence

The affective domain of the CAPL-2 contains measures of motivation and confidence, which encompasses a participant's confidence in being physically active and the motivation to participate in physical activity. Four measures: predilection (preference for PA), adequacy (expectations of success), intrinsic motivation (engagement with PA for enjoyment), and physical activity competence (perceptions of motor competence) are assessed via a motivation and confidence questionnaire. Each measure makes up 7.5 points and is assessed by three items (2.5 points/item). The maximum score in this domain is 30 points. Children's Self-Perceptions of Adequacy in and Predilection for Physical Activity, the "What's Most Like Me" (CSAPPA) (Hay, 1992) questionnaire, is used for predilection (e.g., some kids like or don't like playing sports) and adequacy (e.g.,

some kids are good at active games or find active games hard to play) items. In these items, descriptions such as “some kids don’t like playing sports” against “other kids really enjoy playing sports” are presented to participants. Then participants choose which of the two descriptions are most like them and decide whether this is “really true for me” or “sort of true for me”. For items like intrinsic motivation (e.g., I am active because…I enjoy being active) and physical activity competence (e.g., When it comes to playing active games, I think I am pretty good), a 5-point Likert-respond scale (e.g., ranging from “not true for me” to “very true for me”).

3.3.4 Cognitive Domain—Knowledge and Understanding

The cognitive domain of CAPL-2 contains measures relating to knowledge and understanding, which assesses a participant’s physical literacy knowledge and consists of four multiple-choice questions and one fill-in-the-blanks question, including six blanks to be filled. Each question and blank is worth 1 point, to a maximum score of 10 for the knowledge and understanding domain. The first four items are multiple-choice questions and are related to the knowledge of PA guidelines, terminology related to aerobic fitness, terminology related to muscular strength, and methods to improve a sport skill. The last item is filling the blanks in a paragraph, using provided words, that are associated with PA knowledge.

3.3.5 Physical Activity

Current levels of physical activity were assessed using the Physical Activity Questionnaire Older Children (PAQ-C) (Kowalski et al., 2004). The PAQ-C is a self-administered, seven-day recall instrument. It was developed to assess general physical activity levels throughout the elementary school years for students approximately 8–12 years of age. It has been widely used to assess physical activity in a healthy school-aged population. This self-report measure has been reported with good validity and reliability among school-aged children (Benítez-Porres et al., 2016; Kowalski et al., 1997).

3.3.6 Perceptions of COVID-related Changes in Physical Activities

A child's perceptions of COVID-related physical activity changes were measured by asking, "In comparison to your usual level of physical activity in and around your school to the COVID-19 outbreak and the government ordered restrictions, how would you rate your current level of physical activity?", from six modes of PA (e.g., around the home, transportation, around school, around the neighborhood, at recreation/sports facilities, overall). Moreover, three other items were asked about the child's daily sitting time, their screen-based activity for leisure and study, and their time spent outdoors compared with their usual behaviour before COVID-19. The response options were measured using a 5-point Likert scale: much less, somewhat less, about the same, somewhat more, and much

more. The perceptions of COVID-related changes in physical activity questions are similar to the Spence et al. (2020) study.

In addition, a matching questionnaire was provided to parents, asking them to assess perceived changes in their children's physical activity, sedentary behaviour, and outdoor time. Similarly, the child's behaviour changes were measured by asking: "In comparison to your child's usual level of physical activity around the home to the COVID-19 outbreak and the government-ordered restrictions, how would you rate your child's current level of physical activity around the home?" from six modes of PA, same as the child's questionnaire.

3.3.7 A Composite Variable for Total PA Change

A composite variable for total PA change was computed, using the mean of all PA modalities in the questionnaire, including physical activity, sedentary behaviour, and outdoor time in some of the analysis.

In order to better understand the child's COVID-related behaviour changes and enhance the reliability of the PA change measures, similar with Spence's questionnaire (Spence et al., 2020).

3.4 Ethical Approval

The present study received ethical approval from the Research Ethics Board at the University of Alberta, and the REB ID is Pro00110836. A signed e-consent form was obtained from each participant's parent or legal guardian, following which a signed e-assent form was also obtained from each participant.

3.5 Data Analysis

Descriptive statistics of participant characteristics were analyzed and reported using numbers and percentages. Along with demographic information, current PA, perceptions of changes in PA due to the COVID-19 restrictions, and cognitive and affective measures of physical literacy used regression analysis. An independent t-test, a two-way ANOVA, hierarchical regression and reliability analyses were completed in SPSS (version 26) with an alpha of 0.05. Prior to conducting each analysis, the assumption of normality and linearity were examined, and there were no violation of the assumption.

3.6 Data Collection

In late spring 2021, during regional and provincial COVID-19 lockdowns and restrictions, eligible participants—parents and children—were invited to complete a 10 to 15 minute survey, the link to the survey was sent to each participant via email. Parents

with multiple children were asked to refer only one child to participate. It was asked that the parent's choose the child with the next birthday.

Data were collected over three weeks, from the beginning of June to the beginning of July, during a period of COVID-related restrictions in Edmonton, Alberta, Canada. The timeline of COVID-19 in Alberta and the study context can be seen in Figure 2.

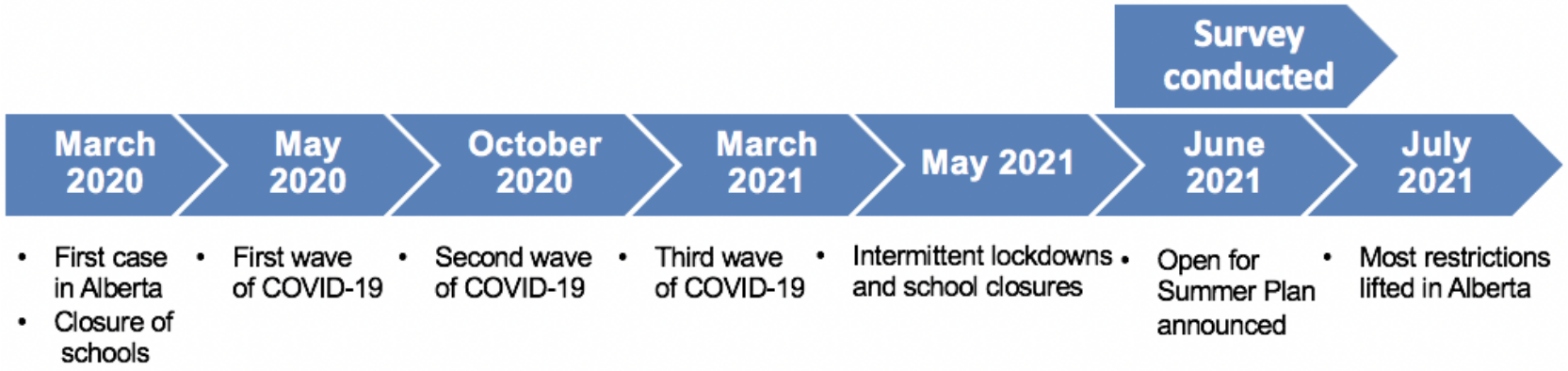
As the first COVID-19 case was reported in Wuhan, China, in December 2019, it soon swept the world. On March 5, 2020, Alberta reported the first COVID-19 case, a woman who had been away on vacation on the Grand Princess cruise ship. As more and more cases were reported, the government declared a local state of public health emergency and announced public health restrictions, while the curve fluctuated for more than a year and summer approached. At the end of April 2021, active cases started to rise again with over 2,000 new cases a day reported for the first time. This resulted in Alberta ranking as the second-highest seven-day average of new cases among all Canadian provinces to that date (Rodriguez, 2021). Therefore, the provincial government announced stricter restrictions again, including transitioning schools to online classes, ordering the closure of indoor gyms, and suspending indoor physical activity programs.

