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Examining geographic variation in children's perceived barriers to physical activity and the implications on behaviour

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Abstract

Low levels of physical activity among Canadian children has become a national public health issue. Recent research has suggested that children's physical activity levels are associated with their perceptions of their everyday environments. A better understanding of the formation of these perceptions within different contexts is needed to explain the extent of the relationship. Using a multi-tool quantitative protocol, this thesis examines geographic variation in socio-ecological factors influencing children's perceptions of barriers to PA, and the extent to which perceptions mediate the relationship of the environment and PA. Results indicate that perceptions form within contexts, and have an influence on PA. The studies take place in Northwestern and Southwestern Ontario. This research provides a starting point for future research, policy, and practice to consider how structures of children's environments determine experiences of PA, suggesting a new way to conceptualize behaviour to determine effective strategies for improving children's PA and overall health.

Keywords

Children; physical activity; urbanicity; rural; accelerometer; socio-ecological model; structural equation modeling; geography

Co-Authorship Statement

Each integrated article within this thesis will be submitted for publication in peer-reviewed journals. Chapters 4 and 5 were written by Leah Taylor as the primary author in both cases, performing data collection in Northwestern Ontario, statistical analysis, and writing in each article. In both cases, Dr. Jason Gilliland designed the original STEAM study. In Chapter 4, Dr. Jason Gilliland and Dr. Andrew Clark are co-authors and were involved in the development of analysis procedures. In Chapter 5, Dr. Jason Gilliland, Dr. Andrew Clark, Dr. Piotr Wilk, and Brenton Button are co-authors. Dr. Jason Gilliland and Dr. Andrew Clark were involved in the development and implementation of analysis procedures. Dr. Piotr Wilk was involved in the development and implementation of the structural equation modeling for this paper. Brenton Button was the team leader on data collection in Northwestern Ontario for the 2016 STEAM project and provided expertise on accelerometer data analysis methods and literature for this paper. Below are the journal targets for both integrated articles.

Chapter 4: Taylor, L.G., Clark, A.F., & Gilliland, J.A. Context Matters: Examining children's perceived barriers to physical activity across varying Canadian environments. Submitted to *Health and Place.*

Chapter 5: Taylor, L.G., Clark, A.F., Wilk, P., Button, B., & Gilliland, J.A. Exploring the effect of perceptions on children's physical activity in varying geographic contexts: a structural equation modelling approach. Prepared for *Social Science and Medicine*.

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Chapter 1

1 Introduction

1.1 Research Context

The benefits of physical activity, especially moderate to vigorous physical activity (MVPA), and the physical, mental, cognitive and social health contributions for children and youth are well established (Poitras et al., 2016). Despite these known benefits of physical activity, most Canadian children are not active enough to reap the health, well-being and development benefits of participation (Colley et al., 2017). The overall physical activity levels of Canadian children were issued a grade of D+ by the *2018 Participaction Report Card on Physical Activity for Children and Youth*, because less than 39% of Canadian children and youth aged 3-17 are meeting the recommendation of an average of 60 minutes of MVPA each day (Colley et al., 2017; Larouche, Garriguet, & Tremblay, 2017; ParticipACTION, 2018).

This is of further concern because physical inactivity in childhood has been associated with long lasting chronic health risks that track into adulthood. Warburton, Nicol, and Bredin (2006) have described the available research as "irrefutable evidence of the effectiveness of regular physical activity in the prevention of chronic diseases" (p.801). These associated health risks include decreases in overall health status, cardiovascular fitness, strength and bone density; and increased risk of health concerns including chronic diseases (such as some cancers, Type 2 Diabetes, and heart disease), premature death, and all-cause mortality (Bauman, 2003; Bruner, Lawson, Pickett, Boyce, & Janssen, 2008; Galloway, 2006; Pate et al., 1999; Smith, Troped, McDonough, & DeFreese, 2015; Warburton et al., 2006). Janssen (2012) has estimated a total cost of physical inactivity in Canada at $6.2 Billion, or 3.7% of the total national health care costs in 2009. Krueger, Turner, Krueger, and Ready (2014) suggest that a modest decrease of 1% in the number of Canadians who are inactive, can have a substantial economic ($20.3 cumulative reduction in burden) and population health impacts. The complexity and interrelatedness

of this issue, however, has led to the need for an important change in the way we must conceptualize physical activity and the health of Canadians.

The recently released *Report on the State of Public Health in Canada 2017* has drawn attention to this change. In her opening statement, Canada's Chief Public Health Officer Dr. Theresa Tam states: "Without being aware of it, our neighbourhoods and how they are built influence how healthy we are" (P.III). This report sought to encourage dialogue in community planning and health promotion for many reasons related to the health of Canadians, one of them being physical activity. Canadian public health leaders are identifying the importance of considering the environmental determinants of health, and the opportunities related to exposure and engagement with the environment for children's physical activity (Tremblay et al., 2015). Associations between children's physical activity and their surrounding physical environments have been widely discussed. Systematic reviews examining the relationship between the physical environment and children's physical activity, indicate relationships with physical environment factors such as residential density, access to recreation facilities, land-use mix, walkability, safety structures, and neighbourhood aesthetics (Ding, Sallis, Kerr, Lee, & Rosenberg, 2011; Oliveira, Moreira, Abreu, Mota, & Santos, 2014; Martins et al., 2017).

Research suggests, however, that physical activity behaviour may not be only based on the objective environment measures, but also depends on differentiating between the individual's cognitive representation, or *perception,* of their environment (Giles-Corti & Donovan, 2002; Hume, Salmon, & Ball, 2004; Orstad, McDonough, Stapleton, Altincekic, & Troped, 2017). Perceptions are defined as "an awareness through the senses", and "the way in which something is regarded, understood or interpreted" (Oxford Dictionary, 2018). A child's perception of their everyday environments is formed through the experience of their context: the interplay of the physical, social, cultural and structural forces they are exposed to, and develop through a cyclical process that is interactive with social, cognitive and affective experiences (Orton et al., 2017; Williams, 2003). One way to conceptualize contexts is through the use of the socio-ecological model.

Giles-Corti and Donovan (2002) have suggested a socio-ecological model of recreational physical activity that considers intrapersonal, interpersonal, and physical environment

level determinants of physical activity behaviour. These different levels of environment operate through reciprocal relationship whereby the individual's physical activity behaviour is affected by multiple levels of environmental influences, and physical activity behaviour shapes the surrounding social environment (Townsend & Foster, 2013). Using this theoretical framework, the present thesis will investigate geographic variation in the determinants of children's physical activity and the influence their environments will have on perceiving barriers to activity. This research will then assess the influence of these perceptions as a mitigating factor in achievement of MVPA guidelines. This thesis argues that context of physical activity environments vary across Ontario, and the importance of understanding these differences for changing behaviour. This research provides insight for future research, policy, and practice to consider how structures of children's environments determine their experiences of physical activity for health. This thesis suggests a new way to conceptualize behaviour to determine effective strategies for affecting children's health.

1.2 Theoretical Context

To meet a gap identified in the literature review, the epistemological approach that will guide the primary stage of my research is the conceptualization of the socio-ecological model. The socio-ecological model suggests individual health is shaped in two ways: "(i) behaviour affects and is affected by multiple levels of influence; and (ii) individual behaviour shapes and is shaped by the social environment (reciprocal causation)" (Townsend & Foster, 2013, p. 1101). This approach theorizes that social and physical environments are interdependent; therefore, health is an outcome of the quality of the person-environment fit (Grzywacz & Fuqua, 2000). There are five levels of influences on health in the socio-ecological model, which have both individual and interrelated effects. The conceptualizing model suggests that an individual's health is shaped by (i) intra- and (ii) interpersonal factors, (iii) community and (iv) organizational factors (or institutional), and (v) public policies (Robinson, 2008) (see Figure 1). The socio-ecological model differs from other epistemologies for dealing with public health issues because of the use of more comprehensive multilevel analyses rather than single level (Robinson, 2008). This is important because it considers the complex web of factors influencing public

health challenges. This view will be applied to understand variations in geographic influences of residence in rural communities on the perceived barriers and facilitators to physical activity

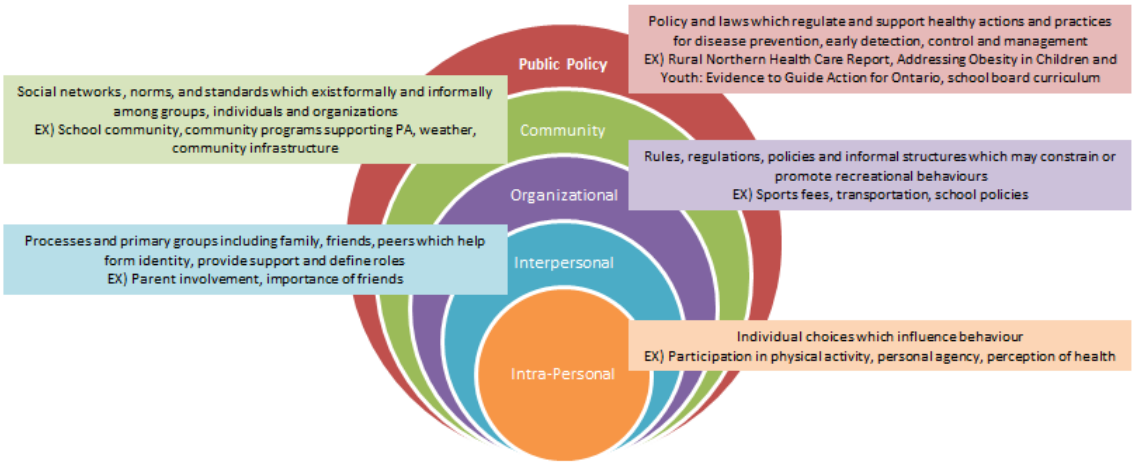

Figure 1.1 Socio-ecological model of influences on children's physical activity levels in rural areas.

Adapted from Townsend and Foster (2013), and Public Health Ontario, (2013), this is an example of how the socio-ecologic epistemology can be utilized to consider the potential influences on children's physical activity in their communities. Sherar et al.'s (2009) categories of influence can be aligned with the intra-personal through community levels within the socio-ecological model.

Giles-Corti and Donovan (2002) suggested a more specific socio-ecological model of recreational physical activity (an adaptation of the above socio-ecological model), which is relevant to this thesis. This model considers three levels of influence: intrapersonal, interpersonal and physical environment, that work within reciprocal causation to form determinants of physical activity behaviour. This model is a more appropriate method of measurement for the children's environments in this study because of the varying policy environments across and within the study areas. Based on an individual's environment level and how they experience the interpersonal and physical environment, their perceptions are formed.

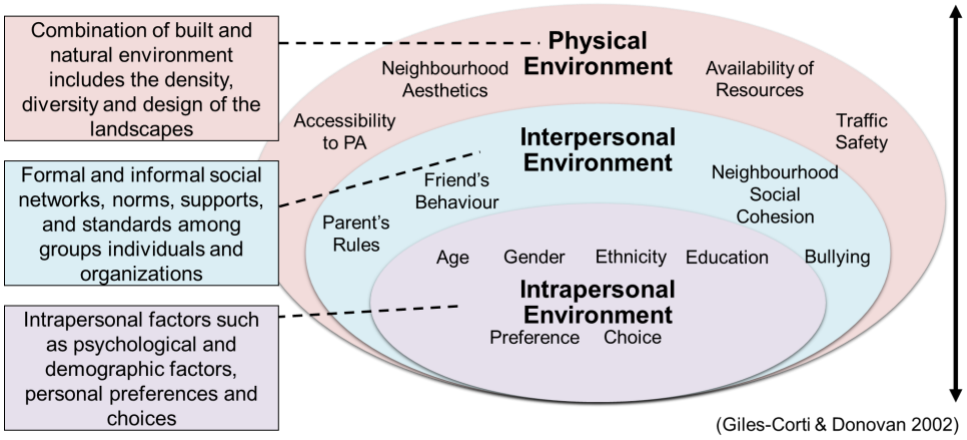

Figure 1.2 Socio-Ecological Model of Recreational Physical Activity, Adapted from Giles-Corti and Donovan (2002).

This chart demonstrates some examples of features that fall within each level, which research has demonstrated to have influence on children's physical activity.

The socio-ecological perspective is the most appropriate epistemology for guiding my research because of the need to consider how individual behaviours and interactions are formed within the larger social and environmental context, when considering the determinants of children's physical activity (PHO, 2013). This strategy for understanding health influencing factors has been used in a variety of similar children's health topics, including fruit and vegetable intake in marginalized groups (Robinson, 2008), children's sport participation (Eime et al., 2013), healthy eating in schools (Townsend & Foster, 2013), and addressing childhood obesity (PHO, 2013). However, this perspective's epistemology of health shaping influences has not yet been applied to understand the influence of, and differences in, barriers to children's physical activity in different rural and urban areas in Ontario, Canada. Therefore, this approach will help to increase the understanding of environmental determinants on the experiences of children, allowing for advocacy and implementation of policy and infrastructure within the communities studied.

1.3 Research Objectives and Questions

The overarching objective of this research is to contribute to the understanding of children's physical activity levels and the relationships with their environment. This thesis was completed using data generated through research projects conducted by Dr. Jason Gilliland and his associates within the Human Environments Analysis Laboratory (HEAL). An overall goal of this work is to encourage acknowledgement of children's voices in physical activity research that seeks to improve their health. Furthermore, this thesis seeks to provide a new perspective for examining children's voices with a health equity lens, by considering unique factors that make up a child's context for health. This includes a definition of rurality that exists as more than a dichotomy of rural versus urban. Guided by a socio-ecological framework, the primary research question this thesis addresses is: what role do children's perception of their geographic environments play in engaging in physical activity? Establishing a better understanding of the formation and effect of perceptions related to geographic variation and physical activity has important implications for health research, policy and programming related to health care, infrastructure, and social programs.

In order to meet these objectives, this thesis will answer the following research questions:

1) How do factors of children's intrapersonal, interpersonal, and physical environments influence their perceptions of barriers to physical activity?

2) What are the similarities and differences in children's perceptions of barriers to physical activity in relation to the level of urbanicity and geographic variation of their home location?

3) Do children's perceptions of barriers to physical activity mediate the relationship between their physical environment (urbanicity) and their MVPA levels?

For the purposes of this thesis, I define urbanicity using Vlahov and Galea's (2002) definition which is the "impact of living in an urban area at a given time", and more specifically "the conditions present in urban areas to a much greater extent than non-urban areas" (p.55). To address these questions, this research will use quantitative data

from the Spatial Temporal Environment and Activity Monitoring (STEAM) project. This project took place in 2010-2013 in 33 schools in Southwestern Ontario, and in 2016 in 4 schools in Northwestern Ontario. Examining how and why children hold perceptions of their environment is complex, however this research seeks to form a starting point for future work to consider determinants within the socio-ecological model, and the impact they will have on how children perceive and engage with their environments in pursuit of physical activity. This research provides a starting point for future work to consider *how* structures of children's environments determine their experiences of physical activity for health by providing objective evidence of behaviour and subjective evidence of children's perceptions. This will help to support development of policy, programs, and practices that incorporate, encourage, and facilitate the use of children's perspectives to determine in practice effective strategies for impacting children's health.

1.4 Thesis Format

This thesis follows an integrated article format and includes two separate but related studies. Each of the two studies aim to understand how children's environments influences their physical activity perceptions and behaviour. Each study has the same objective to examine barriers to children's physical activity in their daily environments, in order to suggest methods for alleviating these barriers to promote activity. The first study does this by examining what children perceive as barriers to gain their point of view. The second study examines the mediating effect of these perceptions in the relationship between the physical environment and objective measures of activity. Through these studies, this thesis aims to suggest the importance of considering geography when conducting research on children's physical activity. The main theme present across both studies is the importance of the environmental context in which children experience and engage in physical activity in their everyday lives. The thesis outline is as follows:

Chapter 2 reviews the existing literature on physical activity and outdoor play in children's various environments to identify gaps, methodological limitations and justifies the need for future research.

Chapter 3 discusses the data collection strategies, tools and analysis rationale to provide the reader with a comprehensive understanding of the research methods.

Chapter 4 examines children's perceived barriers to physical activity across varying Canadian environments in Northwestern and Southwestern Ontario, through a socio-ecological model.

Chapter 5 investigates the relative influence of barriers mediating the relationship between environments and moderate-to-vigorous physical activity levels of Northwestern and Southwestern Ontario children.