By June 2021, the world had been affected by COVID-19 for a year and a half. In Canada, different waves of COVID-19 had caused many intermittent lockdowns, resulting in the intermittent closures of schools, indoor gyms, and facilities. Moreover, those COVID-related restrictions were being described as "the new normal".

The provincial government announced their goal to “Open for Summer”, which aimed to lift the majority of Alberta’s public health orders by July 2021, provided that the number of vaccinations increased, and hospitalizations decreased. Specifically, no more restrictions on sports, gyms, or fitness activities and no additional bans on indoor or outdoor gatherings (Antoneshyn, 2021). In this context, our study was designed to be completed before the “Open for Summer” plan was implemented.

Figure 2.

Timeline of Events and Survey Context during the COVID-19 Pandemic in Alberta, Canada



Chapter 4. Results

4.1 Participant Recruitment

An initial sample of 1,208 parents with children aged 8–12 years from the Green and Gold Sports System (GGSS) at the University of Alberta was selected for the study. GGSS is a sport development program affiliated with the University of Alberta. It provides sport camps and programs to children and youth featuring age-appropriate opportunities for participation across various sports. The program's goal is to ensure that children are prepared to explore, engage, and excel in any sport they choose to pursue (Green and Gold Sport System, n.d.).

Parents were contacted by email to provide informed consent and their child's contact information. After the first invitation email, four reminder emails were sent on different dates, as per the Dillman Method (Millar & Dillman, 2011), to encourage their participation in this study. After the list of parents had received all the prompts, the sample frame was exhausted, and the survey was closed. A total of 265 parents completed the survey, with a 22% response rate. These parents provided consent and contact details for their children, who were then contacted electronically with their first invitation email and another four reminder emails followed on different dates. Following this second stage of recruitment recruitment, 102 children completed the survey, with a 39% response rate. The main reasons for children not participating in the study were: (a)

parental reluctance to share their child's email addresses due to their child's age; and (b) a lack of a personal email address for children aged 8–12. Participants were eliminated from the analysis if they did not agree to participate in the study or logged onto the survey but did not finish it.

4.2 Data Availability and Demographic Characteristics

A total of 265 parents responded to the survey. Fifty-four individuals who only partially completed the survey were removed, leaving a final parental sample size of 211. After the children were contacted via email, a total of 102 children responded to the survey. Twenty-three children who did not agree to participate in the study, or did not complete the survey, were removed from the study, leaving a final children sample size of 79. Table 1 shows the descriptive statistics for the demographic characteristics of the children's sample, by gender and age. All the children ranged in age from 8–12 years, and the majority were boys (56.9%).

Table 1

Descriptive Statistics for Children Respondents by Gender and Age (N = 79)

	Boys (N=45)					Girls (N=32)				
Age (years)	8	9	10	11	12	8	9	10	11	12
Frequency	12	10	11	7	5	3	13	6	7	3
Percentage	15.2%	12.7%	13.9%	8.9%	6.3%	3.8%	16.5%	7.6%	8.9%	3.8%
Height (cm)			141.5 ± 12.4					140.7 ± 9.7		
Weight (kg)			35.0 ± 9.6					35.0 ± 10.0		
BMI (kg/m^2)			16.0 ± 5.0					20.6 ± 4.7		

Note. Two children declined to specify their gender. Height, weight, and BMI are displayed in Mean ± SD.

4.3 Parental Perception of COVID-related Physical Activity Change

In the present study, 211 parents provided complete data regarding their perceptions of COVID-related PA change in their child, age 8–12 years. The questions regarding perceived COVID-related PA change included overall PA change (Overall), PA change at home (Home), PA change for active transport (Transportation), PA change in school (School), PA change in the neighborhood (Neighborhood), PA change in recreation and sports facilities (Sports facilities), PA change in sitting time (Sitting time), PA change in screen time (Screen time) and, PA change in outdoor time (Outdoor time). The 5-point Likert scale ranges from much less, somewhat less, about the same, somewhat more, and much more. The proportions of parental perceptions of COVID-related PA changes are shown in Table 2.

The most reported and negative change in parental perception of children's physical activity change was at recreation and sports facilities. A total of 72.5% of parents reported that their child did much less PA at these facilities. In the "somewhat less" category (category 2): children's PA in overall (53.6%), home (36.0%), school (41.2%), and neighborhood (33.6%) were the most reported by their parents. In the "about the same" category (category 3): PA at home (36.0%), PA for active transport (47.9%), and PA in outdoor (36%) were the most frequent responses by the parents. Sitting time (45.0%) was reported the most negative change in sedentary behaviour by the parents in the "somewhat more" category (category 4). In the "much more" category, screen time

(54.0%) was the most frequent response reported by the parents, followed by sitting time (29.4%).

Table 2

Descriptive Statistics for Parental Perceptions of COVID-related Physical Activity Change in Their School-aged Children (N=211)

	Parent perceived change (N=211)								
	Overall	Home	Transportation	School	Neighbourhood	Sport facilities	Sitting	Screen	Outdoor
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Much Less (1)	47 (22.3)	31 (14.7)	37 (17.5)	61 (28.9)	23 (10.9)	153 (72.5)	0 (0.0)	0 (0.0)	13 (6.2)
Somewhat Less (2)	113 (53.6)	76 (36.0)	48 (22.7)	87 (41.2)	71 (33.6)	40 (19.0)	9 (4.3)	4 (1.9)	68 (32.2)
About the Same (3)	38 (18.0)	76 (36.0)	101 (47.9)	53 (25.1)	57 (27.0)	15 (7.1)	45 (21.3)	13 (6.2)	76 (36.0)
Somewhat More (4)	11 (5.2)	25 (11.8)	21 (10.0)	8 (3.8)	45 (21.3)	3 (1.4)	95 (45.0)	80 (37.9)	37 17.5)
Much More (5)	2 (0.9)	3 (1.4)	4 (1.9)	2 (0.9)	15 (7.1)	0 (1.4)	62 (29.4)	114 (54.0)	17 (8.1)
Mean	2.09	2.49	2.56	2.07	2.8	1.37	3.99	4.44	2.89
Median	2	2	3	2	3	1	4	5	3
Mode	2	3	3	2	2	1	4	5	3

4.3.1 Relationships between Parental Perception of Various Modalities of Activity Change and Overall Activity Change

A correlation analysis was conducted to examine the relationship between parental perceptions of PA, sedentary activities, and outdoor time (shown in Table 3). The scores are from the 5-point Likert Scale from 1 to 5, representing the perceptions of change in behaviour from much less, somewhat less, same, somewhat more, and much more. The results showed the measure of overall PA change was significantly associated with the other eight variables. In particular, overall PA was significantly positively associated with all other PA measures and outdoor time ($r(77) = 0.429$, $p < 0.001$) but significantly negatively related to sitting time ($r(77) = -0.388$, $p < 0.001$) and screen time ($r(77) = -0.307$, $p < 0.001$).