Chapter 6 summarizes the findings and relates the integrated articles to critically analyze how future policy and practice can benefit from this work. This chapter will discuss implications of the work, limitations, and areas for future research.

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Chapter 2

2 Literature Review

The chapter is divided into eight main sections. Section 2.1 provides the reader with context on the search strategy for the literature review to ensure a comprehensive background. Section 2.2 examines the literature on physical activity, and the current Canadian policy on children's physical activity levels. Section 2.3 discusses the ecological perspective for physical activity research. Section 2.4 provides definitions of the environments analyzed within this thesis, as well as the rationale behind them. Section 2.5 provides results of a comprehensive review of the current literature surrounding children's perceptions of barriers and facilitators to physical activity in their environments. Section 2.6 summarizes the evidence regarding previous interpretation of the barriers within the socio-ecological framework of recreational physical activity. Section 2.7 reviews the gaps in the literature that this thesis fills and provides a brief conclusion. Section 2.8 lists the references used within this section.

2.1 Search Strategy

To undergo the literature review, the main search terms used were perceptions, children, physical activity and urbanicity. To obtain a variety of articles related to these terms, synonyms were used throughout the search strings. Additional terms used to locate research were related to methods used by the researchers, including systematic, scoping, and literature reviews, as well as meta-analyses. These types of studies are important because they synthesize large bodies of literature into manageable reading and identify good starting points for mapping out areas of research uncertainty (Petticrew & Roberts, 2006). Quantitative and qualitative studies were used to gain a comprehensive understanding of how children's physical activity patterns are formed in relation to barriers in their communities.

The literature review took place over three main data bases: Web of Science, Scopus, and Google Scholar. Additional literature was collected from the Western University Electronic Thesis and Dissertation Repository, and through searching the reference pages of articles collected. For articles to be considered for the review, the research had to be

available in English and focused on children's physical activity. Many studies were excluded due to a focus on nutrition, obesity, or adult's physical activity.

Approximately sixty papers were collected for the pre-literature review. Studies eliminated from the literature review had a lack of relevance after reading through the abstract and methods. Initially, fifteen articles were drawn on for the pre-literature review for two main reasons: (1) the articles were systematic, scoping, and literature reviews, and synthesized a large majority of the additional articles, and (2) the studies offered specific answers to the research question for children in other settings, and were therefore similar to the proposed study. These studies were used to steer research for the present literature review to ensure comprehensiveness. The following sections present the findings of the complete literature review, based on the initial search.

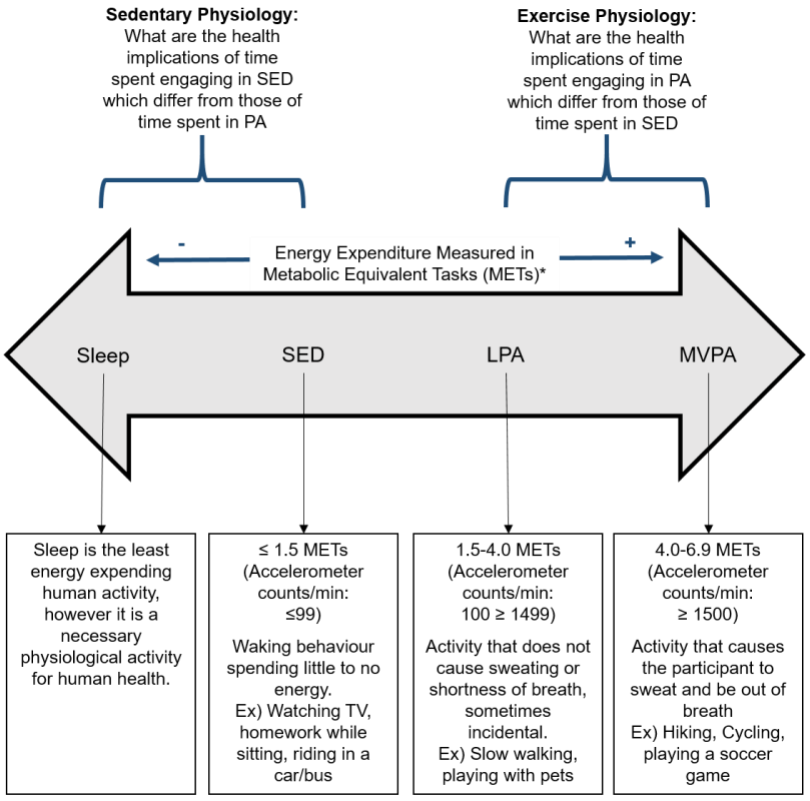
2.2 Physical Activity and the *24-Hour Movement Guidelines*

Physical activity (PA) is defined by the Canadian Society for Exercise Physiology [CSEP] (2017) as "bodily movement produced by skeletal muscles that requires energy expenditure," and this activity "increases heart rate and breathing" (p.1). Researchers have widely examined the benefit of physical activity for children's health (Janssen & LeBlanc, 2010; Poitras et al., 2016). Broadly, physical activity is associated with physical, mental and social health indicators (Poitras et al., 2016). Due to the negative health risks and associated economic health burden of not being physically active (Krueger et al., 2014), policy makers have emphasized the importance of developing these behaviours from a young age. The Canadian Physical Activity Guidelines were developed to help families and caregivers ensure children are meeting the necessary requirements of physical activity to achieve health benefits.

In the past ten years researchers in Canada have produced a number of physical activity guidelines, that have grown to include recommendations on sedentary behaviour, outdoor time, and sleep (Tremblay et al., 2007, 2011a, 2011b, 2012, 2016). The most recent 2016 update to these guidelines is called the *24-Hour Movement Guidelines for Children and Youth*. These guidelines integrate movement across the whole day, with a shift in thinking that conceptualizes physical movement to exist on a continuum. The major difference in

the new guidelines is not the behaviour components, but rather the integration of activity over a 24-hour period. The new guidelines also incorporated recommendations related to light-intensity physical activity (LPA), sleep, and play-based activity (Tremblay et al., 2016). These changes were informed by more recent evidence related to the potential health benefits of incorporating the new recommendations, though more research is needed (Tremblay et al., 2016).

One significant development in conceptualizing physical activity behaviour in the *24-Hour Guidelines*, is using a movement continuum to consider levels of activity and their impact on health, based on time spent engaging. This is a way to implement the concept of the *whole day matters* (Tremblay et al., 2016). According to the CSEP (2017), the continuum (Figure 3) helps to conceptualize that there are distinct differences between physiological systems involved in sedentary behaviour and physical activity, and the two should not be considered opposite. For example, a synthesis of the literature by Tremblay, Colley, Saunders, Healy, and Owen (2010), indicates sedentary behaviour is associated with deleterious health outcomes related to metabolism and physical functioning, that differ from those that can be attributed to a lack of being physically active. This perspective suggests that movement and non-movement behaviours should be considered together when assessing healthy living. As explained by Tremblay et al. (2010), achieving high levels of intense physical activity does not necessarily displace minutes spent being sedentary. As a result, we must consider each item's impact in a total activity achievement throughout the course of a day. This was identified as an important consideration by Tremblay et al. (2010) because this could lead to new approaches for minimizing, surveilling and analyzing sedentary behaviour that are different than those that aim to increase physical activity.



*One metabolic equivalent (MET) is defined as the amount of oxygen consumed while sitting at rest and is equal to 3.5 ml O2 per kg body weight per min.

Figure 2.1 Activity Continuum adapted from Tremblay et al. (2010).

As children's activity behaviour is measured on the continuum, there are different physiological resoponses. As such, sedentary behaviour is not synonomous with physical inactivity

Based on this conception then, it is important we draw a distinction between sedentary behaviour and physical inactivity. Sedentary behaviour is classified by little movement and low energy expenditure (≤1.5 METs) (Tremblay et al., 2010). Examples in children include watching television on a couch, travel via car or bus, and sitting at the computer for homework or browsing. Tremblay et al. (2010) define physical inactivity as the absence of participating in physical activity (at any intensity), and insufficient activity behaviour to meet activity recommendations. This is reflected as the total time or amount being physically inactive. For example, in children and youth this would mean not

achieving 60 minutes of MVPA each day (CSEP, 2017). This draws attention to the concept of total physical activity (TPA), as indicated in the *24-Hour Guidelines.*

2.2.1 Total Physical Activity

The *24-Hour Guidelines* were the first physical activity guidelines in Canada to include recommendations related to total physical activity (TPA). TPA is the overall amount of minutes engaging in physical activity at all intensities (light, moderate, moderate-to-vigorous, vigorous) added together. The goal is to address time spent in physical activity and inactivity across the whole day. This is because research demonstrated evidence of a variety of physiological benefits with total daily physical activity levels. A systematic review conducted by Poitras et al. (2016) synthesized strong positive associations between children's TPA and adiposity levels, several cardio-metabolic biomarkers, physical fitness, and bone health. Furthermore, there was associations locating favourable relationships between TPA and quality of life, motor skill development, and psychological distress. Evidence related to other health indicators such as fat free mass, pro-social behaviour, academic achievement, and self-esteem, were positive but limited (Poitras et al., 2016).

While there is no specific indicator in the *24-Hour Guidelines* recommending children achieve high levels of TPA, this recommendation is phrased within a practical and applicable recommendation. The *Guidelines* suggest specific indicators of moderate-to-vigorous physical activity (MVPA) and vigorous physical activity, "Several hours of a variety of structured and unstructured light physical activities" and "Limited sitting for extended periods". Changing the language of the current *Guidelines* to incorporate TPA throughout the day, will encourage more research related to understanding the impact of total accumulation time of physical activity, rather than the importance of MVPA bouts alone.

2.2.2 Light Intensity Physical Activity

The evidence based decision making by Tremblay et al. (2016) in the formation of the *24-Hour Guidelines* also points to the benefits of encouraging light physical activity (LPA) as a method for minimizing physical inactivity. This is any body movement that does not

result in sweat production or shortness of breath, including incidental activities. Some examples in children and youth include slow walking/walking a dog, household chores, and light games such as hopscotch or croquet (CSEP, 2017). The new *24-Hour Guidelines* recommend children and youth age 5-17 achieve several hours of a variety of structured and unstructured LPA each day (Tremblay et al., 2016). The benefit of encouraging additional minutes of LPA was found to be positively associated with cardio-metabolic biomarkers in the review by Poitras et al. (2016). While there is limited evidence available on the overall health impact of accumulating LPA minutes throughout the day, Tremblay et al. (2016) reiterate the potential benefits of LPA and TPA. While these levels require more research into their positive effects, Tremblay et al. (2016) recommend they should continue to be considered in future work to elucidate the potential health benefits, rather than MVPA alone.

2.2.3 Moderate to Vigorous Physical Activity

The *24-Hour Movement Guidelines* recommend children and youth age 5-17 should accumulate on average a minimum of 60 minutes of moderate-to-vigorous physical activity (MVPA) each day (Tremblay et al., 2016). This is the recommended level of intensity required to achieve the maximum health benefits of physical activity. MVPA is considered activity that causes the participant to sweat, elevate the heart rate and be out of breath (CSEP, 2017). Regular participation in MVPA has been associated with a variety of known health benefits in children and youth including improved body composition, cardiovascular and metabolic health, musculoskeletal health, mental health, and academic achievement (Carson, Tremblay, Chaput, & Chastin, 2016; Janssen & LeBlanc, 2010; Poitras et al., 2016; Strong et al., 2005). This recommendation has remained as an important indicator for disease prevention and health promotion (Tremblay et al., 2016).

2.2.4 Sedentary Behaviour

Sedentary behaviour (SED) has been included in the *24-Hour Guidelines* in order to demonstrate recommendations among the movement continuum, that sedentary time is one component of the whole day (Tremblay et al., 2016). The *Guidelines* recommend limiting sitting for extended periods, no more than 2 hours of recreational screen time per

day and replacing sedentary behaviours with physical activity in order to achieve greater health benefits. There is substantial evidence related to the negative implications of SED on children's health. For example, in a systematic review conducted by Carson et al. (2016), they found a gradient can be observed across health behaviours in school aged children and youth. The results demonstrate that as SED time decreases, there are positive associations with health. Research has indicated links between SED and overweight/obesity status in children and increased risks of cardiovascular disease, cancer, and diabetes into adulthood (Carson et al., 2016; Lewis, Napolitano, Buman, Williams, & Nigg, 2017). These effects are distinct from those attributed to physical inactivity. This further supports the notion that movement and non-movement behaviours should be considered together when assessing children's healthy living behaviours.

2.2.5 Outdoor Time

Researchers are now leaning toward a recommendation of increasing outdoor time as a tool for improving physical activity guideline compliance (Larouche, Garriguet, Gunnell, Goldfield, & Tremblay, 2016; Larouche, Garriguet, & Tremblay, 2017; Tremblay et al., 2015). Evidence suggests increasing time outdoors significantly increases activity and steps achieved per day (Larouche et al., 2017). For example, sixty additional minutes of outdoor times increases a child's average daily TPA by 7 minutes (Larouche et al., 2016). This is the first time in Canada's use of the guidelines that this recommendation has been made, and is related to the recent *Position Statement on Active Outdoor Play* for improving children's health (Tremblay et al., 2015).

2.3 Socio-Ecological Perspective to Physical Activity Environments

A growing body of research on physical activity takes a socio-ecological approach to understanding how children's health is shaped by their surrounding environments. According to this framework, interpersonal and physical environments are interdependent, whereby an individual's experience of health and factors impacting physical activity are nested as the innermost level within a variety of influence structures (Bronfenbrenner, 1979). Therefore, when concerned about the current trend in children's

physical activity levels, researchers must consider how determinants form an integrated effect on behaviour and health (Humpel, 2002). As explained by Mitchell, Clark, and Gilliland (2016) neighbourhoods and the community environment both limit and facilitate physical activity in children, based on the opportunities available and restrictions impeding activity. For example, Smith et al. (2015) highlighted how aspects of the built environment (streets, buildings, park availability) influence adolescent's ability to move freely through their communities as they cannot drive and lack financial resources. This is a result of the structures both deliberately created (i.e., the built environment) and unintended consequences on the intrapersonal level (characteristics/factors within individual that determine physical activity) of influence.

Giles-Corti and Donovan (2002) suggested a socio-ecological model of recreational physical activity that considered individual, social and physical environment determinants of physical activity behaviour. Giles-Corti and Donovan (2002) propose the importance of such a model is access to supportive physical environment alone is not sufficient for increasing physical activity behaviours. Rather, individual and social environment factors that form environmental perceptions of barriers to physical activity may be equally as important for predicting behaviour as the objectively measured physical environment (Hume et al., 2004). By considering the environmental influences on physical activity through a socio-ecological lens, we can begin to consider how children's physical activity levels are influenced by external, modifiable larger social and environmental contexts (Public Health Ontario, 2013). In order to better understand how these perceptions influence activity in different environments, it is first important to understand how to define varying levels of urbanicity.

2.4 Defining Environments

2.4.1 Understanding "Rural"

The literature review determined that there is a lack of clarity surrounding the definitions of terms used to describe different environments, such as rural and suburban. There are a variety of definitions that tend to emphasize many different indicators for these (and similar) land use terms, but often the characteristics emphasized are density, and distance

to density (Abraham, Sommerhalder, & Abel, 2010; Davison & Lawson, 2006; Lofshult, 2004; Markey, B., Lauzon, G., & Ryser, 2015; Sandercock, Angus, & Barton, 2010). Statistics Canada's definition indicated rural areas have less than 1000 residents, and may contain agricultural lands, and remote and wilderness areas (Statistics Canada, 2015). Any areas with over 1000 people are instead considered population centres, that vary in size between small, medium and large population centres (Statistics Canada, 2015). However, this definition is inadequate for determining the experience of individuals because it neglects communities that fall in between these categories but still consider their lifestyle to fit within a rural category, especially when compared to the largest census metropolitan areas. This can create a variety of implications for health research and programming, such as inappropriate blanketing policies applying to population centres, which neglect to consider the history, geography, socio-economic status, and development trajectories of small communities. These "one-size-fits-all" policies can cause insufficient availability health care, infrastructure, and social programs. Therefore, in order to better operationalize the concept of urbanicity to include a variety of experiences of rurality, a population density spectrum approach will be utilized in this thesis.

2.4.2 Defining Urbanicity and the Population Density Spectrum

Urbanicity was previously defined by Vlahov & Galea (2002) as the "impact of living in an urban area at a given time", more specifically "the conditions present in urban areas to a much greater extent than non-urban areas" (p.55). This definition highlights the contrast between cities and the surrounding areas, and these differences have been shown to have an association with health (Cyril, Oldroyd, & Renzaho, 2013; Jones-Smith & Popkin, 2010). Rather than using the dichotomous definition, as explained by Jones-Smith & Popkin (2010) a spectrum approach enables both an inter- and intra-urban and rural comparison.

A population density and built form spectrum to measure indicators of urbanicity allows for a definition that considers heterogeneity of different land uses, while providing an objective method to operationalize data (Babey, Tan, Wolstein, & Diamant, 2015). This spectrum splits communities into definitions of urbanicity based categorization of built

form and population density, with five categories to provide greater insight into differences in physical activity versus a more simplistic rural versus urban, or trilateral (including suburban) division as recommended by Sandercock et al. (2010). Therefore, *urban large-cities* areas are characterized by grid-like road networks, high population density, and high land use mix within settlements greater than 100,000 people. *Suburban large-cities* are areas that are characterized by cul-de-sac road networks, lower population density, and low land use mix within settlements greater than 100,000 people. *Urban small-towns* in this definition accounts for settlement areas with a population between 10,000 and 100,000 people. *Rural small-towns* are settlements with a population between 1,000 and 10,000. Areas defined as simply *rural* are all other areas of our study area mostly characterized by agricultural land and natural areas.

When considering levels of urbanicity in communities, research has demonstrated mixed results on the influence on children's physical activity patterns. Sandercock et al. (2010) conducted a systematic review on the differences in physical activity levels living in different built environments, classified by land use. The majority of studies indicated either no differences, or that urban children were less likely to be active than rural children. This included two studies which compared urban and rural children in Canada, and in both groups no significant differences in MVPA presented (Plotnikoff, Bercovitz, & Loucaides, 2004; Tremblay et al., 2005). Contrary to the results of this systematic review, Moore, Brinkley, Crawford, Evenson, and Brownson (2013) found daily MVPA was significantly lower in rural youth versus urban youth. This group of authors reference their work to be consistent with Davis et al. (2008) who indicated rural children expend less energy in physical activity than urban children each week.

What Moore et al. (2013) neglect to highlight, however, is that Davis et al. (2008) also found that urban children had higher rates of sedentary behaviour than rural counterparts. Davis et al. (2008) attribute this to the possibility that rural children participated in more activities not covered by traditional self-report physical activity assessments, such as farm chores. This conclusion draws attention back to findings of the systematic review by Sandercock et al. (2010), that indicates that the majority of the studies analyzed used a

simple urban versus rural division of groups. This is problematic because a dichotomous division between urban and rural neglects to highlight heterogeneity of land uses.

In five of the articles authors found by Sandercock et al. (2010) (Joens-Matre et al., 2008; Kristjansdottir & Vilhjalmsson, 2007; Nelson, Gordon-Larsen, Song, & Popkin, 2006; Springer, Hoelscher, Castrucci, Perez, & Kelder, 2009; Springer, Hoelscher, & Kelder, 2006), when using a spectrum approach (i.e., considering more than a dichotomous rural versus urban relationship) to explaining the built environment, that includes suburban or small city populations, rural *and* urban children were less active than children in suburban areas or small cities. The authors of this work hypothesize that suburban children are the most active because suburban areas have a mixture of urban (access) and rural (openness) characteristics of the environment, but also because of the typically higher levels of socio-economic status, and low populations of ethnic minorities in suburban areas (Sandercock et al., 2010). This is an important mediating factor to consider because both minority status low socio-economic status are significantly associated with decreased levels of physical activity (Felton et al., 2002; Nelson et al., 2006; Sandercock et al., 2010). This demonstrates the need to utilize an approach such as the socio-ecological framework, which accounts for social and geographic determinants of health.

Sandercock et al. (2010) go so far as to say that because the articles they examined oversimplified environments by splitting them into rural *or* urban, this may have led to a misinterpretation of the results. Therefore, a comprehensive understanding of urbanicity's effect on physical activity is still unknown, as current research has been limited by heterogeneous definitions of urbanicity and rurality, and methodologies for measuring environment types (Sandercock et al., 2010; Davidson & Lawson, 2006). However, researchers do agree that characteristics within a child's neighbourhood environment, specifically the presence of environmental supports (including the social, physical and political environment) such as social cohesion, local infrastructure, and accessibility to green areas for playing, influence their physical activity (Moore et al., 2013). Current work recommends researchers conduct work using larger studies, objective measures of physical activity, a less simplified comparison for classifying urbanicities, and attempt to understand how influences within these communities are similar and different

(Sandercock et al., 2010; Hume et al., 2004), a contribution which my research seeks to make.

A number of assumptions exist surrounding the similarities and differences in environmental barriers influencing physical activity. For example, research indicates children are impacted by overarching social characteristics of their communities including socioeconomic status, infrastructure (quality and quantity), presence of nature, and safety (Loebach & Gilliland, 2010; Walia & Liepert, 2012; Yousefian, Ziller, Swartz, & Hartley, 2009), as well as geographic factors such as accessibility to physical activity opportunities especially based on community size (i.e., population less than 10,000 versus 250,000 or more demonstrated a greater lack of accessibility to physical activity opportunities) (Canadian Fitness and Lifestyle Research Institute, 2013). Despite the threats to population health in Canada presented by physical inactivity, there is a paucity of research on the opportunities for physical activity and aspects of the built environment across the spectrum of urbanicity (Yousefian et al., 2009). The majority of literature regarding environment-activity links focuses on larger cities, neglecting areas outside of larger metropolitan areas, and little research has been conducted to examine opportunities for physical activity in built environment across rural and urban settings (Yousefian et al., 2009; Moore et al., 2013). This is a gap which my research seeks to fill.

Furthermore, research highlights the need to study variation between different rural communities (DesMeules et al., 2006; Markey, Lauzon & Ryser, 2015; Walia & Liepert, 2012). In Ontario alone, there are five general types of rural (and northern or remote) communities: urban fringe communities, agriculture communities, cottage country communities, Northern Ontario communities, and Indigenous communities (Markey et al., 2015). In Canada this can extend further to include prairie and maritime communities (Walia & Leipert, 2012). This demonstrates the importance of considering heterogeneity between rural communities (DesMeules et al., 2006), especially when attempting to form health-influencing policy. Walia and Leipert (2012), who conducted qualitative research on barriers to physical activity in Southwestern Ontario, suggest research in different types of rural communities would allow for insights on "issues common and unique to various rural contexts and rural youth populations" (p.12).

2.5 Factors Influencing Physical Activity across Environments

When considering issues or opportunities that hinder/encourage physical activity, a valuable way to consider the environmental influences on children's perceptions is through recognition of barriers and facilitators to physical activity in different urbanicities. Researchers recognize the value in understanding the personal and situational influences on physical activity engagement of children (Loebach & Gilliland, 2010). These perspectives demonstrate the importance of understanding influences and how future interventions will best enhance facilitators, while mitigating barriers to physical activity (Sherar et al., 2009). Sherar et al. (2009) offered useful categories for classifying barriers that have been adapted to define both barriers and facilitators in local outdoor spaces for participating in physical activity in rural communities. *Barriers* are factors that make physical activity difficult or completely inhibit it in outdoor spaces. *Facilitators* are factors that make physical activity possible and promote the behaviour in outdoor spaces.

2.5.1 Barriers and Facilitators to Physical Activity

Table 1 was developed based on 49 studies, to demonstrate similarities and differences between the urban (including suburban), and rural areas in children's perceptions of barriers and facilitators to physical activity. This table provides a summary of the number of articles located within each subheading that presented significant findings. Two additional tables are available in the appendices. Appendix A provides all titles included with a corresponding number, and Appendix B uses these numbers to demonstrate which of the articles fall within each facilitator/barrier heading in Table 1.

Table 2.1 Number of findings demonstrating barriers and facilitators discussed by urbanicity, available in the literature.

		Individual				Social					Physical		
Level of Urbanicity Identified	Facilitator (F) or Barrier (B) to PA	Perceived Safety/Unsafe	Pref. for Weather	Perceived Aesthetics/ Quality	Pref. for Activities	Social Factors	Accessibility (transportation)	Parent perceptions/ rules	Socio-economic circumstance	Planned/ structured activities	Facilities & Amenities	City Planning/ Design	Access (proximity/ availability)
Rural	F	1			1	1	1	1	1	2	1	1	1
	B	3	1		1	2	4	4	2	2	2	3	4
Urban	F	3		2	1	5	2			1	3	1	1
	B	4	1			1	1	2	1	1	2	3	3
Not Stated	F	2		2		2	1				1	1	1
	B	4	2	1	1	1	1				1		3

** Only significant findings represented*

Access to physical activity facilities at the community level was both a barrier, and somewhat a facilitator in rural and urban populations studied; however, it is important to provide further context within this level to understand how researchers categorized access. In the urban populations, access was usually determined by ability to walk or bike to locations for physical activity (Loebach & Gilliland, 2010; Grow et al., 2008). Whereas in rural populations, lack of access was usually determined as a barrier if use depended on the need to drive to locations because of a lack of activities close to home (Grow et al., 2008; Loebach & Gilliland, 2010). This example can be expanded upon further in the city planning and design category. Although three barriers to physical activity and one facilitator to physical activity were found in both the urban and rural study populations, there is a difference in the context of what city planning and design means for the communities. For example, in urban communities the layout of streets (i.e., lack of connectivity, intersecting train tracks, and traffic volume) acted as a barrier to physical activity (Loebach & Gilliland, 2010). In rural populations, however, street planning presented as a barrier within the built environment due to underdeveloped centers, dispersed residential patterns, and lack of public open space (Yousefian et al., 2009).

Interpersonal barriers to physical activity are much higher for rural populations, whereas interpersonal facilitators are strong predictors of physical activity in urban areas. One

strong facilitator of physical activity in urban areas was neighbourhood social cohesion and social factors, including social relationships with neighbours and nearby community centres that promote social interaction (Aarts, Wendel-Vos, Van Oers, Van De Goor, & Schuit, 2010). Walia and Liepert (2012) indicated that as a result of distance in rural communities, and the reliance on parents for transportation to visit friends, it is difficult for youth in rural communities to engage in spontaneous group social activities. These researchers suggest rural communities must facilitate social cohesion by allowing for gathering spaces to promote physical activity through social opportunities. By identifying the impact of factors of rural residence that create perceived barriers to interpersonal forces influencing physical activity, this could help researchers to understand one way to adapt the environments of children in an effort to promote physical activity. Considering the positive impact of social factors on children's physical activity in urban areas, more research is needed to understand the influence of such factors in rural populations.

The number of findings for individual barriers and facilitators in rural and urban populations are similar. This may indicate that individual perceptions have a similar level of influence between rural and urban communities (Loebach & Gilliland, 2010). However, it is important to note differences in the types of examples given in the populations for these barriers. For example, perceived lack of safety in an urban area may be due to poor lighting, crime, or traffic volume and speed (Hume et al., 2004; Grow et al., 2008; Loebach & Gilliland, 2010); whereas in rural areas, lack of safety extended to include lack of adult supervision in the neighbourhood, a fear of hunters, and wild animals or loose dogs (Holt et al., 2016). Another example of similarities between the two urbanicities in this theme was perceived aesthetics. Researchers working with rural populations often encouraged greening/street beautification in rural areas to improve children's physical activity (Smith et al., 2015), something that was proven to be a facilitator in urban areas (Abraham et al., 2010, Loebach & Gilliland, 2010).

Suburban was often grouped in the definition of urban in all except one study (Babey et al., 2015), rather than standing alone as a level of urbanicity. This is important to note because children living in suburban areas have demonstrated higher levels of physical activity than rural and urban children (Sandercock, Angus, & Barton, 2010). This

highlights the importance of considering a spectrum of urbanicities, rather than a single dichotomous relationship.

The evidence above indicates the utility of using the same indicators for measuring physical activity barriers and facilitators across the urbanicity spectrum. This approach gives us an indication of what we need to look for in where these differences lie across these different environments. Due to the heterogeneity of the urbanicities, it is important to gather more specific context as to how children's physical activity is affected in the respective populations. For example, if safety was indicated as a concern among people in all urbanicities, what aspects of safety are the specific populations (i.e., rural, urban, suburban) most concerned about? This would allow for better suited policy related to mitigating barriers with facilitators to physical activity. Appendix A demonstrates all findings for barriers and facilitators that were discussed in articles found. The strength of my research is that we used the same survey in all study areas, which vary in urbanicity. This means the research will use identical measurement of barriers across the levels of urbanicity. By using the same indicators across the spectrum to allow for comparability, this will provide future practitioners better direction in where to focus their energy with interventions in order to most effectively impact children's physical activity levels.

2.6 Evidence found within the Socio-ecological Framework of Recreational Physical Activity

The following sections consider evidence regarding previous interpretation of the barriers within the Giles-Corti and Donovan (2002) version of the socio-ecological framework of recreational physical activity.

2.6.1 Individual Environment

The individual environment is shaped by the influence of intrapersonal factors such as psychological and demographic factors, personal preferences and choices (Townsend & Foster, 2013). These factors are widely accepted to have significant impact physical activity behaviour. Demographic factors accepted as health-related dimensions include gender, ethnicity, education, disability, age and sexual orientation (Insel, Roth, Irwin &

Burke, 2016). These dimensions influence what an individual perceives as a barrier in the social or physical environment.

2.6.2 Social Environment

The social environment includes social networks, norms, supports, and standards among groups, individuals, and organizations (Townsend & Foster, 2013). These forces which exist formally and informally throughout children's neighbourhoods. This level of the socio-ecological model has demonstrated a well-established association on the influence of physical activity, but is sometimes overlooked (Ball, 2006; Clark & Scott, 2013). Main themes discussed in the literature as mechanisms of influence within this category for children are parental influence (i.e. rules and perceptions), and relationships with peers positively (i.e. presence of friends) and negatively (i.e. bullying). These themes in a variety of contexts have demonstrated significant influence on the physical activity of children (Abraham et al., 2010; Beets & Foley, 2008; Hume, Salmon, & Ball, 2004; Jago et al., 2009; Lee et al., 2015; Sherar et al., 2009). Given the knowledge that an association exists, this thesis will seek to understand the amount of influence the social environment has on children's physical activity compared with, and in relation to other levels of the socio-ecological model.

2.6.3 Physical Environment

The physical environment is defined as a combination of built and natural environment that influences children's neighbourhoods. As explained by Clark and Scott (2013), this includes the density, diversity and design of the landscapes. These factors have both passive (i.e. urban design influencing accidental physical activity) and active (infrastructure built to promote physical activity) influence on the individual (Giles-Corti & Donovan, 2002). While there is a general consensus that the physical environment impacts physical activity levels (Clark & Scott, 2013), researchers report on a variety of mechanisms by which this relationship may occur. The main themes identified throughout the literature were: accessibility to physical activity resources, availability, neighbourhood aesthetics, and safety.

When considering a lack of accessibility as a barrier to physical activity opportunities, the literature discusses this issue due to proximity and distance of facilities and opportunities (including inability to walk), transportation related issues, and residential density and design. While there are many examples in the literature, some facilities and opportunities mentioned include parks, playgrounds, recreation centers, sports fields, beaches, and public pools. Researchers tend to agree, there is a significant positive association of accessibility to these opportunities and physical activity levels, however the strength of the relationship varies based on children's ages. Controlling for age, evidence has indicated children were more likely to be physically active if there was a physical activity facility within a census block of their home (Gordon-Larsen, Nelson, Page, & Popkin, 2006), as well as within a 500 meter walk of their home (Gilliland et al., 2012). Whereas when children perceived accessibility to physical activity opportunities as a barrier in their neighbourhood, they were less likely to be physically active (Timperio, Crawford, Telford, & Salmon, 2004). Researchers hypothesize that accessibility may especially be an issue for children in rural areas. Markey, Lauzon, and Ryser (2015) indicated parents in smaller communities (population less than 10,000) were more likely to indicate accessibility as a barrier to physical activity for their children than those in the largest communities. This concern was echoed by the voices of children in qualitative research (Jago et al., 2009; Sherar et al., 2009; Walia & Leipert, 2012). This evidence highlights the importance of considering the impact of accessibility on children in the many different types of neighbourhoods across Canada, as they may experience barriers at varying levels in their environments. It is also important however, to consider the types, amount, and availability of infrastructure accessible to the populations being served.