Table 3

Correlations between Parental Perceptions of Overall COVID-related PA Change and Selected Activity Modalities (N=211)

Parental Perception ΔPA	PA Measures						Sedentary Measures		Outdoor
	1	2	3	4	5	6	7	8	9
1. Overall ΔPA	1.00								
2. Home ΔPA	.159*	1.00							
3. Active transport ΔPA	.284**	-.113	1.00						
4. School ΔPA	.323**	.073	.233**	1.00					
5. Neighbourhood ΔPA	.478**	.075	.325**	.257**	1.00				
6. Sport & Rec ΔPA	.352**	-.038	.028	.093	.149*	1.00			
7. Sitting time	-.388**	.000	-.087	-.163*	-.276**	-.243**	1.00		
8. Screen time	-.307**	-.044	-.043	-.164*	-.007	-.269**	.525**	1.00	
9. Outdoor time	.429**	.075	.323**	.192**	.580**	.011	-.303**	-.138*	1.00

* $0.01 < p < 0.05$. ** $p < 0.01$

4.3.2 Prediction of Parental Perception of Overall COVID-related Physical Activity Change

To better understand the overall parent-perceived PA change, a regression analysis was performed with overall PA change as the dependent variable and the other eight PA modalities, including sedentary activity and outdoor time, as independent variables. Results showed that 42.3% of the variance ($F(8,202) = 20.29$, $p < 0.001$) in parent-perceived overall PA change was accounted for by the eight predictors. Looking at the individual contributions of the predictors, the result shows that the home PA (β=0.139, t=2.591, p=0.01), transportation PA (β=0.12, t=2.071, p=0.04), school PA (β=0.137, t=2.45, p=0.015), neighbourhood PA (β=0.211, t=3.096, p=0.002), sport facilities PA (β=0.25, t=4.475, p<0.001) and outdoor time (β=0.175, t=2.594, p=0.01) demonstrated positive correlations to, and made significant contributions to, the prediction of overall PA change. Although sitting time (β=-0.133, t=-2.034, p=0.043) was negatively related to the change in overall PA time and made a significant contribution to the overall prediction, the change in screen time ((β=-0.096, $p>0.05$) did not.

Table 4

Regression Analysis for Predicting Parental Perception of Overall COVID-related Physical Activity Change (N=211)

Category	*r*	*β*	*R*
Home	.159*	.139**	
Transportation	.284**	.120*	
School	.323**	.137*	
Neighbourhood	.478**	.211**	
Sport facilities	.352**	.250**	
Sitting time	-.388**	-.133*	
Screen time	-.307**	-.096	
Outdoor time	.429**	.175**	.667
			F(8, 202)=20.29**
			R^2= .445
			Adj R^2= .423

* 0.01 < p < 0.05. ** p < 0.01

4.4 Children's Perception of COVID-related PA Change

A total of 79 children provided complete data regarding their perceptions of COVID-related PA change. The proportions of children's perceptions of COVID-related PA change are shown in Table 5.

Most of the children's PA categories responses fall in the "somewhat less" category, such as overall PA (43.0%), PA at home (41.8%), PA for active transport (41.8%), PA in the neighborhood (35.4%) and PA at recreation and sports facilities (44.3%). The rest of physical activity and outdoor time responses mainly fall into the "about the same" category, with overall PA (32.9%), home PA (34.2%), PA for active transport (35.4%), PA in school (35.4%), PA in neighborhood (31.6%) and outdoor time (38.0%). The PA in sport facilities were reported most frequently in the "much less" category. In the "somewhat more" category (category 4), sitting time (54.4%) and screen time (49.4%) were the most frequent responses reported by the children. Moreover, some of the children even reported their sedentary behaviour fell into the "much more" category, with sitting time (17.7%) and screen time (25.3%).

Table 5

Descriptive Statistics for Child Perceptions of COVID-related Physical Activity Change (N=79)

	Child perceived change (N=79)								
	Overall	Home	Transportation	School	Neighbourhood	Sport facilities	Sitting	Screen	Outdoor
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Much Less (1)	7 (8.9)	10 (12.7)	10 (12.7)	7 (8.9)	6 (7.6)	27 (34.2)	0 (0.0)	0 (0.0)	2 (2.5)
Somewhat Less (2)	34 (43.0)	33 (41.8)	29 (36.7)	33 (41.8)	28 (35.4)	35 (44.3)	5 (6.3)	2 (2.5)	23 (29.1)
About the Same (3)	26 (32.9)	27 (34.2)	28 (35.4)	28 (35.4)	25 (31.6)	13 (16.5)	17 (21.5)	18 (22.8)	30 (38.0)
Somewhat More (4)	12 (15.2)	8 (10.1)	8 (10.1)	9 (11.4)	14 (17.7)	3 (3.8)	43 (54.4)	39 (49.4)	17 (21.5)
Much More (5)	0 (0.0)	1 (1.3)	4 (5.1)	2 (2.5)	6 (2.8)	1 (1.3)	14 (17.7)	20 (25.3)	7 (8.9)
Mean	2.54	2.45	2.58	2.57	2.82	1.94	3.83	3.97	3.05
Median	2	2	3	2	3	2	4	4	3
Mode	2	2	2	2	2	2	4	4	3

4.4.1 Relationships between Children's Perception of Various Modalities of Activity Change and Overall Activity Change

The relationships between children's perceptions of PA, sedentary activities, and outdoor time were assessed via linear correlation (Table 6). Scores ranged from 1 to 5, representing the perceptions of change in behaviour from much less, somewhat less, about the same, somewhat more, and much more. The results show that a child's perceived overall PA change was significantly associated with the other eight variables. In particular, overall PA was significantly positively associated with other PA measures and outdoor time ($r(77) = 0.618$, $p < 0.001$) but significantly negatively related to sitting time ($r(77) = -0.413$, $p<0.001$) and screen time ($r(77) = -0.406$, $p < 0.001$).

Table 6

Correlations between Children's Perceptions of Overall COVID-related Physical Activity Change and Selected Activity Modalities (N=79)

Children's Perception ΔPA	PA Measures						Sedentary Measures		Outdoor
	1	2	3	4	5	6	7	8	9
1. Overall ΔPA	1.00								
2. Home ΔPA	.494**	1.00							
3. Active transport ΔPA	.414**	.215	1.00						
4. School ΔPA	.538**	.456**	.505**	1.00					
5. Neighbourhood ΔPA	.544**	.482**	.290**	.443**	1.00				
6. Sport & Rec ΔPA	.452**	-.119	.143	.207	.143	1.00			
7. Sitting time	-.413**	-.384**	-.152	-.460**	-.234*	-.235*	1.00		
8. Screen time	-.406**	-.133	-.345**	-.183	-.148	-.211	.478**	1.00	
9. Outdoor time	.618**	.398**	.357**	.530**	.635**	.254*	-.318**	-.303**	1.00

* $0.01 < p < 0.05$, ** $p < 0.01$

4.4.2 Prediction of Children's Perception of Overall COVID-related Physical Activity Change

The children's perceptions of overall COVID-related physical activity change were also investigated. A regression analysis was performed with overall PA change as the dependent variable and other eight PA modalities, including sedentary activity and outdoor time, as independent variables, similar to the parental perceptions of overall COVID-related physical activity change in section 4.3.2. Results reveal that 57.6% of the variance in children-perceived overall PA change can be accounted for by the eight predictors collectively, ($F(8,70) = 14.22$, $p < 0.001$). Moreover, looking at the individual contributions of the predictors, the results show that home PA (β=0.192, t=2.112, p=0.038), sports facilities PA (β=0.271, t=3.487, p<0.001) and outdoor time (β=0.212, t=1.992, p=0.05) demonstrated positive correlations with, and made significant contributions to, the prediction of child-perceived overall PA change. Although sitting time (β= -.013, p>0.05) and screen time (β= -.177, p>0.05) were negatively related to the change in overall PA, they failed to make a significant contribution to the overall prediction.