Availability of physical activity promoting infrastructure is described as the presence and amount of age appropriate equipment/activities/landscape design features etc. that provide the opportunities to participate in physical activity. This could include the presence of playgrounds, sports nets, sidewalks, and hiking/biking trails. Availability differs from accessibility because for example, although a park may be close in proximity it may not be perceived as an appropriate play structure by older children, and what is considered appropriate is unavailable. Furthermore, access works in tandem with availability; if a sidewalk is not present (availability) there is no possibility that children can access it.

Research dictates the importance of perceived availability of safe and useable physical activity infrastructure for the promotion of physical activity behaviour (Davison & Lawson, 2006; Evenson et al., 2006; Grow et al., 2008; Yousefian et al., 2009). While some researchers have found a lack of association between availability of bike lanes and walking trails with physical activity in specific demographic groups (such as by gender, age, and socio-economic status) (Davison & Lawson, 2006; Ewing, Schroeer, & Greene, 2004; Jago, Baranowski, Zakeri, & Harris, 2005), arguably this demonstrates the importance of a more detailed understanding as to who experiences a lack of availability of specific resources as a barrier, in order to cater more specifically to the population with the highest risk of negative health concerns.

Less discussed in the literature was the availability of neighbourhood aesthetics, and their role in promoting physical activity. Research has indicated that aesthetically pleasing public landscapes have been found to foster individual wellbeing (Abraham et al., 2010), but more research is needed to understand specifically the influence on children. Features such as trees along streets, interesting things to look at, and neighbourhood lighting, have been found to influence children's physical activity levels (Evenson et al., 2006; (Grow et al., 2008; Loebach & Gilliland, 2010; Mota, Almeida, Santos, & Ribeiro, 2005), however some researchers argue not the presence but the absence of aesthetically pleasing landscapes (causing neighbourhood disorder i.e. presence of garbage, lack of lighting and presence of graffiti) is more important to influence physical activity (Davison & Lawson, 2006; Jago et al., 2005, Mota et al., 2005). Important to note, Loebach & Gilliland (2010) suggest when considering neighbourhood aesthetics and disorder for influencing physical activity, there is a need to understand how children perceive these factors specific to their environments. By attempting to comprehend how children perceive such features, we can better understand how to mitigate these barriers to physical activity. For example, children often associate poor neighbourhood aesthetics with a lack of safety (Loebach & Gilliland, 2010). This demonstrates the interplay of physical environment factors within the socio-ecological model.

Throughout the literature, a lack of neighbourhood safety has been interpreted in a number of ways, such as presence or fear of strangers, loose animals, traffic dangers, poor

neighbourhood infrastructure (e.g., lack of lighting and sidewalks), and crime rates (including gang activity). The implications of poor neighbourhood safety have demonstrated mixed results among the research that has been conducted. In a literature review conducted by Davison and Lawson (2006), of nine studies identified which discussed a perceived lack of safety and children's physical activity, the majority reported no association (Adkins, Sherwood, Story, & Davis, 2004; Mota et al., 2005; Sallis, Alcaraz, Mckenzie, & Hovell, 1999; Trost et al., 2002; Zakarian, Hovell, Hofstetter, Sallis, & Keating, 1994; Burdette & Whitaker, 2005). However, many researchers are reporting the opposite. For example, Evenson et al. (2006), Carver et al. (2005), Gómez, Johnson, Selva, and Sallis (2004), and Molnar, Gortmaker, Bull, & Buka (2004) found perception of safety in neighbourhood was positively associated with physical activity levels. Furthermore, results of a national survey in the United States (2007-2009) indicated a significant association between safety concerns and time spent outside (Larson, Green, & Cordell, 2011), a known positive influencer of physical activity levels. Qualitative studies which sought the perception of respondents through interviews and focus groups found supportive evidence for this association (Smith & Barker, 2001; Loebach & Gilliland, 2010). While the relationship is unclear, Beets and Foley (2008) suggest it may not be the presence of actual environmental characteristics that directly affect safety influencing physical activity levels, but rather the perceptions of neighbourhood characteristics that promote safety perhaps are more influential in decisions to participate in physical activity. This highlights the importance of considering the intersectionality of the socio-ecological model between the individual and social environments and the physical environment.

2.7 Discussion and Conclusions

The purpose of this chapter was to provide an overview on the literature surrounding Canadian physical activity guidelines and evidence for practice, and children's perceptions of their activity environments. This is specifically pertaining to children's perceived barriers and the resultant influence on physical activity levels. While researchers tend to agree across the literature that the most appropriate model for understanding environmental influence on physical activity is the socio-ecological model,

there is a paucity of research focusing on children in rural areas in Canada, and a tendency for research to focus efforts on metropolitan areas. This literature review further highlighted research gaps, as explained throughout this chapter.

This chapter highlighted several gaps in the literature. Firstly, there is a lack of clarity surrounding terminology and problematic division of definitions when it comes to thinking about rurality and urbanicity. A large majority of previous research uses a dichotomous, or trichotomous scale for measuring differences between rural and urban, and often defining rural as not urban. The way of thinking creates a problematic gap because it lumps children into inappropriate subgroups, which can lead to a skewed interpretation of the physical activity evidence. In order to mitigate this issue, this thesis will use a population density and built form spectrum to measure indicators of urbanicity. This will allow for a definition that considers heterogeneity of different land uses while maintaining objectivity in measurement. Furthermore, this research will add to the literature due to the current lack of research focusing on Canadian children outside of metropolitan areas.

The importance of this research lies in addressing the gap of rural children's perceptions on what barriers affect their physical activity in outdoor spaces. The literature review determined the need for researchers to include the voices of children in planning decisions (Lee et al., 2015). Despite the recognition of the influence physical activity in outdoor spaces has on children, there is still a lack of understanding of the relationship between the neighbourhood and children's perceptions and behaviours (Loebach & Gilliland, 2010).

2.8 References

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Chapter 3

3 Data Collection; Tools and Measurement

The following chapter will provide more information on specific data collection procedures for the subsequent studies included in this thesis. By describing these details, this chapter aims to provide more clarity on the study area, participants and recruitment, tools to measure variables, and data cleaning procedures, to give the reader context into decisions related to the statistical analysis throughout the remainder of the thesis. This thesis follows an integrated article format and therefore some of the information discussed here to provide clarity will be repeated within the studies in following chapters. This chapter, however, will not provide additional detail on statistical methods for analyzing data, which will instead appear only in the relevant studies. The chapter is divided into six main sections. Section 3.1 provides an in-depth description of the research setting and participant recruitment. Section 3.2 discusses the data collection tools and decision making for data reduction. Section 3.3 discusses the data analysis procedures related to the dependent variables. Section 3.4 will justify the methods selected to analyze the variables examined throughout the remainder of this thesis. Section 3.5 will conclude this chapter and Section 3.6 will provide the references used within this chapter.

3.1 Research Setting

The studies will draw on a multi-year, population based study called the Spatial Temporal Environment and Activity Monitoring (STEAM) project conducted by the Human Environmental Analysis Laboratory (HEAL) at Western University. STEAM used a combination of methods including GPS monitoring, accelerometers, daily activity diaries, parent and child surveys and focus groups to investigate effects of the built environment on health behaviours in children. Data was collected over 14 days at two time points in each study cohort, allowing for an understanding of the influences of children's environments on their perceptions of health behaviour opportunities over time. This study was approved by the Non-Medical Research Ethics Board of the University of Western Ontario (NM-REB #: 17918S & 108029) prior to the onset of the studies (see Appendix C and D). All schoolboards participating in the STEAM project granted permission through

their internal research ethics board to complete the protocol. Parents provided consent for their children to participate, and all children provided assent to participation (see Appendix E and F).

3.1.1 Sample

Between the years of 2010-2013, data was collected in six regions (with varying urbanicities) of Southwestern Ontario across four public schoolboards and one private (English and French). Research was conducted in both the fall and spring months in seven day intervals for each study period. Across the time span, data was collected from a total of 33 randomly selected schools (2 in year 1, 6 in year 2, 10 in year 3, and 14 in year 4) of 63 initially contacted. These schools represented a socially and spatially stratified sample of the total population. Across the four-year study period, there was 100% retention of schools. Recruitment presentations were made to 1394 students, of which 932 agreed to participate (66.9% participation rate). A total of 791 students (84.9%) in this group completed the data collection across both time points in the Southwestern Ontario cohorts.

In 2016, the study was replicated in three Northwestern Ontario communities located in the Thunder Bay District, in four schools (English only), in two public schoolboards. Research was conducted in the fall and winter in seven day intervals during each study period. Across the time span, data was collected from purposefully selected schools. Purposeful selection was the result of two major factors: 1) a pre-existing relationship of the research team with the school boards and community, and 2) these were the only four schools located in the areas. Across the study period, there was 100% retention of schools. Recruitment presentations were made to 194 students, of which 136 participated in data collection in the first round of the study (70.1% participation). A total of 125 students (91.2%) in this group completed the data collection across both time points in the Northwestern Ontario cohort.

This thesis will draw from a total data set of 892 students in study one (Chapter 4), and 546 students in study two (Chapter 5) between the ages of 8-14 years. The data used to inform this research will include all child surveys to understand perceptions (self-

reported), corresponding parent surveys to determine demographics, GPS derived home location (Study 2), and accelerometry to determine the physical activity levels within urbanicities (Study 2).

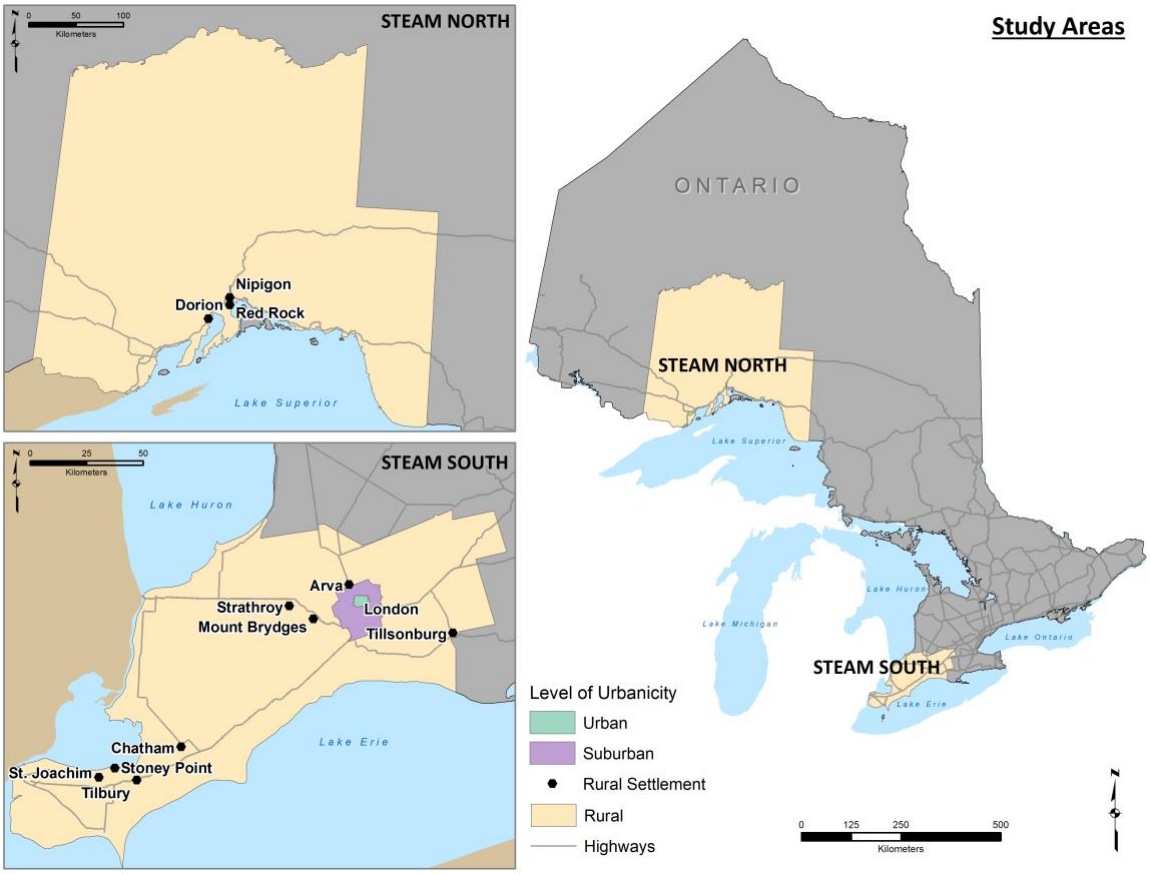

Figure 3.1 Map of STEAM Study Areas in Northwestern and Southwestern Ontario including levels of urbanicity.

3.2 Data Collection

The following section discusses the major tools used to collect data that will be analyzed in the present studies.

3.2.1 Survey Tools

The parent and youth surveys for the STEAM project were developed by the HEAL at Western University. These questions were initially developed for the pilot study but have evolved to include questions regarding the perceptions of home and school environments,

active travel to school, healthy eating, physical activity habits, parents' rules, safety and crime perceptions, quality-of-life measurements, and individual-level social and demographic questions including postal code. The most recent version of the relevant survey tool questions can be found in Appendix G.

Eight questions incorporated to measure barriers in Study 1 relating to safety on the streets, presence of crime and local infrastructure were adapted from a commonly used and validated tool called *The Neighbourhood Environment Walkability Survey* (NEWS) (Brownson et al., 2004). NEWS is used to measure residents' perceptions of their neighbourhoods and the design features related to physical activity (Brownson et al., 2004; Cerin, Saelens, Sallis, & Frank, 2006). This tool has demonstrated modest correlations of neighbourhood design with physical activity measured with accelerometers (Atkinson, Sallis, Saelens, Cain, & Black, 2005) and self-reported (De Bourdeaudhuij, Sallis, & Saelens, 2003). The NEWS was developed based on transportation and urban planning literature, and with input from urban planners. Questions initially listed in the NEWS were recoded from facilitators into barriers in the present study to measure the influence of perceiving barriers to activity.

The additional nine questions used in Study 1 were developed based on background relationships identified in the literature, use in previous studies, or to measure necessary socio-demographic characteristics of the participants. Specifications related to data management and background literature are discussed in Chapter 4.

3.2.2 Accelerometers

To synthesize results in Study 2, physical activity levels will be measured objectively using accelerometer data. Accelerometry is the gold standard tool for assessing field-based physical activity in children (Borghese et al., 2017). The model utilized in this study was the Actical® Z accelerometers (Phillips - Respironics, Oregon, USA). This device uses 30-s epochs to measure energy expenditure (METS), providing an index of physical activity intensity throughout the course of wear time. This tool has demonstrated high levels of reliability especially compared to other devices (Esliger & Tremblay, 2006), with one major benefit being the ability to differentiate between time spent

engaging in sedentary, light, moderate and vigorous physical activity behaviour (Puyau, Adolph, Vohra, Zakeri, & Butte, 2004).

Participants in the STEAM study were asked to wear portable Actical® Z accelerometers on their right hip attached with a nylon-elastic band. Participants wore the device for eight consecutive days (4-6 weekdays and 2-3 weekend days) for all waking hours, removing it only for sleeping, bathing and swimming. To determine activity levels, validated movement thresholds were applied (see Figure 2.1 for range indicators) (Puyau et al., 2004; Tremblay et al., 2016).

One limitation to the use of accelerometers, however, is the lack of an established standard wear time requirement in the literature when measuring children's physical activity. This includes a lack of clarity on the importance of weekdays versus weekend days when attempting to interpret children's physical activity behaviour trends despite known differences in physical activity levels (Trost, Pate, Freedson, Sallis, & Taylor, 2000). Trost, et al., (2000) however found that a 4-5 day monitoring period has a test-retest reliability of 0.8 among children (grade 1 to 6), and 0.7 among adolescents (grade 7 to 12). Furthermore, an inclusion of at least one weekend day has been found to be more representative of physical activity patterns as a whole (Comte et al., 2013). As well, in a study by Rich et al. (2013) it was found that the reliability measure of activity using accelerometers increased by 6% when including both weekday and weekend measurements of children's physical activity behaviour. Based the literature review related to use of the device, allowing for comparability of studies, and using the established evidence, this study will use a minimum of four valid days (ten consecutive hours of wear time) including one weekday and one weekend. This criteria maximizes our sample potential while attempting to best represent average physical activity behaviours in a typical week.

3.2.3 GPS Devices

Home location for each child was identified through the passive tracking of participants with the use of a VisionTac VGPS-900 GPS logger. This device continuously records spatial locations in 1-second intervals. Participants were asked to wear the GPS devices

during all waking hours for 8 consecutive days unless they were sleeping, bathing, or swimming.