Table 7

Regression Analysis for Predicting Children's Perception of Overall COVID-related Physical Activity Change (N=79)

Category	*r*	*β*	*R*
Home	.494**	.192*	
Transportation	.414**	.082	
School	.538**	.129	
Neighbourhood	.544**	.165	
Sport facilities	.452**	.271**	
Sitting time	-.413**	-.013	
Screen time	-.406**	-.177	
Outdoor time	.618**	.212*	.787
			F(8, 70)=14.22**
			R^2= .619
			Adj R^2= .576

* 0.01 < p < 0.05, ** p < 0.01

4.5 Understanding the Role of Physical Literacy in Children's Perceptions of COVID-related PA Change

4.5.1 Composite Variable for Total PA Change

To enhance the reliability of the COVID-related PA change measures, a composite variable for total PA change was computed using the mean of seven PA change measures: home PA, transportation PA, school PA, neighborhood PA, sports facilities PA, and outdoor time. Initially, a reliability analysis was conducted to test the reliability of the measures. However, the analysis showed that the two sedentary measures, sitting time and screen time, weakened the reliability, so those two variables were removed. The final results showed that the total PA change has Cronbach's Alpha at the value of 0.82, which showed the items have a good internal consistency (Taber, 2018a) (see Table 8).

Table 8

Descriptive of a Composite Variable for Total PA Change

	Variable	Mean	SD	*r*	Cronbach's Alpha
Item (7)	Overall PA	2.54	0.86	0.82***	
	Home PA	2.46	0.89	0.62***	
	Transportation PA	2.58	1.01	0.58***	
	School PA	2.57	0.90	0.77***	0.82
	Neighborhood PA	2.82	1.06	0.74***	
	Sport facilities PA	1.94	0.88	0.41***	
	Outdoor time	3.05	0.99	0.77***	
Scale	Total PA change	17.96	4.56	1.00	

***$p < 0.001$

4.5.2 Physical Literacy Domains and COVID-related Physical Activity Changes

The cognitive and affective domains of physical literacy were assessed using CAPL-2 (HALO, 2017). Affective scores ranged from 0-10, and cognitive scores ranged from 0-30. A third PL domain, PA behaviour, was measured by PAQ-C, and scores range from 0-5. An independent t-test and ANOVA were performed to test if there were significant differences between gender and age group in knowledge and understanding, motivation and confidence, and PA behaviour. The scores in Table 9 indicate that the three domains of physical literacy numerically increase as the age goes up. Boys have numerically higher scores in knowledge and understanding and motivation and confidence domains, but lower scores in the physical activity behaviour domain, compared with girls. However, no statistically significant mean difference was found in any of the gender or age groups.

Based on the CAPL-2 score categorization, for the cognitive domain, 41.8% of the children are in the "excelling" category, which means they are excelling at the recommended level of physical activity knowledge and health benefits. 31.6% of the children are in the "progressing" category, which means they need to gain more knowledge about physical activity. However, 11.4% of the children are still in the "beginning" category. For affective domain, the majority of the children, 67.1%, are in the "excelling" category, and 27.8% of the children are still in the "beginning" and "progressing" categories. This is shown in Table 10.

Table 9

Descriptive Statistics for Physical Literacy Domain Scores by Gender and Age Level (N=79)

PL Domain	Age					Gender	
	8 (n=15)	9 (n=23)	10 (n=18)	11 (n=15)	12 (n=8)	Boys (n=45)	Girls (n=32)
Cognitive	7.13 ± 2.07	7.13 ± 2.07	6.61 ± 2.00	7.93 ± 1.62	8.00 ± 1.60	7.42 ± 1.94	7.03 ± 2.02
Affective	25.47 ± 4.46	25.40 ± 4.02	25.02 ± 4.17	26.15 ± 3.23	26.69 ± 4.82	25.99 ± 4.00	24.87 ± 4.07
PA behaviour	3.09 ± 0.64	3.39 ± 0.65	3.10 ± 0.71	2.92 ± 0.67	3.53 ± 0.84	3.08 ± 0.68	3.32 ± 0.71

Note. Data was presented in Mean ± SD.
Cognitive scores ranged from 0-10, Affective scores ranged from 0-30, PA behaviour scores ranged from 0-5.
Two children did not specify their gender.

Table 10

Canadian Assessment of Physical Literacy Affective and Cognitive Domain Scores by Interpretation Category

	Beginning[a]	Progressing[b]	Achieving[c]	Excelling[d]
Cognitive Domain	11.4%	31.6%	15.2%	41.8%
Affective Domain	2.5%	25.3%	5.1%	67.1%

Note. a = Child is just beginning to develop physical literacy.
b = Child is progressing on the physical literacy journey and is performing at a level similar to peers.
c = Child is achieving recommended scores indicative of the physical literacy needed to obtain health benefits from a physically active lifestyle.
d = Child is exceeding recommended physical literacy levels associated with substantial health benefit.

4.5.3 Relationships between Physical Literacy Domains, Demographic Variables, and COVID-related PA Change

A principal goal of this research is to determine the relationship between physical literacy domains, demographic variables, and COVID-related PA change. It was hypothesized that a combination of physical literacy measures, including affective and cognitive measures of physical literacy and current physical activity, will reliably predict perceived change in COVID-related Physical Activity levels. In addition, it was hypothesized that the addition of demographic measures of BMI, gender, and age would not increase the predictive ability of the model. To test this hypothesis, a hierarchical regression analysis was performed. The composite variable for total PA change was used as the dependent variable. The three domains of physical literacy, cognitive, affective, and PA behaviour, were entered on the first step of the analysis. The demographic variables, BMI, age, and gender were entered on the second step of the analysis.

Results reveal that the three PL measures can account for 8.9% of the variance in total PA change collectively, $F(3,73) = 2.386$, $p=0.076$, for the first step of the hierarchical regression analysis. Then, BMI, age, and gender were added to the model, improving the R square to 15.0%, meaning that 15.0% of the variance in total PA change can be accounted for by the six predictors, with $F(6,70) = 2.053$, $p=0.07$. However, the significance of an R square change in the second step is F Change = 1.66, $p=0.184$, which failed to significantly improve the prediction ability of the model. It can be deduced that

the demographic variables, BMI, age, and gender failed to increase the predictive ability of the COVID-related PA change.

A post-hoc analysis was performed after the study had been completed and used the obtained sample size and effect size to find the power of the study to be 0.77. Given that adequate power has traditionally set at 0.8 (Jones et al., 2003), a decision was made to set alpha at 0.1 to reduce the possibility of a Type II error (Dahiru, 2008).

Given the unique individual contributions of the predictors, the result shows that the affective measures of PL, motivation and confidence (β=0.327, t=2.757, p=0.007), positively predict total PA change. This suggests that children who have higher scores in the affective measures of the CAPL, motivation and confidence, were more likely to have maintained or increased their total PA behaviour during COVID-19.

Table 11

Prediction of Children's Perceptions of Composite Total PA Change

		r	B	*β*	R	F	F Change
Step 1					0.3	2.39*	2.39*
	Cognitive Domain	0.07	-0.01	-0.02			
	Affective Domain	0.29**	0.05**	0.31**			
	Current PA Levels	-0.01	-0.05	-0.05			
Step 2					0.39	2.05*	1.66
	Cognitive Domain	0.07	-0.02	-0.07			
	Affective Domain	0.29**	0.05**	0.33**			
	Current PA Levels	-0.01	-0.03	-0.03			
	BMI	-0.21	-0.04**	-0.24**			
	Age	0.08	0.05	0.09			
	Gender	-0.01	0.04	0.03			

** $p < 0.05$, * $0.05 < p < 0.1$

Chapter 5. Discussion

The purpose of this study was to gain insight into school-aged children's physical activity change during COVID-19 from a sample of Canadian children aged 8–12 years. In addition, the research sought to investigate the role that physical literacy plays in COVID-related physical activity changes.

A significant finding of the study was that both children and parents perceived a decrease in children's physical activity and outdoor time and an increase in sedentary-related behaviours during a time of COVID-related restrictions. Moreover, the affective domain of physical literacy played an important role in predicting children's COVID-related physical activity changes. This suggests that children with higher scores in motivation and confidence, as measured by the CAPL, were more likely to maintain or increase their health-related physical activity behaviours during the lockdown. The implications of these key findings will be discussed below.

5.1 Health-related Behaviour between Child Self-reports and Parent Proxy-reports During COVID-19

The first goal of the study was to understand children's physical activity change during a regional and provincial COVID-19 lockdown. It was hypothesized that both parents and children would perceive less PA participation and less outdoor activity, and

more time spent in sedentary activities among a sample of Canadian school-aged children during the COVID-19 lockdown.

I found that the majority of the children and parents reported a decrease in children's physical activity, and an increase in sedentary-related behaviours in the time of COVID-19, which was consistent with previous studies (Dunton et al., 2020; Moore et al., 2020; Schmidt et al., 2020). Specifically, child respondents reported they engaged in less PA around the home, in and around school, and at recreation and sports facilities. Also, children reported being involved in more sedentary-related behaviour. Daily sitting time and screen-based activities both increased during the lockdown. This is in line with the Canadian national data (Moore et al., 2020) that children and youth were less active, played outside less, were more sedentary and engaged in more screen-based activities during the period of COVID-related restrictions. The potential reasons for these findings are due to provincial lockdown and restrictions, governments closed sport and recreational facilities and schools, where children usually accumulate their daily physical activity.

Moreover, the majority of parents reported many of the same changes that their children reported in terms of their children's participation in less PA overall, in and around school and at recreation and sports facilities, and much more time spent in screen-based activities. The parents' reports are consistent with other Canadian parent proxy-reports that their child's PA at home remained unchanged (32.9%) or increased (48.8%)

since the pandemic, and half of the parents perceived their children decreases playing at outdoor (52.7%) and public spaces (53.7%) (McCormack et al., 2020). Moreover, over half of the parents perceived increases in watching television (58.8%), playing video games (56.4%), and using screen-based devices (75.9%) (McCormack et al., 2020). However, a number of studies reported the difference between child self-reports and parent proxy-reports. Children tend to report more outside play and less television viewing than their parents reported during COVID-19 (Koning et al., 2018). The reasons for the different results are not clear, but it may be that parents are not fully aware of their children's activities, or that there is the potential for social desirability bias and recall bias between parents and children (Koning et al., 2018; Krumpal, 2013). Meaning that parents may mispresent self-reported behaviours by over-reporting behaviours considered socially desirable, and underreporting undesirable ones (Krumpal, 2013) and they may not accurately remember previous events or experiences, or may omit details of their children to cause the recall bias (Infante-Rivard, 2000).

Moreover, based on the present study, I could not conclude whether the parent's or the children's perceptions are more accurate, however, considering the age group of this sample of children, the combination of child self-reports and parent proxy-reports has the potential to provide a more comprehensive estimate of children's PA change.

To my knowledge, there are no studies that have investigated both child self-report and parent proxy reports in children's health-related PA behaviour during the time of

COVID-19. However, before COVID-19, studies have proved that parents can be a useful proxy report of children's PA even though the result was limited by time spent with their children (Chaumeton et al., 2011).

5.2 Demographic Variables, Domains of PL and COVID-related PA Change

To test the hypothesis that a combination of physical literacy domains will reliably predict perceived change in physical activity but the demographic variables such as gender, age and BMI will not increase the predictive ability of the model, a hierarchical regression analysis was conducted. The domains of PL were entered in the first step and the demographic variables, gender, age, and BMI were added in the second step of the model.

I found that 15.0% of the variance in total PA change can be accounted for by the six predictors.

A post hoc power analysis was conducted using G Power (Faul et al., 2007). The sample size of 79 was used for the analysis and six predictor variables were used as the baseline. The alpha level used for this analysis was $p<0.05$. The post hoc analyses revealed the statistical power for this study was 0.77. Due to the low power, there is a potential for Type II error. However, the timing of the COVID-19 lockdown prevented us from recruiting a larger sample. Thus, we set our alpha at 0.1 as the significant level in

the hierarchical regression analysis for detecting the relationships. It is acknowledged that the sample size, and subsequent change in alpha from a power perspective, are weaknesses of the current study. A future study could recruit more participants to support this evidence.

Based on the results, we obtained a significant prediction of total PA change on the first step of the regression analysis ($F(3,73) = 2.386$, $p < 0.1$, R square of 0.089) with the affective domain being the only reliable contribution to the prediction. For the second step, external variables of BMI, age, and gender were added and no improvement of the prediction ability was found.

These results can also be supported by many studies that found increased motivation levels were related to greater physical activity participation (B. Owen et al., 2014; Deci & Ryan, 2000; Rutten et al., 2012). Previous studies have also supported the relationships between physical literacy score and physical activity behaviour and sedentary behaviour guidelines, that children who meet the physical activity guidelines or sedentary behaviour guidelines had higher physical literacy domain scores for physical competence and motivation and confidence compared to those not meeting either guideline. These studies also reported there were no significant findings identified for the cognitive domain (Belanger et al., 2018). These findings are in line with my results.

According to my findings, the cognitive domain was not correlated to PA change, which is inconsistent with previous studies that have reported that knowing the physical

activity guidelines, and having better health-related fitness knowledge, are related to higher levels of physical activity (Ferkel & Judge, 2014; Roth & Stamatakis, 2010), and the promotion of health-related behaviours (Zhu et al., 2020). Educators should be addressing the limited knowledge of physical activity demonstrated by children and adolescents through health education and physical education classes in schools. Children and adolescents should be given correct information about exercise given its increasing popularity and potential health benefits.

Other studies provided conflicting evidence of a non-significant association between knowledge and understanding, and PA level, which may not be unusual.

Belanger and colleagues (2018) reported that a child who does not participate in PA may lack an understanding of the concept and principles that underlie a healthy, active lifestyle. In addition, Li and her colleagues (2020) found that the affective measures of PL in the CAPL was a reliable instrument for measuring motivation and confidence in PA. However, the questionnaire for the cognitive domain, relating to knowledge and understanding of PA, displayed low reliability. The reasons for the low reliability may be due to the limited number of items in the subscale or too many nominal variables with many scores represented by “right” or “wrong” (Li et al., 2020); a statistical limitation when grouping items together within this domain (Taber, 2018b). Moreover, in another Canadian study, researchers examined the reliability of CAPL and found limited reliability in some items, such as how to improve sports skills (Longmuir et al., 2018).