3.2.4 Median Household Income

When attempting to control for parental income, the research team had to adapt the measure from Study 1 to Study 2. Rather than using parents' self-report information median household income (MHHI) measured in CAD at the dissemination area level was controlled for in the model. This strategy was used because a large majority of parents elected not to report their income on the parent survey. We were unable to impute this information to account for missing cases because this information was not missing at random.

Dissemination areas (DA) are geographic units made up of one or more adjacent dissemination blocks. DA are the smallest standard geographic unit available for Canadian census data (Statistics Canada, 2012). MHHI was determined by overlaying child participants' home locations, based on the GPS monitoring, with DA level census data for the corresponding year of study (i.e. 2011 or 2016) in ArcGIS 10.1 (ESRI, 2017; Statistics Canada, 2016). MHHI as a control was applied in the path analysis. This was because previous work (Study 1) determined parent's income had a significant effect on the likelihood of children reporting perceived barriers to their physical activity. Furthermore, the 2011 and 2016 Canadian Census information demonstrate differences in the MHHI in the study areas thereby indicating a need to control for this information (see https://censusmapper.ca).

3.3 Justification for Analysis of Variables

3.3.1 Procedure for Analyzing Children's Perceptions

Each study handles the use of the child's report of perceiving barriers differently. This was due to the specific research questions of the studies, and the statistical analysis methods used in each. The original survey questions were asked with four point Likert-type questions. These questions forced children to choose between *strongly disagree*, *disagree, agree,* and *strongly agree*, rather than allowing them to take a neutral stance.

In Study 1, children's responses to the survey questions were treated as dependent variables. This study analyzes the relationship of children's environments and the likelihood that they would agree to perceiving specific barriers to physical activity. As a result, the 4-point data were recoded to binary variables (i.e., 0 for disagree, 1 for agree) to enhance validity of inference in this analysis (Harwell & Gatti, 2001). Furthermore the extent that children agree or disagree that the barrier was present was not necessary for measuring the objective of this study. Four questions asked about the presence of facilitators and were reverse recoded to maintain consistency of measuring barriers in this study (i.e., *do not* know people, *not* enough sidewalks, *not* enough bike lanes, *not* enough trees). In order to help the reader understand the findings in relation to one another, the results were presented by organizing them thematically into three groups. These groups were *safety*, *social*, and *neighbourhood* barriers, and were developed based on the literature review.

In Study 2, children's responses were included as independent variables within a structural equation model to understand their effect on objectively measured MVPA of participants. This study used the three thematically defined groups to assess children's responses as Likert scales. Each score has a minimum of four questions, that were combined into a single composite score for each participant, to provide a quantitative interval measurement scale (i.e. 1 for *strongly disagree*, 2 for *disagree*, 3 for *agree*, 4 for *strongly agree*) (Boone & Boone, 2012). This tool was used to consider the responses as continuous variables within the structural equation modeling.

3.3.2 Changes in Analysis of Activity

In the creation of the new *24-Hour Movement Guidelines for Children and Youth*, Tremblay et al. (2016) adapted a new analysis method when assessing adherence to the behaviours included in the guidelines. Previously, the measure focused on physical activity adherence and analyzed if 60 minutes of MVPA was achieved on at least 6 of 7 days per week, in isolation of the other behaviour recommendations (Colley et al., 2011; Tremblay et al., 2016). The new methodology suggests instead that researchers should examine time spent engaging in behaviours, and average them across the entire week.

Tremblay et al. (2016) suggest this paradigm shift recognizes the variability in movement behaviours on the continuum (Figure 3), and the total accumulation of volume of activity.

As a result of the new methodology, minutes of activity tend to be inflated when compared to the previous 6 of 7 days method (33% versus 7% respectively achieving MVPA recommendation) (Colley et al., 2017). The average approach, however, recognizes the day to day variations in activity emphasizing sufficient total weekly volume and ensures consistency in the approach for each movement behaviour (Janssen, Roberts, & Thompson, 2017; Roberts et al., 2017). Based on the trends in recent literature related to measuring adherence to the *Guidelines* and the likelihood for analyzing these behaviours using the average approach in future research, this thesis will use this method when analyzing accelerometer data. By using the average approach, this will allow for comparability between studies past and future using the same method.

3.3.3 Measuring Urbanicity and the Spectrum Tools

In Study 1, urbanicity in which the primary home of each child is located was classified into five groups: (1) Urban large-city, which includes areas that are characterized by grid-like road networks, high population density, and high land use mix within settlements greater than 100,000 people; (2) Suburban large-city, which includes areas that are characterized by irregular, looping and cul-de-sac road networks, lower population density, and low land use mix within settlements greater than 100,000 people; (3) Urban small-town, which includes settlement areas with a population between 10,000 and 100,000 people; (4) Rural small-towns, which include settlements with a population between 1,000 and 10,000; and (5) Rural areas, which are all other areas of our study area, with low population density and mostly characterized by agricultural land and natural areas. Home location was compared to this categorization of built form and population density spectrum to determine level of urbanicity, allowing for greater insight into location-based presence of environmental physical activity barriers.

After completion of Study 1 Taylor, Clark and Gilliland determined that the approach could be further improved upon to better explain the variation between the most rural and urban areas. Using the GPS home identified location, we were able to classify participants

within the urbanicity spectrum based on intersection and population density. These measures have been used previously in the literature to measure urbanicity and the association of built environment features with MVPA in adolescents (Boone-Heinonen, Popkin, Song, & Gordon-Larsen, 2010). According to a nationally representative sample in American children in a study by Boone-Heinonen et al. (2010), differences in MVPA levels were found to exist in adolescents with a three-level urbanicity categorization. This categorization included a 1, 3, 5, and 8 km buffer, controlling for population density (increases as urbanicity increases) and measuring intersection density. Boone-Heinonen et al. (2010) found MVPA was positively and independently associated with increasing intersection density (3 or more-way intersections per square km). These measures were determined to provide a good starting point for our research as they allow for objectively measured data, that we could compare our GPS identified points with reliable indicators collected in the Canadian Census. In order to create our urbanicity spectrum, six main steps were carried out.

Using Canadian Census data (Statistics Canada, 2016), dissemination block population density (people/km^2) for each child's home location was calculated using ArcGIS 10.1 (ESRI, 2017). A dissemination block is an area bounded on all sides by roads and/or boundaries of standard geographic areas, and is the smallest geographic area population and dwelling counts are disseminated in the census (Statistics Canada, 2012). The next step was to create a 500m Euclidean buffer around each child's home. According to Cavagna, Franzetti, and Fuchimoto (1983), at age 12, children can walk up to 5km/hour, meaning a 500m buffer is about 6 minutes walking distance for the average child (Mitchell, Clark, & Gilliland, 2016). Step three was to compute the number of 4-way intersections within the 500m buffer, and step four was to compute intersection density for each buffer (# of intersections / km^2). This captured the built form measurement of the spectrum (Boone-Heinonen et al., 2010). Results up to this point were transferred from ArcGIS into the Statistical Package for Social Sciences software (SPSS) (IBM Corp, 2016). Step five was to compute Z-scores for each child, using the raw scores of population density and intersection density. The final step was to compute the index for urbanicity. The formula was: ($Z_{\text{Population Density}} \times Z_{\text{Intersection Density}}$). This formula was

moderately correlated with the original urbanicity score measure used in Study 1 ($r_s = -0.69$, $p < 0.001$), representing the geography of the regions.

3.4 Measuring the Data

The following table demonstrates all variables that went into the statistical models in the studies, details on how they were measured, and where they were derived from.

Table 3.1 Measuring Variables

Variable	Independent, Dependent or Control	Study 1 or Study 2	How it was Measured	Data Source
Demographic Variables				
Gender	Independent in Study 1 Control in Study 2	Both	Binary Variable (No children selected other).	Child Survey
Age	Independent in Study 1 Control in Study 2	Both	Continuous Variable	Child Survey
Visible Minority	Independent	Study 1	Binary Variable	Child Survey
# of Parents in Main Home	Independent	Study 1	Binary Variable	Child Survey
Household Arrangement	Independent	Study 1	Binary Variable	Child Survey
Parental Employment	Independent	Study 1	Binary Variable	Parent Survey
Median Family Income	Independent	Study 1	Continuous Variable	Income at DA Level of residence
Household Income at Dissemination Area Level	Control	Study 2	Continuous Variable	Income at DA Level of residence
Urbanicity				
Urbanicity	Independent	Study 1	Ordinal, Categorical Variable	Postal Code, Child or Parent Survey
Urbanicity	Exposure	Study 2	Continuous Variable	GPS, Census Data
Perceptions				
Perceptions of Barriers	Dependent	Study 1	4-point Likert data was recoded to	Child Survey

			binary variables (disagree/agree) to enhance validity of inference with regression	
Perceptions of Barriers	Independent	Study 2	Created scored index based on themed questions using 4-point Likert data	Child Survey
Physical Activity				
MVPA	Dependent	Study 2	Total Average Minutes	Accelerometers

3.5 Conclusion

The purpose of this chapter was to discuss rationale of the data collection strategies, and analysis of the following studies. The aim was to give the reader a comprehensive understanding of the research tools and measurement, to provide insight into decision-making and thought processes. Due to the integrated article format of this thesis, justification details of methods are not included in length in the studies. After reading this chapter, one should have a better grasp of the background for all tools used in Chapters 4 and 5. Having this knowledge will provide a foundational understanding for the selected statistical methods for analyzing data, which appears in the relevant studies.

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Chapter 4

4 Context Matters: Measuring children's perceived barriers to physical activity across varying Canadian environments

4.1 Introduction

Recent research suggests less than 35% of Canadian children and youth are meeting the daily recommendation of 60 minutes of moderate to vigorous physical activity (MVPA) (Colley et al., 2017; ParticipACTION, 2018). It has been well established that low levels of physical activity (PA) among children is of serious concern because inactivity in childhood creates long-lasting health risks that track into adulthood (Bauman, 2003; Pate et al., 1999; Warburton, Nicol, & Bredin, 2006). It is widely accepted that an individual's PA behaviour is shaped by their interactions with their physical and social environments of daily life. This is the major tenet of the socio-ecological perspective; health is an outcome of the quality of the individual-environment fit (Grzywacz & Fuqua, 2000). It emphasizes that the intrapersonal and interpersonal factors, that form environmental perceptions of barriers to PA, may be as important for predicting behaviour as the objectively measured physical environment (Giles-Corti & Donovan, 2002; Hume, Salmon, & Ball, 2004). The primary objective of this study is to demonstrate how intrapersonal, interpersonal, and physical environment factors influence children's perceptions of barriers to PA. The secondary objective of this study is to utilize an expanded definition of urbanicity to determine the similarities and differences in children's perceptions in relation to the level of urbanicity of their home location.

4.1.1 Literature Review

Giles-Corti and Donovan (2002) have suggested a socio-ecological model of recreational PA which considers intrapersonal, interpersonal, and physical environment level determinants of PA behaviour. These different levels of environment operate through a reciprocal relationship whereby the individual's PA behaviour is affected by multiple levels of environmental influences, and PA behaviour shapes the surrounding social environment (Townsend & Foster, 2013). The intrapersonal environment is shaped by the

influence of intrapersonal forces such as psychological and demographic factors, personal preferences and choices (Townsend & Foster, 2013). Factors within this level include gender, ethnicity, and age (Townsend & Foster, 2013). The interpersonal environment includes social networks, norms, supports, and standards, among groups, individuals, and organizations (Townsend & Foster, 2013). Main themes discussed in the literature as mechanisms of influence are socio-economic status, parental influence, and relationships with peers. These dimensions influence what an individual perceives as a barrier to PA in their environment, a key contributor to children's activity levels (Hume et al., 2004).

While research surrounding children's perceptions of PA barriers exists, there is little focusing on children in the diverse rural communities of Canada. This is important because evidence suggests there is an elevated risk for health concerns related to physical inactivity in rural versus urban Canadian communities due to differences in built environment and social factors (Moore, Brinkley, Crawford, Evenson, & Brownson, 2013). However, in a systematic review conducted by Sandercock, Angus, and Barton (2010), most studies indicated either no differences, or that urban children were less likely to be active than rural children. This is a problematic conclusion because a dichotomous division between urban and rural populations neglects to highlight heterogeneity of land uses. For example, when using a spectrum approach (i.e., considering more than a dichotomous rural versus urban relationship) to explaining the built environment, that includes suburban or small city populations, many researchers found rural *and* urban children were less active than children in suburban areas or small cities (Joens-Matre et al., 2008; Springer, Hoelscher, Castrucci, Perez, & Kelder, 2009, Springer, Hoelscher, & Kelder, 2006). This highlights the value of considering barriers to PA with a geographical classification system (Sandercock et al., 2010), such as a spectrum from rural to urban.

In order to understand how children engage in MVPA across Canada, there is a need to understand geographic variation in the determinants of activity (Orton et al., 2017). One approach that can be conceptualized is the use of children's daily contexts of living. Regarding health, context has been described as the circumstantial environment in which something takes place, and includes the interplay of the physical, social, cultural and

structural environments coming together to shape the individual's experience (Orton et al., 2017; Williams, 2003). When considering the health and MVPA of children across varying environments, whether they are experienced at the intrapersonal, interpersonal or physical level, we must consider the interplay of the variety of factors that shape how behaviour is formed within interactions of daily life.

4.2 Methods

4.2.1 Data Source and Population

The study uses data from a larger population-based project investigating environmental influences on children's health and well-being, including PA and perceptions of barriers to PA. Study design has been described in detail elsewhere (Mitchell et al., 2016). This study involves participants from Southwestern and Northwestern Ontario and will be using data from surveys of youth and their parents, including responses to questions about socio-demographics, socio-economic status, and perceptions of the barriers for PA participation. This study was conducted in accordance with the Declaration of Helsinki and the Canadian Tri-Council Policy Statement; Ethical Conduct for Research Involving Humans and the protocol was approved by the University Non-Medical Research Ethics Board and the respective research officers and/or committees of the participating school boards. All children who participated in this study provided assent and were given parental consent.

Data was collected between 2010 and 2013 in 33 Southwestern Ontario schools, including 932 children in grades 5 to 8 (age 9-14) (66.9% participation rate). Schools were randomly selected and stratified by geographical context and neighbourhood socio-economic status to ensure the participating sample was representative of the population in the region. In 2016, the study was replicated in four rural Northwestern Ontario schools (100% response rate), including 136 students in grades 4 to 8 (age 8-14) (70.1% participation rate).

A child participant's data was included in this study if it met three criteria: 1) completion of survey by the child participant; 2) completion of a corresponding survey by the child's

parent/guardian; and 3) identified postal code of their home location. Data for 892 (out of 1068) children met the inclusion criteria and were retained for analysis.

4.2.2 Dependent Variables

The dependent variables in this study are dimensions of children's perceptions of barriers to PA. The measures of children's perceptions of barriers are based on child survey questions assessing barriers to activity in the respondents' neighbourhood parks/playgrounds, trees in their neighbourhood and safety in their neighbourhood. A full list of the questions can be found in Table 1. Responses were provided on a 4-point Likert scale (strongly disagree, somewhat disagree, somewhat agree, strongly agree), but the 4-point data was recoded to binary variables (i.e., 0 for disagree, 1 for agree) to enhance validity of inference for this analysis (Harwell & Gatti, 2001). Four questions asked about the presence of facilitators and were reverse recoded to maintain consistency in this study (i.e., *do not* know people, *not* enough sidewalks, *not* enough bike lanes, *not* enough trees).

4.2.3 Independent Variables

The independent variables were identified in the PA literature and organized into levels of the social-ecological model: intrapersonal, interpersonal, and physical environment (Giles-Corti & Donovan, 2002). The intrapersonal variables include demographic data from the child survey. Gender is based on child self-identification and coded as a binary variable: girl (0) or boy (1). Age is a continuous variable measured in years. Visible minority is based on reported ethnicity and is coded as a binary variable: Caucasian (0) or non-Caucasian ethnicity (1).

Six variables are used to measure a child's interpersonal environment. Lone parent household is a binary variable defined as a child living with two parents (0) or one parent (1). Household arrangement is dichotomized into a child living in one home (0) or more than one home (1). Parental employment status is measured for both mother and father, with unemployed parents (including self-identified as unemployed, at home with children, students, or on disability/sick leave) as (0) and employed parents (including self-employed, full-time employed, or part-time employed) as (1). Median Family Income (CAD) is the median family income from the 2011 National Household Survey measured

at the census dissemination area in which the home is located and categorized as under $60,000 (0); between $60,000 - $99,999 (1); and $100,000 and more (2) (Statistics Canada, 2017a, 2017b).