Future research could consider developing a new version of the Knowledge & Understanding questionnaire, similar to the Physical Literacy Knowledge Questionnaire (Longmuir et al., 2018), or compare the questionnaire with the validity and reliability among the knowledge domains of different measurements.

For the demographic variables, previous studies found gender and age group related differences indicating that girls were less active than boys and youth were less active than children (Moore et al., 2020a). Cai and colleagues found (2017) weight status was negatively related to physical activity and positively related to sedentary behaviour. In addition, a study reported that children who had a healthier weight status had higher CAPL scores than children who were overweight or obese (Delisle Nyström et al., 2018). Although I noted an anomaly of a significant beta with a non-significant *r* in BMI, the gender, age, and BMI variables in the second step of the analysis failed to increase the predictive ability of the analysis.

5.4 Strengths and Limitations

5.4.1 Strengths

My study assessed changes in children's PA during the COVID-19 pandemic, not only from the child's perspective but also from parent proxy-reports. Without the objective measures of a child's PA due to the COVID-19 lockdown and social distancing

restrictions, adding parent's reports offered the potential for a more comprehensive understanding of children's PA change to help us better understand the behaviour of children during the COVID-19 pandemic.

Secondly, some studies reported PA change without investigating, in more detail, the PA modalities. My study provided more comprehensive aspects of PA, seven different PA modalities, and two sedentary activities. It can help us better understand what modalities have been affected the most during COVID-19 and aid which modalities are most in need of targeted interventions.

5.4.2 Limitations

The limitations of this study are:

1. All the measures, such as PA, were based on the children's self-report. This type of measurement generally has a relatively lower validity and reliability compared with objective measurements. As I did not anticipate the onset of COVID-19, I did not do any pre-COVID PA measures for this study; all measures of PA change were the self-reported perceived changes in activity levels.
2. I asked participants to reflect on their past behaviours and compared them to the present, which can generate recall error in participants and create potential social desirability bias.
3. The process of recruiting a sample of young children via an online survey was

difficult because some parents are reluctance to share their child's email address, or lack of a personal email address for children aged 8–12.

4. My data collection had to be completed before the "Open for Summer" plan was implemented, when almost all the COVID-restrictions were lifted in Alberta. This time constraint limited the ability to recruit multiple waves of participants.
5. My sample was drawn from a database of Green and Gold Sports System participants, an athlete development program. The children in the sample may have been more active and have higher physical literacy levels than the "normal" population.
6. Due to COVID-19, an in-person assessment was impossible to conduct. Therefore, the physical competence domain of physical literacy, including motor performance and fitness tests, were not assessed. It was, therefore, not possible to collect a complete physical literacy score.
7. Due to a smaller than intended sample size and the inability to recruit a larger sample because of the timing of the COVID-19 situation, I set the alpha at 0.1 to reduce the possibility of a Type II error. It is acknowledged that this is a weakness of this study.

Chapter 6. Conclusion

6.1 Conclusion

This study provides evidence of school-aged children participating less in physical activity and engaging in more sedentary behaviour during the time of COVID-related restrictions compared to before the pandemic. In addition, the physical literacy measures of the affective domain of PL made a significant contribution to the prediction of change in physical activity during COVID-19 restrictions. These findings suggest that at least one component of physical literacy helped to strengthen the ability of children to withstand the changes brought about due to pandemic-related restrictions, in terms of maintaining—or increasing—health-related PA.

6.2 Contribution, Recommendations, and Future Directions

There are emergent concerns to bring attention to the likely impact of the COVID-related restrictions and lockdown on the movement behaviour of children and youth (Chen et al., 2020). Our findings provide some perspective on which children's movement behaviours were most affected by COVID-restrictions, and how children's motivation and confidence in physical activity positively contribute to their health-related movement behaviour.

I suggest the following recommendations to facilitate the development of home-based and community-based PA programs to help increase the daily physical activity level, especially during COVID-19 restrictions or for similar crises in the future. The public need to be made aware that official restriction measures do not necessarily mean that physical activity must be limited. On the other hand, home PA can be encouraged through engaging in more housework or yard work, by completing bodyweight home workouts, and by promoting digitally based PA, such as PA apps or online fitness classes. In addition, promoting neighborhood-based PA and outdoor activities—free play, running, or cycling—in a responsible and attentive socially distanced manner, can also help us to successfully meet the recommended PA guidelines, which could bring health-related benefits.

My results also reveal the importance of the affective domain of physical literacy in participation in physical activity. I also recommend that efforts be made to facilitate the prime components of children's affective domain—motivation and confidence—in their participation in physical activity and sports. Based on Ryan and colleagues's findings in 2009 self-determination theory, the internalization and integration of motivation for physical activity are fostered by supporting the three basic needs: support for relatedness, competence, and autonomy. As for the children's confidence, research has shown that it can be improved by advocating a parent's supportive behaviours and through parental modelling effect (Trost et al., 2003). Therefore, these findings can inform strategies to

mitigate potential harm during the post-COVID recovery period and future COVID-related restrictions or a similar pandemic in the future.

Future research is needed to investigate the relationship between the cognitive domain of PL and physical activity, since the findings in different research studies is inconsistent.

Moreover, future research that minimizes the potential for social desirability bias and recall error is needed. This future research can employ objective measures of PA to provide a more accurate estimate of school-aged children's PA levels compared with self-report measures. In addition, more research is needed to establish the direction of causality between the domains of physical literacy and physical activity, and to determine effective interventions or policies to increase physical activity and decrease sedentary-related behaviour so school-aged children might then gain health-related benefits, even during COVID-related restrictions.

Still today, we are encountering ongoing waves of the COVID-19 pandemic. The likelihood that COVID-19 may not be eliminated should not be ignored. We must learn live with COVID-19. From another perspective, the COVID-19 pandemic was a good natural test of children's resistance to adverse effects on their physical activity behaviour. It will help us study how physical literacy can inoculate children against the impact of similar environmental/societal changes, which have the potential to affect physical activity behaviour negatively.

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Appendices

Appendix A

Parental Consent Form

Dear Parent or Legal Guardian:

We invite you and your child to take part in a research study being conducted by Liaoyan (Gary) Gan, from the Faculty of Kinesiology, Sport, and Recreation as part of his Master's degree at the University of Alberta. The study, as well as your child's rights as a participant, are described below.

The purpose of this consent is to give you the information you will need to help you decide whether you and your child could be in this study or not. You may have questions about the purpose of the study, what we would ask you and your child to do, the possible risks and benefits, you and your child's rights as a volunteer and anything else about this research. As your child is under 18, we request that you read the information about this study before you give permission for your child to participant. Thanks for your time and cooperation.

Title of the study: The Relationship between the Cognitive and Affective Measures of Physical Literacy and Changes in Physical Activity in a Sample of Children and Adolescents During COVID-19

Principal Investigator:
Liaoyan (Gary) Gan
Graduate Student
Faculty of Kinesiology, Sport, and Recreation
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Supervisor:
Dr. Kerry Mummery
Professor and Dean
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Information about the Study: The research will be conducted using an online survey that includes questions about physical activity behaviour, perceptions of COVID-related change in physical activity, and cognitive measures of physical literacy such as motivation & confidence, knowledge and understanding. We will expect a number of 150 children to participate in this study. The online survey is anonymous, and it will take about 10 minute for you to complete and 20 minutes for your child to complete.

Purpose of the study: From this research we wish to learn about the effects of the pandemic on physical activity levels in school children and trying to determine who may have been most affected and why.

Benefits: There are no direct benefits from participating in this study. However, you and your child's responses may help us learn more about physical activity behaviour and its correlates in the time of COVID.

Risks: There are no known risks associated with participating in this study.

Confidentiality and Anonymity: The information collected from you and your child will be kept confidential, and all the information will only be used for the purposes of this project. Given the anonymous nature of the survey, once you and your child has submitted the responses, it will no longer be possible to withdraw them from the study. All information taken from the study will be coded to protect each participant's name and no names or other identifying information will be used when discussing or reporting data. Once the data has been fully analyzed it will be destroyed, including your child's email address. Follow-up emails will only be sent when necessary, you and your child could also choose to opt out by sending an email to the principal investigator.

Contact Information: If you have any questions or require more information about the study itself, you may contact the researcher Liaoyan (Gary) Gan at gan@ualberta.ca

The plan for this study has been reviewed by a Research Ethics Board at the University of Alberta, and the REB ID is **Pro00110836**. If you have any questions regarding your child's rights as a research participant or how the research is being conducted you may contact the Research Ethics Office at 780-492-2615.

Once you have consented your child to participate in the study by signing the parental e-consent form via REDCap. You will need to complete a simple survey about estimating your child's physical activity changes from pre-COVID to now. Then, a recruiting email and the link of the child assent form will be sent to your child via email. They will have the chance to read the information about the study and decide if they want to be in this study or not.

Child Assent Form

Title of the study: The Relationship between Cognitive Measures of Physical Literacy and Physical Activity in a Sample of Children and Adolescents during COVID-19

Principal Investigator: Liaoyan (Gary) Gan
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We want to tell you about a research study we are doing. A research study is a way to learn more about something. We would like to find out more about your physical activity levels in the time of COVID. You are being asked to join the study because you are children between the ages of 8 and 12 and in a good health. We hope that 150 children will join this study.

Participation: If you are willing to join this study, you will need to fill out an online survey. It will take you about 20 minutes to complete. It is ok to get help from your parents if you are not sure or do not know about the answer. For example: your height and weight.

Risks: There are **no** known risks associated with this study. We asked your parents. And they said that we could ask you if you want to be in it. You can talk this over with them before you decide.

Purposes: This study will help us learn more about the child's physical activity. Also, what factors will influence it in the time of COVID.

What you should know: You do not have to join this study. It is up to you. No one will be mad at you if you don't want to be in the study. No one will know your answer once you submitted your survey. All the information collected about you

during this study will be safe. If you are not willing to continue the survey, you can always end the survey by closing the link. We will not record your name, so it is not possible to withdraw your response once you have submitted the survey. We will send you follow-up emails only when necessary. You could also choose to quit by sending an email to gan@ualberta.ca.

Contact information: Before you say yes or no to being in this study, we will answer any questions you have. If you join the study, you can ask questions at any time. Please email Gary Gan.

Appendix B

Children Survey

We want to know what kids, like you, think about physical activity and the reasons why you might be physically active. There are no right or wrong answers, we only want to know what you think. If you do not know an answer, please write your best guess. There is no time limit, so please take all of the time you need.

Part 1. Demographic information

1. Year of birth?
   _____

2. Month of birth?
   _____

3. What school grade are you in?
   _____

4. Are you a Boy or a Girl?
   a) Boy
   b) Girl
   c) Prefer not to answer

5. What is your height (in centimeters)?
   _____

6. What is your weight (in kilograms)?
   _____

Part 2. Motivation and Confidence

Boys and girls can be active by doing all sorts of things:
Exercise (walking, keeping fit, or gym class)
Playing outside or doing active things (like playing in the park)
Sports (like soccer, tennis, hockey, dance or swimming)

Below are some reasons why you might be active, please read each sentence and tell us how true it is for you.

1. I really like playing active games
    a) Really true for me
    b) Sort of true for me
    c) Not really true for me
    d) Not true for me

2. I have a good time playing sports
    a) Really true for me
    b) Sort of true for me
    c) Not really true for me
    d) Not true for me

3. I really enjoy playing sports
    a) Really true for me
    b) Sort of true for me
    c) Not really true for me
    d) Not true for me

4. I am good at active games
    a) Really true for me
    b) Sort of true for me
    c) Not really true for me
    d) Not true for me

5. I do well in most sports
    a) Really true for me
    b) Sort of true for me
    c) Not really true for me
    d) Not true for me

6. I can learn to play active games easily
    a) Really true for me
    b) Sort of true for me
    c) Not really true for me
    d) Not true for me

7. I am active because being active is fun
    a) Really true for me

b) Sort of true for me
c) Sometimes true for me
d) Not really true for me
e) Not true for me

8. I am active because I enjoy being active
a) Really true for me
b) Sort of true for me
c) Sometimes true for me
d) Not really true for me
e) Not true for me

9. I am active because I like being active
a) Really true for me
b) Sort of true for me
c) Sometimes true for me
d) Not really true for me
e) Not true for me

Below are some sentences describing how you feel about being active, please read each sentence and tell us how much each sentence is like you.

10. When it comes to playing active games, I think I am pretty good
a) Really like me
b) Quite a lot like me
c) Sometimes like me
d) Not really like me
e) Not like me at all

11. I think I do well at activities compared to other children
a) Really like me
b) Quite a lot like me
c) Sometimes like me
d) Not really like me
e) Not like me at all

12. When it comes to being active, I have good skills
a) Really like me
b) Quite a lot like me
c) Sometimes like me
d) Not really like me

e) Not like me at all

Part 3. Knowledge and Understanding

Please read the questions about physical activity and choose one answer for each question

1. How many minutes each day **should** you and other children do physical activities that make your heart beat faster and make you breathe faster, like walking fast or running? Count the time you should be active at school and also when you are at home or in your neighbourhood.

a) 20 minutes
b) 30 minutes
c) 60 minutes or 1 hour
d) 120 minutes or 2 hours

2. There are many different kinds of fitness. One type is called endurance fitness, or aerobic fitness, or cardiorespiratory fitness. Cardiorespiratory fitness means:

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

3. Muscular strength or muscular endurance means:

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

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

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

5. This story about Sally is missing some words. Choose from the words in the list to fill in the missing words in the story. Each word can only be used to fill one blank space in the story. There are more words than blank spaces, so not all words will be used.

a) Fun
b) Stretches

c) Endurance
d) Pulse
e) Breathing
f) Flexibility
g) Good
h) Strength
i) Bad
j) Sport

Sally tries to be active every day. Running every day is good for her heart and her lungs. Sally thinks that physical activity is 5. _____ and is also 6. _____ for her. At her sport team's practice, she does more running to improve her 7. _____. The team also does exercises like push-ups and sit-ups that increase her 8. _____. When cooling down, she 9. _____to improve her flexibility and slow her heart rate. After exercising, she checks her heart rate which is also called a 10._____.