The physical environment variable included in this study is the level of "urbanicity" in which the primary home of each child is located (Tillmann, Clark, & Gilliland, 2018). We categorize urbanicity into five classes: (1) Urban large-city, which includes areas that are characterized by grid-like road networks, high population density, and high land use mix within settlements greater than 100,000 people; (2) Suburban large-city, which includes areas that are characterized by irregular, looping and cul-de-sac road networks, lower population density, and low land use mix within settlements greater than 100,000 people; (3) Urban small-town, which includes settlement areas with a population between 10,000 and 100,000 people; (4) Rural small-town, which includes settlements with a population between 1,000 and 10,000; and (5) Rural areas, which are all other areas of our study area, with low population density and mostly characterized by agricultural land and natural areas. Home location was compared to this categorization of built form and population density spectrum to determine level of urbanicity, allowing for greater insight into location-based presence of environmental PA barriers.

4.2.4 Data Analysis

A series of logistic regression models with robust standard errors in STATA IC 15 (StataCorp., 2015) were used to compare what children consider to be barriers to their PA at varying levels of the socio-ecological model. Logistic regression was selected because it is more robust and has assumptions such as normal distribution or equal variance (Hosmer, Lemeshow, & Sturdivant, 2013). Odds ratios (OR) were calculated to examine associations between a variety of barriers and levels of the socio-ecological model. They were interpreted as the odds of agreeing with a barrier having influence on PA over disagreeing (Hilbe, 2011), and included robust standard error accounts for the observations biased due to clustering (such as within schools). Barriers children reported as influential were significant if $p \leq 0.05$.

4.3 Results

Descriptive statistics are presented in Table 4.1 and the sample distribution of independent variables is presented in Table 4.2. To better categorize barriers, results were organized by themed barrier groups: barriers to safety (Table 4.3); social relationships (Table 4.4); and neighbourhood environment (Table 4.5). A total of 34 barriers were found to be significant, based on the associations of what children perceived as influential in their environments. While there was some variety in the patterning of results, all independent variables demonstrated a relationship with children's perceptions of barriers except paternal employment status. Full model results are presented in Tables 4.3-4.5.

Table 4.1 Survey questions measuring barriers, and sample distribution of responses.

Question Measuring Barrier	Representing code in Table 4.3-4.5	Sample Size (N)	% Agreed
Perception of Safety			
There is so much traffic on streets near my home that it's difficult/unpleasant to bike or play on the street	*Too much traffic*	852	21.7
Most drivers go too fast while driving in our neighbourhood	*Drive too Fast*	848	37.4
I am worried about being or walking by myself in my neighbourhood and local streets because I am worried about being taken or hurt by a stranger	*Worried about Strangers*	851	18.9
There is a lot of crime in my neighbourhood (ex: strangers, gangs, drugs)	*Crime*	850	9.1
Perception of Social Factors			
There are no other kids to play with at parks/playgrounds in my neighbourhood	*No one to play with*	850	35.3
I get bullied or teased when I go to parks/playgrounds in my neighbourhood	*Bullied at park*	847	7.2
I have nobody to go with to parks/playgrounds in my neighbourhood	*No one to go with*	840	25.2
I [do not] know a lot of people in my neighbourhood	*Do not know people*	853	21.8
There are too many people/it feels too crowded at parks/playgrounds in my neighbourhood	*Too crowded at park*	849	15.1
Perception of Neighbourhood Environment			
Parks/playgrounds in my neighbourhood are too far from my house/takes too much time to get there	*Too Far from Home*	850	17.9
There is not enough room at parks/playgrounds in my neighbourhood for the activities I like	*Not enough room*	848	20.87
There is too much garbage/graffiti at parks/playgrounds in my neighbourhood	*Garbage/Graffiti*	850	13.9
There are [not] enough sidewalks on the street in my neighbourhood	*Not enough sidewalks*	847	37.5
There are [no] bicycle lanes or trails in or near my neighbourhood that are easy to get to	*Not enough bike lanes*	851	48.4

There are [not] a lot of trees along the streets in my neighbourhood	*Not enough trees*	852	23.9
There is no or not enough equipment or activities I like	*Not enough equipment*	848	32.2

Note: numbers may not add to full sample size due to missing values

Table 4.2 Descriptive characteristics of independent variables

Independent Variable	**N**	**% of Total (N= 892)**
Intrapersonal Environment		
Gender		
Boy	396	44%
Age, mean years (Std. Err.)	11.1 (0.03)	
Visible minority	240	28%
Interpersonal Environment		
# of parents in main home		
Living with one parent	200	22%
Household Arrangement		
Live in more than one home	144	16%
Mother Employment Status		
Unemployed	138	16%
Father Employment Status		
Unemployed	54	6%
Median Family Income, CAD		
Middle Family Income, $60,000 - $99,9999	128	14%
High Family Income, $100,000 and more	224	25%
Physical Environment		
Urbanicity		
Suburban Large City	399	45%
Urban Large City	83	9%
Urban Small-Town	80	9%
Rural Small-Town	147	16%
Rural	183	21%

4.3.1 Intrapersonal Factors

At the intrapersonal level, each independent variable demonstrated statistically significant influence on reporting perception of at least one barrier. Girls and visible minorities were more likely to report social barriers than their counterparts. Girls were 1.4 times more likely to report *No one to go with (*$p = 0.044$*)* than boys. Children who are visible minorities were 1.6 times more likely to report *Do not know people* ($p = 0.016$) as a barrier to PA than Caucasian children. Neighbourhood barriers were reported in two cases. With each increase in age by one year, children were more likely to report *Not enough room* as a barrier ($p = 0.047$). As well, children who are visible minorities were 1.5 times more likely to report *Not enough room for activities* ($p = 0.006$) compared to their counterparts. Two of three groups of children were more likely to report lack of safety as a barrier to their PA compared to their counterparts. With each increased year in age, older children report *Worried about strangers* ($OR = 0.79$, $p = 0.014$) and *Too much traffic* ($OR = 0.84$, $p = 0.050$). Girls are also 2.2 times more likely indicate *Worried about strangers* ($p < 0.01$), and 1.5 times more likely to report *Drive too fast* as a significant barrier ($p = 0\ .013$) compared to boys.

4.3.2 Interpersonal Factors

The interpersonal variables were found to have some significant relationships with reporting safety, social and neighbourhood barriers. The children who reported the most significant barriers were those whose mother is employed. These children reported experiencing the safety-related barrier of *Drive too fast* ($OR = 0.61$, $p = 0.028$), the social barrier of *Too crowded at park* ($OR = 0.37$, $p = 0.019$), and neighbourhood barriers of *Garbage/graffiti* ($OR = 0.35$, $p = 0.005$) and *Not enough equipment* ($OR = 0.61$, $p = 0.047$). A child's mother being unemployed and paternal employment status were not related to significantly reporting barriers to PA. Children in lone-parent households reported two significant neighbourhood barriers to PA, including *Not enough sidewalks* ($OR = 1.46$, $p = 0.039$) and *Not enough bike lanes* ($OR = 1.48$, $p = 0.047$) when compared to children in single-parent household. Children who lived in one home (versus multiple) also reported three significant barriers to PA, including *Too crowded at parks* ($OR = 1.84$, $p = 0.042$), *Not enough trees* ($OR = 2.33$, $p = 0.004$), and *Garbage/graffiti* ($OR =$

2.33, $p = 0.004$). Three barriers were significantly related to parental income, where children in low income families were more likely to report perceiving barriers than those from middle income families. This included being 3.3 times more likely to report *Not enough room* ($p = 0.004$) and 2 times more likely to report *No one to play with* ($p = 0.013$) than children from middle income families. There were no significant differences in reporting barriers between children in low and high income families.

4.3.3 Physical Environment

Children in the rural areas experienced significant barriers related to their neighbourhood environment and local infrastructure for PA when compared to children in suburban areas. This was represented in three barriers, *Too far from home* ($OR = 4.32$, $p < 0.000$), *Not enough sidewalks* ($OR = 3.91$, $p < 0.001$) and *Not enough bike lanes* ($OR = 2.06$, $p < 0.001$). On the other hand, suburban children were more likely to perceive barriers related to safety than the rural groups. This group of children was 3.5 times more likely to report *Crime* compared to rural ($OR = 0.17$, $p < 0.001$) and 5.9 times more likely than rural small-town (, $p < 0.001$) children. They were also 2.8 times more likely to report *Garbage/graffiti* compared to rural children ($p = 0.008$), 3.6 times more likely to report *Too much traffic* ($p < 0.001$) and 1.9 times more likely to report *Do not know people* ($p = 0.039$) compared to rural small-town children. Comparing urban and suburban children, urban children were more likely to report *Too much traffic* ($OR = 1.82$, $p = 0.017$), *Worried about strangers* ($OR = 2.01$, $p = 0.001$), *Do not know people* ($OR = 2.71$, $p = 0.002$), *Not enough room* ($OR = 1.97$, $p = 0.028$), and *Not enough equipment* ($OR = 1.68$, $p = 0.040$). The only reported barrier to PA that remained significant for urban small-town and rural small-town children was a *Not enough trees* (see Table 4.5).

Table 4.3 Logistic regression models examining factors related to children perceiving safety barriers to physical activity.

	Too much traffic		***Drive too Fast***		***Worried about Strangers***		***Crime***	
	OR (Std Err)	p	OR (Std Err)	p	OR (Std Err)	p	OR (Std Err)	p
Intrapersonal Environment								
Boys	0.79 (0.14)	0.167	0.66 (0.11)	0.013*	0.45 (0.08)	0.000*	1.40 (0.38)	0.208
Age	0.84 (0.07)	0.050*	0.92 (0.06)	0.209	0.79 (0.07)	0.014*	0.96 (0.13)	0.735
Visible Minority	0.92 (0.16)	0.630	0.68 (0.14)	0.070	1.45 (0.31)	0.085	1.41 (0.37)	0.182
Interpersonal Environment								
Lone Parent Household	1.24 (0.36)	0.470	1.28 (0.28)	0.247	1.21 (0.29)	0.422	1.17 (0.24)	0.441
Live in one home	1.04 (0.25)	0.870	1.05 (0.24)	0.820	0.95 (0.26)	0.851	1.39 (0.45)	0.309
Mother unemployed	0.60 (0.16)	0.052	0.61 (0.14)	0.028*	1.08 (0.25)	0.734	0.62 (0.24)	0.215
Father unemployed	0.92 (0.19)	0.703	0.72 (0.19)	0.229	0.64 (0.21)	0.171	1.58 (1.00)	0.474
Family Income (ref: Low Family Income)								
Middle Income	0.58 (0.21)	0.134	1.11 (0.28)	0.667	0.92 (0.34)	0.812	2.48 (1.31)	0.082
High Income	0.64 (0.18)	0.102	0.80 (0.17)	0.300	0.55 (0.20)	0.099	1.34 (0.77)	0.607
Physical Environment								
Urbanicity (*ref: Suburban Large City*)								
Urban Large City	1.82 (0.46)	0.017*	1.67 (0.50)	0.086	2.01 (0.43)	0.001*	1.46 (0.40)	0.167
Urban Small-town	1.25 (0.28)	0.318	1.51 (0.35)	0.077	1.07 (0.32)	0.800	0.41 (0.40)	0.059
Rural Small-town	0.28 (0.75)	0.000*	1.21 (0.22)	0.301	0.82 (0.23)	0.464	0.29 (0.08)	0.000*
Rural	1.04 (0.28)	0.889	1.29 (0.30)	0.279	1.25 (0.43)	0.525	0.17 (0.07)	0.000*
Constant	2.41 (2.47)	0.4390	1.86 (1.36)	0.399	3.70 (4.13)	0.242	0.07 (0.12)	0.116
Pseudo R2	0.0537		0.026		0.0542		0.0856	

Table 4.4 Logistic regression models examining factors related to children perceiving social barriers to physical activity.

	No one to play with		***Bullied at park***		***No one to go with***		***Do not know people***		***Too crowded at park***	
	OR (Std Err)	p	OR (Std Err)	p	OR (Std Err)	p	OR (Std Err)	p	OR (Std Err)	p
Intrapersonal Environment										
Boys	0.77 (0.11)	0.080	1.17 (0.30)	0.533	0.71 (0.12)	0.044*	1.00 (0.20)	0.990	1.42 (0.26)	0.062
Age	0.94 (0.08)	0.501	0.81 (0.11)	0.120	1.01 (0.10)	0.903	0.90 (0.07)	0.169	1.03 (0.08)	0.696
Visible Minority	1.08 (0.16)	0.582	1.14 (0.39)	0.705	1.37 (0.23)	0.061	1.64 (0.33)	0.016*	1.44 (0.38)	0.160
Interpersonal Environment										
Lone Parent Household	1.19 (0.21)	0.296	0.88 (0.53)	0.471	1.11 (0.26)	0.640	1.03 (0.22)	0.875	1.31 (0.37)	0.338
Live in one home	1.17 (0.21)	0.715	0.31 (0.35)	0.743	1.19 (0.26)	0.415	0.89 (0.21)	0.606	1.84 (0.55)	0.042*
Mother unemployed	0.62 (0.16)	0.070	0.68 (0.20)	0.063	0.78 (0.19)	0.313	1.10 (0.37)	0.772	0.37 (0.16)	0.019*
Father unemployed	0.71 (0.24)	0.302	0.67 (0.30)	0.373	1.20 (0.38)	0.564	1.37 (0.54)	0.419	0.75 (0.40)	0.580
Family Income (*ref: Low Family Income*)										
Middle Income	0.50 (0.14)	0.013*	0.59 (0.41)	0.447	0.93 (0.30)	0.822	1.13 (0.37)	0.708	0.84 (0.36)	0.691
High Income	0.90 (0.22)	0.435	0.62 (0.36)	0.419	1.50 (0.55)	0.272	1.04 (0.35)	0.904	0.78 (0.30)	0.514
Physical Environment										
Urbanicity (*ref: Suburban Large City*)										
Urban Large City	1.32 (0.33)	0.272	0.55 (0.26)	0.213	1.92 (0.65)	0.052	2.71 (0.85)	0.002*	0.98 (0.54)	0.974
Urban Small-town	0.71 (0.27)	0.366	1.15 (0.64)	0.802	0.83 (0.22)	0.479	1.53 (0.38)	0.086	0.82 (0.30)	0.599
Rural Small-town	0.83 (0.29)	0.584	1.47 (0.43)	0.186	1.32 (0.32)	0.255	0.53 (0.16)	0.039*	0.98 (0.23)	0.926
Rural	1.22 (0.28)	0.372	0.72 (0.26)	0.363	1.54 (0.49)	0.175	0.95 (0.29)	0.876	1.14 (0.34)	0.699
Constant	1.50 (1.52)	0.687	1.03 (1.74)	0.987	0.17 (0.18)	0.104	0.60 (0.50)	0.541	0.06 (0.06)	0.007
Pseudo R2	0.020		0.055		0.030		0.047		0.035	

Table 4.5 Logistic regression models examining factors related to children perceiving neighbourhood environment barriers to physical activity.

	Too Far from Home		*Not enough room*		*Garbage/Graffiti*		*Not enough sidewalks*		*Not enough bike lanes*		*Not enough trees*		*Not enough equipment*	
	OR(Std Err)	p	OR(Std Err)	p	OR(Std Err)	p	OR(Std Err)	p	OR(Std Err)	p	OR(Std Err)	p	OR(Std Err)	p
Intrapersonal Environment														
Boys	0.70(0.13)	0.057	1.07(0.19)	0.695	0.99(0.24)	0.975	0.99(0.12)	0.926	0.87(0.12)	0.297	1.11(0.19)	0.565	1.01(0.14)	0.967
Age	0.83(0.09)	0.070	0.90(0.05)	0.047*	0.89(0.06)	0.094	1.04(0.06)	0.501	0.93(0.09)	0.438	0.99(0.07)	0.927	1.08(0.07)	0.204
Visible Minority	0.97(0.21)	0.882	1.51(0.23)	0.006*	1.06(0.22)	0.795	1.22(0.24)	0.308	1.08(0.14)	0.585	1.22(0.26)	0.349	1.31(0.23)	0.127
Interpersonal Environment														
Lone Parent Household	0.67(0.16)	0.090	0.95(0.27)	0.857	1.37(0.41)	0.293	1.46(0.26)	0.039*	1.48(0.29)	0.047*	1.51(0.35)	0.078	0.87(0.19)	0.521
Live in one home	0.69(0.20)	0.212	1.07(0.28)	0.793	2.33(0.68)	0.004*	1.25(0.24)	0.237	1.24(0.26)	0.305	1.80(0.43)	0.014*	1.00(0.21)	0.984
Mother unemployed	0.91(0.27)	0.757	0.62(0.16)	0.070	0.35(0.13)	0.005*	0.92(0.23)	0.724	0.79(0.17)	0.293	0.76(0.17)	0.215	0.61(0.15)	0.047*
Father unemployed	1.12(0.49)	0.804	0.98(0.31)	0.938	1.88(0.90)	0.188	0.86(0.30)	0.674	1.07(0.31)	0.816	1.45(0.53)	0.308	0.79(0.23)	0.408
Family Income (ref: Low Family Income)														
Middle Income	1.64(0.75)	0.280	0.30(0.13)	0.004*	0.82(0.29)	0.583	1.27(0.44)	0.497	0.80(0.18)	0.328	1.52(0.52)	0.222	0.73(0.23)	0.315
High Income	1.62(0.68)	0.249	0.57(0.20)	0.115	0.68(0.27)	0.340	0.93(0.20)	0.751	1.04(0.20)	0.858	0.99(0.26)	0.968	0.75(0.22)	0.333
Physical Environment														
Urbanicity (*ref: Suburban Large City*)														
Urban Large City	1.18(0.39)	0.606	1.97(0.61)	0.028*	1.39(0.44)	0.305	1.06(0.20)	0.751	0.85(0.22)	0.523	0.86(0.31)	0.662	1.68(0.43)	0.040*
Urban Small-town	1.73(0.63)	0.131	1.61(0.50)	0.123	1.26(0.47)	0.530	1.37(0.38)	0.256	1.64(0.65)	0.210	2.47(0.92)	0.016*	0.92(0.29)	0.795
Rural Small-town	1.49(0.73)	0.413	0.82(0.23)	0.472	0.63(0.16)	0.067	2.05(0.76)	0.053	1.18(0.18)	0.267	1.49(0.22)	0.007*	0.78(0.20)	0.321
Rural	4.32(1.67)	0.000*	1.50(0.35)	0.077	0.36(0.13)	0.008*	3.91(1.30)	0.000*	2.06(0.34)	0.000*	1.46(0.47)	0.239	1.09(0.29)	0.743
Constant	1.12(1.40)	0.926	0.83(0.62)	0.803	0.39(0.34)	0.286	0.16(0.12)	0.016	1.62(1.87)	0.677	0.11(0.09)	0.008	0.23(0.17)	0.048
Pseudo R2	0.085		0.041		0.057		0.052		0.024		0.030		0.015	

4.4 Discussion

This study employed a series of logistic regression models to examine associations between children's perceptions of barriers to PA and different intrapersonal, interpersonal, and physical environmental factors. This study contributes to the literature on children's physical activity by examining and interpreting how children from a wide range of environmental contexts perceive barriers to PA. To our knowledge, this is the first Canadian study that considers PA barriers for a full range of geographic contexts (i.e., five levels of "urbanicity"). By demonstrating the differing impacts of the integrated social and environmental contexts in relation to the varying intrapersonal environments for diverse groups of children, we can better prioritize areas for mitigating barriers to PA, by targeting variation in the experience of place to most effectively address the issue.

There are several key findings in this study. First, girls perceived more barriers than boys and children who are visible minorities perceived more barriers than Caucasian children. Second, maternal employment status had a significant effect on children's perceptions of barriers while paternal employment status did not, and children in low-income families were more likely to report barriers than those in middle- or high-income families. Finally, children from every level of urbanicity reported different significant barriers. These results demonstrate variations in how barriers to activity are experienced based on a child's context of place. While there were some commonalities across environments, there are striking differences in the way that context influences what children perceive as barriers to their PA.

Previous research has reported mixed results on the importance of children's perceived safety in their community as a barrier to PA (Davison & Lawson, 2006). Although the present study did not link perceptions to actual PA, the findings support other studies that report perceived lack of safety has a negative association with PA levels (e.g., Gómez, Johnson, Selva, & Sallis, 2004). By considering different sub-themes of safety (i.e., traffic, crime, and strangers), the present study offers a deeper understanding into how perceptions of safety may act as a barrier to children's PA.

The present study found various aspects of traffic safety in the neighborhood were significant barriers to PA for girls, older children, and children whose mother was employed. This aligns with trends highlighted within a systematic review by Lee et al., (2015) who reported traffic safety was considered a barrier that decreases activity levels in studies they analyzed. A finding unique to this study however, is that children from suburban areas were more likely to report traffic related issues as a barrier to PA than rural small-town children. Based on this finding, policy initiatives in these areas should focus on strategies for traffic calming methods to reduce the threat of traffic speed in neighbourhoods (Larsen, Gilliland, & Hess, 2012).

Perception of crime was considered a significant barrier to PA for children in suburban large cities compared to rural small towns and rural areas. Additionally, children in urban areas were more likely to report being worried about being taken or hurt by a stranger in their neighbourhood than their suburban counterparts. Beets and Foley (2008) suggested that it may not be the actual measure of crime, but rather the perceived measure of safety in the environment that is important to children. This example shows how children's experience of place may be misaligned with the reality of their situation. As a result, research must focus on the ways children feel crime is present in their communities in addition to objective crime rates, to understand strategies for mitigating this as a barrier to PA.

Children whose mothers were employed reported five out of sixteen examined barriers had significant influences on their PA. On the other hand, none of the examined barriers were statistically significant for children whose mothers were unemployed; likewise, paternal employment status did not have a significant influence on children's responses to reporting barriers. These findings raise several new questions. How and why do the gendered patterns of parental employment status influence children's perception of barriers to PA? Furthermore, how is a child's experience of place influenced by their parent's employment? Future research may use qualitative methods to investigate more deeply why maternal employment status seems to matter more for children's PA perceptions than paternal employment.

In response to objective two, this study used an expanded definition of urbanicity to determine the similarities and differences of children's perceptions in different geographical contexts. The investigation of context was related to categorization of physical environments by level 'urbanicity' taking into consideration dimensions of built form and population density. It was determined that children in the largest areas (urban large-city and suburban large-city) and the smallest areas (rural) reported the most barriers, however these differed relative to urbanicity. While children in urban and suburban areas reported issues related to safety and social barriers, children from the less populated areas consistently reported experiencing physical environment barriers to being physically active. Children in the rural areas reported absence of infrastructure and distance as the major barriers, while children in rural small towns and urban small towns reported these resources were present, but other forces such as neighbourhood aesthetics are perceived to influence their PA behaviour. This makes an important distinction of the differing needs of Canadian children in different contexts, highlighting the importance of considering rural children's variation in the experience of place, rather than one homogenous "*not urban"* population.

This study demonstrated the need for a place-specific approach to understanding the barriers children perceive as influential to their PA. By separating a dichotomous rural-urban definition into five levels in a spectrum, a distinction in the way children experience their environment demonstrates the importance of considering context specific definitions of both urban and rural spaces. In areas with characteristics similar to the urban and suburban areas of study, policy should focus on improving perceptions of safety and interventions should focus on drawing on social connections in the community to alleviate barriers of crime, garbage/graffiti and strangers.

The results of this study suggest policymakers in rural and urban small-towns should seek to engage children as stakeholders for improvements to the current infrastructure and improve the variety of available activities. Policy interventions for rural areas need to focus on opportunities for mitigating perceived distance through transportation opportunities, including active travel (i.e. sidewalks, bike trails) to improve independent

mobility, promoting efficacy for children to access resources that currently exist (i.e. school playgrounds out of school time).

4.4.1 Strengths and Limitations

As with any research, this study presents several limitations that must be considered. First, there may have been other confounders at all levels of the socio-ecological model that were not accounted for in the models. This could include indicators for which we did not have specific measures or adequate data, such as household-level socio-economic status, or additional variables that could have been considered at the built environment level, such as access to recreation facilities and parks. This research focused on a more general environment level to build on the gaps of previous research; however, future work will look for significance with more specific built environment factors and identify their impact on PA levels. The second limitation was there was no consideration of facilitators to activity. While these are important to understand for promoting physical activity in children, we chose to focus our modelling on the presence of barriers. This is a potential area for future research. Additionally, the present study did not link the perception of barriers with a measurement of PA. Nevertheless, the aim of this study was to thoroughly examine children's perceptions of barriers, to provide a basis for future research that may examine how these factors represent actual barriers to children's PA. Future research should focus on examining how these perceived barriers relate to actual PA behaviour.

Despite the limitations mentioned above, it is important to note that the current study assessed how the perceptions of barriers to PA for a large sample of children varied in relation to multiple intrapersonal, interpersonal and physical environment factors across a wide variety of geographical contexts within Ontario. To the best of our knowledge, this is the first study assessing perceived barriers to PA, in such a large sample of children. Additionally, this is the first study to assess differences in perceptions of barriers to PA by place, at a five level urbanicity spectrum, demonstrating the value of this approach for future research especially in the Canadian context. This research highlights not only the heterogeneity of children's physical environments, but also the variety in how children experience barriers based on their intrapersonal and interpersonal environment. While results may be limited in generalizability due to the particular geographic context of

Southwestern and Northwestern Ontario, they provide an important new perspective on understanding children's physical activity behaviour in practice. A criticism of Canadian health policy and practice is the one-size-fits-all approach to targeting health issues, especially in rural areas (Markey, Lauzon, & Ryser, 2015). The present research provides evidence to suggest the variation in experiences of children in different places, highlighting the need for context-specific investigation and interventions. This work emphasizes the importance of gaining children's perspective as stakeholders in practice and policy, in order to effectively impact their environment for promoting health.

4.5 Conclusion

Future work must consider targeting barriers for specific groups in the formation of policy and practice to improve effectiveness of programs. Policy must focus on two main areas for alleviating barriers to outdoor PA; improve centralization of recreation in communities, and ensure infrastructure is relevant to user needs, accessible, aesthetically pleasing, and safe. For health professionals in practice, interventions should target girls and younger children focusing on discussions around plans for safety and the presence of crime in children's neighbourhoods. Finally, researchers should continue to recognize the heterogeneity of neighbourhoods, viewing more than an urban versus rural dichotomous definition and consider the implications of external factors on children's PA levels.

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Chapter 5

5 Exploring the effect of perceptions on children's physical activity in varying geographic contexts: a structural equation modelling approach.

5.1 Background

The ongoing trend of low levels of physical activity in Canadian children is a concern for population health (Colley et al., 2017; ParticipACTION, 2018), as physical activity participation is associated with many physical, mental and social health benefits (Janssen & LeBlanc, 2010; Poitras et al., 2016; Strong et al., 2005). Over the past two decades, research has consistently demonstrated strong evidence of positive linear relationships between type, duration and intensity of physical activity and a variety of health outcomes, prompting recommendations for increasing regular physical activity as a health promotion and disease prevention strategy in children (Poitras et al., 2016; Strong et al., 2005; Warburton, Nicol, & Bredin, 2006; Biddle, Gorely, & Stensel, 2004; Fletcher et al., 1996). Physical activity, especially moderate-to-vigorous physical activity (MVPA) has been associated with benefits related to adiposity, cardiovascular health, brain development, musculoskeletal health and fitness, pro-social behaviour, academic achievement, and quality of life improvements, for children and youth (Jiménez-Pavón, Kelly, & Reilly, 2010; Poitras et al., 2016; ParticipACTION, 2018; Strong et al., 2005). The current Canadian guidelines for physical activity recommend children achieve 60 minutes of MVPA per day to achieve these optimal health benefits (Tremblay et al., 2016).

Despite the wide variety of potential benefits to children's health, only 33% of Canadian children achieve the recommended weekly average of at least 60 minutes of MVPA each day (Colley et al., 2017). A number of individual factors have been associated with the achievement of physical activity guidelines. These include ethnicity, adiposity, education or literacy, preference and choice (Sallis, Prochaska, & Taylor, 2000;Van Der Horst, Paw, Twisk, & Van Mechelen, 2007). While the influence of these individual factors demonstrate mixed results and clarity of these relationships is needed, three factors have

consistently and independently been associated with children's activity levels: age, gender and socioeconomic status. The literature has established that as children get older, they are less likely to be physically active, and achieve physical activity standards (Colley et al., 2017; Dumith, Gigante, Domingues, & Kohl, 2011). It has been well documented that girls are less likely to be physically active than boys (Colley et al., 2017; Dumith et al., 2011; Sallis et al., 1992). Finally, with increasing socioeconomic status, activity levels increase and sedentary time decreases (Epstein et al., 2006; Gebremariam et al., 2015; Sallis et al., 1992; Van Der Horst et al., 2007). In addition to these individual factors, physical environment factors play an important role in formation of activity behaviour.

Associations between children's ability to be physically active and their surrounding physical environments have been widely discussed. Recent systematic reviews examining the relationship between the physical environment and children's physical activity indicate relationships with physical environment factors, including a combination of the built and natural environments (Ding et al., 2011; Martins et al., 2017; Oliveira et al., 2014). Physical activity levels are not just influenced by their objective physical environment; as explained by Orstad, McDonough, Stapleton, Altincekic, and Troped (2017), physical activity behaviour also depends on the individual's perception (cognitive representation) of their physical environment. These perceptions are formed through their experiential context. Context is the environment in which children live, including objective measures that can be measured and evaluated such as population density and built form; but context also includes the interplay of the physical, social, cultural and structural forces to which they are exposed (Orton et al., 2017; Williams, 2003). Orstad et al. (2017) explain that children's perceptions of their surrounding environment develops through a cyclical process that is interactive with social, cognitive and affective experiences. Research has indicated that one's perceptions of their environment may be more important than the physical environment alone for predicting physical activity behaviour (Carroll-Scott et al., 2013; Hume et al., 2004; Orstad et al., 2017). The purpose of this study is to assess the mediating effect of children's perceptions of barriers to activity on the relationship between their environments and MVPA.

When considering issues or opportunities that hinder/encourage physical activity, a valuable way to consider the environmental influences on children's perceptions is through recognition of barriers to physical activity. Based on an individual's experience of context, children living in the same physical environment may experience differences in perception of barriers relative to their interactions with their environment. Three groups of barriers consistently demonstrate an influence on physical activity: neighbourhood, social, and safety barriers. Neighbourhood barriers are usually related to availability of and/or accessibility to physical activity resources in a child's environment and have consistently demonstrated an effect on activity levels. This could include issues due to distance to facilities, transportation options, and residential density or design factors, and the presence/amount of age appropriate equipment/activities/landscape design features for activity in a child's community (Davison & Lawson, 2006; Ding et al., 2011; Oliveira, Moreira, Abreu, Mota, & Santos, 2014, Martins et al., 2017). Social barriers are forces that exist formally and informally throughout children's neighbourhoods and have demonstrated significant influence on the physical activity of children throughout the literature. Mechanisms of influence include parental influence, and relationships with peers positively (i.e. presence of friends) and negatively (i.e. bullying) (Abraham et al., 2010; Beets & Foley, 2008; Hume, Salmon, & Ball, 2004; Jago et al., 2009; Lee et al., 2015; Sherar et al., 2009).

Throughout the physical activity literature, safety barriers have been interpreted in various ways and have demonstrated mixed results. Barriers include presence or fear of strangers, loose animals, traffic dangers, poor neighbourhood infrastructure, and crime (Davison & Lawson, 2006; Loebach & Gilliland, 2010; Smith & Barker, 2001). Beets and Foley (2008) suggest it may not be the presence of actual environmental characteristics that directly affect safety influencing physical activity levels, but rather the perceptions of neighbourhood characteristics that promote safety perhaps are more influential in decisions to participate in physical activity. Previous work by the authors (Chapter 4) sought to understand how these barriers were associated with children's environments. It was determined that 34 barriers related to safety, social relationships, and the neighbourhood were perceived to have influenced physical activity, and these perceptions differed related to children's environmental contexts.