Part 4. Physical Activity

*We are trying to find out about your level of physical activity from **the last 7 days** (in the last week). This includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.*

Remember:
*1. There are no right and wrong answers — **this is not a test**.*
*2. Please answer all the questions as **honestly** and **accurately** as you can — this is very important.*

1. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)
   a) I don't do PE
   b) Hardly ever
   c) Sometimes
   d) Quite often
   e) Always

2. In the last 7 days, what did you do most of the time at recess? (Check one only.)
   a) Sat down (talking, reading, doing schoolwork)
   b) Stood around or walked around
   c) Ran or played a little bit
   d) Ran around and played quite a bit

e) Ran and played hard most of the time

3. In the last 7 days, what did you normally do at lunch (besides eating lunch)? (Check one only.)
   a) Sat down (talking, reading, doing schoolwork)
   b) Stood around or walked around
   c) Ran or played a little bit
   d) Ran around and played quite a bit
   e) Ran and played hard most of the time

4. In the last 7 days, on how many days right after school, did you do sports, dance, or play games in which you were very active? (Check one only.)
   a) None
   b) 1 time last week
   c) 2 - 3 times last week
   d) 4 - 5 times last week
   e) 6 - 7 times last week

5. In the last 7 days, on how many evenings did you do sports, dance, or play games in which you were very active? (Check one only.)
   a) None
   b) 1 time last week
   c) 2 - 3 times last week
   d) 4 - 5 times last week
   e) 6 - 7 times last week

6. On the last weekend, how many times did you do sports, dance, or play games in which you were very active? (Check one only.)
   a) None
   b) 1 time last week
   c) 2 - 3 times last week
   d) 4 - 5 times last week
   e) 6 - 7 times last week

7. Which one of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.
   a) All or most of my free time was spent doing things that involve little physical effort
   b) I sometimes (1-2 times last week) did physical activities in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics)
   c) I often (3—4 times last week) did physical activities in my free time
   d) I quite often (5 — 6 times last week) did physical activities in my free time

e) I very often (7 or more times last week) did physical activities in my free time

8. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

Mark only one oval per row.

	None	Little bit	Medium	Often	Very often
Monday	⬭	⬭	⬭	⬭	⬭
Tuesday	⬭	⬭	⬭	⬭	⬭
Wednesday	⬭	⬭	⬭	⬭	⬭
Thursday	⬭	⬭	⬭	⬭	⬭
Friday	⬭	⬭	⬭	⬭	⬭
Saturday	⬭	⬭	⬭	⬭	⬭
Sunday	⬭	⬭	⬭	⬭	⬭

9. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)
   Yes
   No

   If Yes, what prevented you?

   _____

Part 5. Perceptions of COVID-related changes in physical activity

The next series of questions ask you to compare your current level of various activities to pre-COVID levels (i.e. before March 2020)

1. In comparison to your usual level of physical activity around the home to the COVID outbreak and the government ordered restrictions, how would you rate your current level of physical activity around the home?
   a) Much less
   b) Somewhat less

c) About the same
d) Somewhat more
e) Much more

2. In comparison to your usual level of physical activity for transportation prior to the COVID outbreak and the government ordered restrictions, how would you rate your current level of physical activity for transportation?
   a) Much less
   b) Somewhat less
   c) About the same
   d) Somewhat more
   e) Much more

3. In comparison to your usual level of physical activity in and around your school to the COVID outbreak and the government ordered restrictions, how would you rate your current level of physical activity in and around your school?
   a) Much less
   b) Somewhat less
   c) About the same
   d) Somewhat more
   e) Much more

4. In comparison to your usual level of physical activity in and around your neighborhood prior to the COVID outbreak and the government ordered restrictions, how would you rate your current level of physical activity in and around your neighborhood?
   a) Much less
   b) Somewhat less
   c) About the same
   d) Somewhat more
   e) Much more

5. In comparison to your usual level of physical activity at recreation and sporting facilities prior to the COVID outbreak and the government ordered restrictions, how would you rate your current level of physical activity at recreation and sports facilities?
   a) Much less
   b) Somewhat less
   c) About the same
   d) Somewhat more
   e) Much more

6. OVERALL, in comparison to your usual level of physical activity and exercise prior to the COVID outbreak and the government-ordered restrictions, how would you rate your current level of physical activity?
   a) Much less
   b) Somewhat less
   c) About the same
   d) Somewhat more
   e) Much more

7. In comparison to the amount of time you spent in the day sitting prior to the COVID outbreak and the government-ordered restrictions, how would you rate your current level of daily sitting?
   a) Much less
   b) Somewhat less
   c) About the same
   d) Somewhat more
   e) Much more

8. In comparison to your usual level of screen-based activities (computer use, television, smartphone, etc.) prior to the COVID outbreak and the government-ordered restrictions, how would you rate your current level of screen-based activity?
   a) Much less
   b) Somewhat less
   c) About the same
   d) Somewhat more
   e) Much more

9. In comparison to your usual level of time spent outdoors prior to the COVID outbreak and the government-ordered restrictions, how would you rate your current level of outdoor time?
   a) Much less
   b) Somewhat less
   c) About the same
   d) Somewhat more
   e) Much more

Parental Survey

Perceptions of COVID-related changes in physical activity survey

The next series of questions ask you to compare your perceptions of your child's current level of various activities to their pre-COVID levels

In comparison to your child's usual level of physical activity around the home to the COVID outbreak and the government-ordered restrictions, how would you rate your child's current level of physical activity around the home?

1. Much less
2. Somewhat less
3. About the same
4. Somewhat more
5. Much more

In comparison to your child's usual level of physical activity for transportation prior to the COVID outbreak and the government-ordered restrictions, how would you rate your child's current level of physical activity for transportation?

1. Much less
2. Somewhat less
3. About the same
4. Somewhat more
5. Much more

In comparison to your child's usual level of physical activity in and around school to the COVID outbreak and the government ordered restrictions, how would you rate your child's current level of physical activity in and around school?

1. Much less
2. Somewhat less
3. About the same
4. Somewhat more
5. Much more

In comparison to your child's usual level of physical activity in and around your neighborhood prior to the COVID outbreak and the government-ordered restrictions, how would you rate your child's current level of physical activity in and around your neighborhood?

1. Much less

2. Somewhat less
3. About the same
4. Somewhat more
5. Much more

In comparison to your child's usual level of physical activity at recreation and sporting facilities prior to the COVID outbreak and the government-ordered restrictions, how would you rate your child's current level of physical activity at recreation and sport facilities?

1. Much less
2. Somewhat less
3. About the same
4. Somewhat more
5. Much more

OVERALL, in comparison to your child's usual level of physical activity and exercise prior to the COVID outbreak and the government-ordered restrictions, how would you rate your child's current level of physical activity?

1. Much less
2. Somewhat less
3. About the same
4. Somewhat more
5. Much more

In comparison to the amount of time your child spent in the day sitting prior to the COVID outbreak and the government-ordered restrictions, how would you rate your child's current level of daily sitting?

1. Much less
2. Somewhat less
3. About the same
4. Somewhat more
5. Much more

In comparison to your child's usual level of screen-based activities (computer use, television, smartphone, etc.) prior to the COVID outbreak and the government-ordered restrictions, how would you rate your child's current level of screen-based activity?

1. Much less
2. Somewhat less
3. About the same

4. Somewhat more
5. Much more

In comparison to your child's usual level of time spent outdoors prior to the COVID outbreak and the government ordered restrictions, how would you rate your child's current level of outdoor time?

1. Much less
2. Somewhat less
3. About the same
4. Somewhat more
5. Much more