It has been well established the environment and perceptions of barriers impact children's MVPA (Chapter 2), and that children perceive barriers in their environments differently (Chapter 4); while there is very little known about how the perceptions of barriers to physical activity alter the relationship between the physical environment and MVPA. To fill this gap, this paper will examine if children's perceptions of barriers to MVPA mediate the relationship between children's contexts and their MVPA behaviour. This research will provide valuable information to take a direct approach to targeting the MVPA of Canadian children and youth (Barnes & Tremblay, 2017). Furthermore, while research exists assessing of the relationship between subjective environmental barriers to physical activity with objective physical activity, results in the literature primarily focus on populations in large urban or mid-sized cities, especially outside of Canada (Davison & Lawson, 2006; Ding et al., 2011; Martins et al., 2017). Based on the heterogeneous nature of the Canadian context, it is important to acknowledge the lack of generalizability of previous work to children's health in rural areas of this country. The present study will aim to address the paucity of research discussing children outside of large urban centers, by incorporating a spectrum measurement tool to assess the physical environment at multiple levels of urbanicity. This is one of the first studies in physical activity literature on Canadian children to take such an approach.

On the basis of the literature and evidence reviewed, the major hypothesis of this study was that children's perceived barriers to physical activity mediate the relationship between physical environment of their home neighbourhood with physical activity levels. The secondary hypothesis was that all three themed barrier scales (i.e., social, neighbourhood, and safety barriers) would have a significant effect on MVPA, based on existing literature and the findings of Chapter 4; however, these relationships would vary in intensity. We hypothesized perceived social barriers would have the strongest mediating effect between the physical environment and MVPA. This is because social factors such as neighbourhood social cohesion, relationships with neighbors, and availability of spontaneous group social activities have consistently demonstrated a positive association with children's physical activity levels in urban and rural subsamples of children (Aarts, Wendel-Vos, Van Oers, Van De Goor, & Schuit, 2010; Walia & Liepert, 2012). Perceived neighbourhood and safety barriers were hypothesized to have

the mediating effects to a lesser extent. While evidence of a relationship between perceiving greater barriers within these themes and experiencing lower physical activity levels does exist (Grow et al., 2008; Holt et al., 2016; Hume et al., 2004; Loebach & Gilliland, 2010; Yousefian et al., 2009), these forces are context specific and can change based on personal factors such as perceived self-efficacy for engaging (Ryan & Dzewaltowski, 2002), or external forces such as parental rules and local policies (Holt et al., 2016; Lee et al., 2015; Loebach & Gilliland, 2010; Ou et al., 2016; Yousefian et al., 2009).

5.2 Methods

This study draws from the Spatial Temporal Environment and Activity Monitoring (STEAM) project, a multi-year mixed methods research study (2010-2016) that investigates the environmental influences on the health and well-being of children ages 8 to 14 years. The data collection took place in two study locations, in Southwestern Ontario (2010-2013) and in Northwestern Ontario (2016). Schools in Southwestern Ontario were randomly selected based on socio-economic status and urbanicity of the school environment and all of the schools in the Northwestern Ontario community were selected to participate. All selected schools were invited to participate and enrolled through the principal. Children in grades 5 through 8, plus grade 4 children in Northwestern Ontario, were invited to participate in the study during classroom presentations. Children were allowed to participate once they received informed parental consent and provided their own informed assent. The STEAM protocol was approved by the University Non-Medical Research Ethics Board and the respective research officers of the participating school boards. Details of the project recruitment process can be found elsewhere (Loebach & Gilliland, 2016; Mitchell, Clark, & Gilliland, 2016).

For each cohort of students, data was collected over two seasons to allow for an examination of the impact of seasonality on children's mobility and health-related behaviours. This study focused on one season from each cohort to ensure the general seasonality is comparable between groups of children: spring (2010-2013) in the South and fall (2016) in the North. This study uses data provided by passive-GPS tracking, accelerometers, and the youth survey. The GPS monitor was worn by the participants

during all waking hours for up to 8 days and used in this study to identify spatially-accurate home locations for each child. Participants were also asked to wear an accelerometer, to objectively measure their activity levels, for eight consecutive days (4-6 weekdays and 2-3 weekend days) for all waking hours, removing it only for sleeping, bathing, and swimming. Finally, participants were asked to complete a detailed survey that asked children about demographics, and perceptions about their barriers to physical activity.

The initial dataset used for this study included 1,068 children from 33 schools across Ontario. Before conducting any analyses, a series of inclusion criteria were developed to ensure the quality and completeness of the observations used. The first criteria was that participants must have at least four days of accelerometer data with a minimum of 10 hours of valid wear time (Trost et al., 2000), and at least 1 valid weekday, and 1 valid weekend day (n=565) (Comte et al., 2013; Rich et al., 2013). Non-wear time was classified as 60 or more minutes of motionless bouts, and was excluded from analysis (Puyau et al., 2004). The second criterion was that participants must have completed questions on the youth survey about age, gender, and perceptions of barriers to PA (n=892). The final criterion was that a valid home location must be determined by the GPS data. Applying all the inclusion criteria to the dataset left a final dataset has 546 children (62% of all children in the sample) with complete data.

5.2.1 Measurement Instruments

5.2.1.1 Outcome Variable

The outcome variable used in this study was an objective measure of MVPA, defined as the average number of minutes children spend in MVPA across all valid days (Tremblay et al., 2016). The outcome variable was measured using a portable Actical® Z accelerometer that participants wore on their right hip (so as to not impede activity) attached with a nylon-elastic band. This device was calibrated to measure energy expenditure at 60-second epochs, providing an index of physical activity intensity throughout the course of wear time (Heil, 2013). MVPA movement thresholds were defined as 1,500 or more activity counts per minute (Puyau et al., 2004).

While there is no consistent gold standard for minimum thresholds for measuring accurate PA, the inclusion/exclusion criteria of 4 valid days with at least one weekday and one weekend day is found to be an acceptable threshold in the literature (Comte et al., 2013). A 4-5 day monitoring period has a test-retest reliability of 0.8 among children (grade 1 to 6), and 0.7 among adolescents (grade 7 to 12) (Trost et al., 2000). One valid weekday and one valid weekend day is required to ensure the differences in physical activity behaviour between weekdays and weekend days are accounted for when measuring average MVPA. Requiring both types of days created a better representation of physical activity levels for each participant across an entire week (Comte et al., 2013; Rich et al., 2013).

5.2.1.2 Exposure Variable

Previous work by Taylor, Clark and Gilliland (Chapter 4) demonstrated the need for considering more than a dichotomous urban-rural definition when analyzing the influence of children's environments on perceptions of barriers to physical activity. This study used objective measures of population density and intersection density to develop an urbanicity index, which is a spectrum approach considering the heterogeneity of built form and land uses, while providing an objective tool for classifying data (Babey et al., 2015). The urbanicity index was created based on the sum of z-scores of both population density and intersection density around the home location for each child. Population density was measured by identifying the number of people per square kilometer within each home location's census dissemination block. Intersection density was measured by the number of 4-way intersections per square kilometer within 500-metres of each home location.

5.2.1.3 Mediator

The mediating variables in the model were children's reported perceptions of barriers to their physical activity. These barriers were measured by the child survey, with a full list of questions found in Table 1. Survey questions were adapted from the validated *Neighbourhood Environment Walkability Survey* (Brownson et al., 2004). Additional questions were developed based on background relationships identified in the literature, use in previous studies, or to measure necessary socio-demographic characteristics of the participants. Four questions asked about the presence of facilitators and were reverse

recoded to maintain consistency in this study (i.e., *do not* know people, *not* enough sidewalks, *not* enough bike lanes, *not* enough trees). The survey was conducted with 4-point Likert-type questions (strongly disagree, somewhat disagree, somewhat agree, strongly agree), but the Likert-type data was recoded to three thematically defined groups to assess children's responses as Likert scales (see Table 5.1). Each score has a minimum of four questions, which were combined into a single composite score for each participant to provide a quantitative interval measurement scale (i.e. 1 for *strongly disagree*, 2 for *disagree*, 3 for *agree*, 4 for *strongly agree*) (Boone & Boone, 2012). This tool was used to consider the responses as continuous variables within the structural equation modeling.

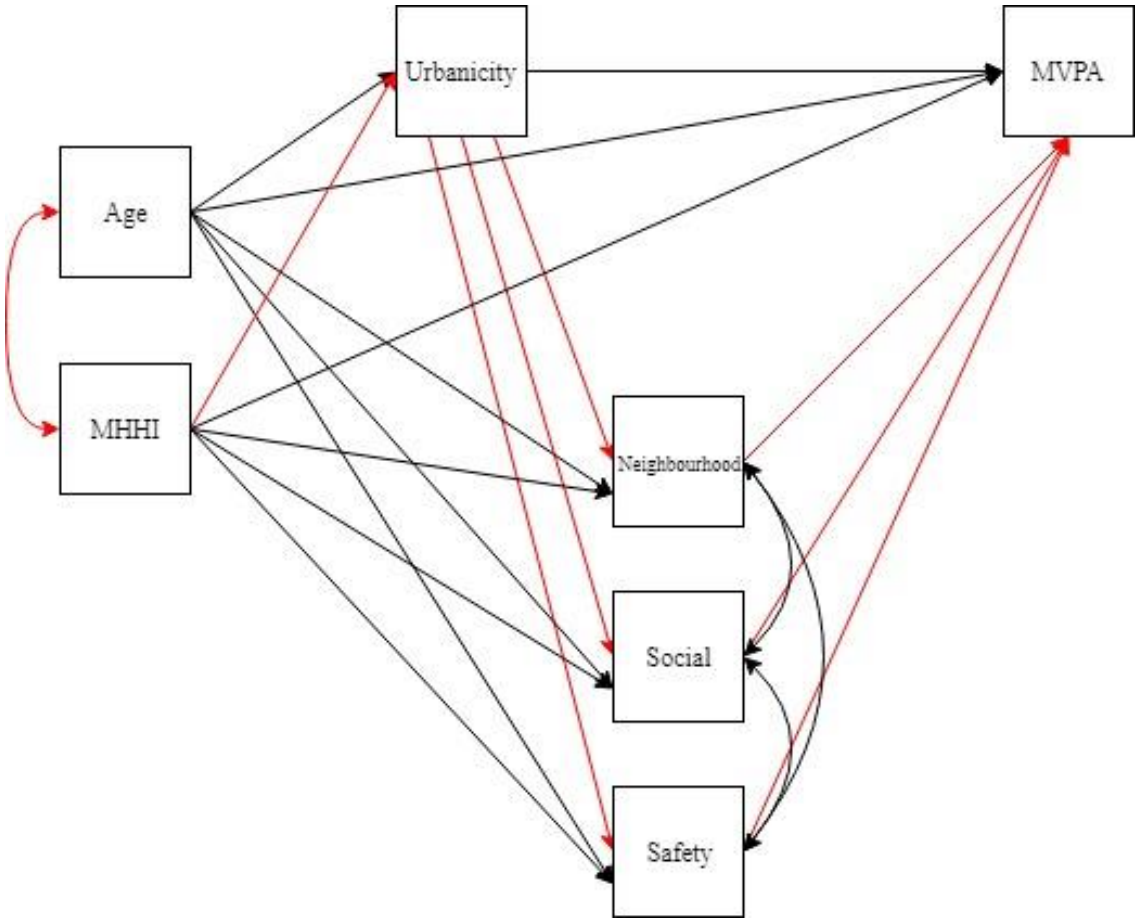
Table 5.1 Survey questions measuring barriers, and the corresponding themed groups.

Perceptions (Themed Groups)	**Corresponding Survey Questions**
Neighbourhood Barriers (Neighbourhood)	1. Parks/playgrounds in my neighbourhood are too far from my house/takes too much time to get there 2. There is not enough room at parks/playgrounds in my neighbourhood for the activities I like 3. There is too much garbage/graffiti at parks/playgrounds in my neighbourhood 4. There are [not] enough sidewalks on the street in my neighbourhood 5. There are [no] bicycle lanes or trails in or near my neighbourhood that are easy to get to 6. There are [not] a lot of trees along the streets in my neighbourhood
Social Barriers (Social)	1. There are no other kids to play with at parks/playgrounds in my neighbourhood 2. I get bullied or teased when I go to parks/playgrounds in my neighbourhood 3. I have nobody to go with to parks/playgrounds in my neighbourhood 4. I [do not] know a lot of people in my neighbourhood 5. There are too many people/it feels too crowded at parks/playgrounds in my neighbourhood
Safety Barriers (Safety)	1. There is so much traffic on streets near my home that it's difficult/unpleasant to bike or play on the street 2. Most drivers go too fast while driving in our neighbourhood

3. I am worried about being or walking by myself in my neighbourhood and local streets because I am worried about being taken or hurt by a stranger
4. There is a lot of crime in my neighbourhood (ex: strangers, gangs, drugs)

5.2.1.4 Effect Modifier and Co-Variates

The model used gender as an effect modifier, as it was hypothesized that the magnitude of effect of the exposure urbanicity mediated by perceptions of barriers on MVPA would vary according to a child's gender. The hypothesis was made because girls are more likely to perceive significantly more barriers to physical activity than boys (Chapter 4) and boys achieve significantly more minutes of MVPA than girls (Colley et al., 2017). Median household income (MHHI in Figure 5.1) and age (age in Figure 5.1) are included in the model as control variables due to their strong explanatory power with both barriers to physical activity and MVPA. MHHI (in Canadian Dollars) is measured at the Census dissemination area that a child's home is located within. Data from the 2011 National Household survey was used for Southwestern Ontario and 2016 Census on Canada was used for Northwestern Ontario. Age, measured as a continuous variable in years, was assessed in the child survey as a demographic question.



NOTE: In SEM, observed variables are demonstrated with squares, and relationship pathways are demonstrated with arrows. As explained by Gunzler, Chen, Wu, and Zhang (2013), straight arrows with a single head indicate a causal relation from the base to the head. A curved arrow with two heads indicates a potential association between variables.

Figure 5.1 Conceptual model.

This model will be run twice with gender as the effect modifier. The red path indicates indirect measurement of the main research question: what is the effect of children's perceptions on the relationship between varying geographic contexts of the physical environment and MVPA behaviour?

5.2.2 Statistical Analysis

To assess the fit of the hypothesized model (Figure 5.1) to the data collected from participants we employed structural equation modeling (SEM). SEM allows researchers to test multiple regression equations simultaneously but instead of assuming a perfect relationship between all independent variables (as in regression), measurement error is accounted for in the model (Hoyle, 1995). SEM makes the assumption that all variables

are additive in a linear relationship, assessing the direct and indirect effects of the variables within the model (Hoyle, 1995). Data cleaning and preliminary analyses to test the data quality were conducted in SPSS (IBM Corp. 2016). Missing data were handled with full-information techniques. Statistical significance was determined at $p < 0.05$. Model testing was conducted in Mplus 7.4 (Muthén & Muthén, 2015). Model fit was not tested because it was a saturated model, therefore all possible pathways were included.

5.3 Results

The relationship between all of the measured variables within the model are presented in Table 5.2. The specific mediating effect measuring the main research question is presented in Table 5.3. Results are descriptively presented separately for girls and boys below.

Table 5.2 Results of the relationship between all variables within the model.

			Model 1: Girls				Model 2: Boys			
			b	se	z	*p*-Value	b	se	z	*p*-Value
Neighbourhood	on	MVPA	0.52	1.79	0.29	0.77	-5.63	2.66	-2.11	0.04*
Social			-4.30	1.66	-2.59	0.01*	-0.38	2.54	-0.15	0.88
Safety			0.01	0.02	0.80	0.43	0.02	0.02	0.96	0.33
Urbanicity			-0.85	0.84	-1.01	0.31	-3.10	1.31	-2.37	0.02*
Age			-2.36	1.17	-2.01	0.04*	-4.96	2.09	-2.38	0.02*
MHHI			-0.53	0.50	-1.06	0.29	-0.15	0.70	-0.22	0.83
Perceptions										
Urbanicity	on	Neighbourhood	-0.06	0.03	-2.02	0.04*	-0.07	0.04	-2.03	0.04*
Age			0.01	0.04	0.34	0.74	-0.04	0.06	-0.74	0.46
MHHI			-0.03	0.02	-1.86	0.06	-0.05	0.02	-2.39	0.02*
Urbanicity	on	Social	0.02	0.03	0.50	0.62	0.00	0.04	-0.00	0.00*
Age			-0.02	0.05	-0.40	0.69	-0.00	0.06	-0.06	0.95
MHHI			-0.01	0.02	-0.35	0.73	-0.03	0.02	-1.27	0.21
Urbanicity	on	Safety	-0.22	3.10	-0.07	0.94	4.01	4.30	0.94	0.35
Age			6.87	4.37	1.57	0.12	0.49	6.95	0.07	0.94
MHHI			2.09	1.86	1.13	0.26	2.56	2.29	1.12	0.26
Social	with	Neighbourhood	0.29	0.04	7.59	0.00*	0.27	0.05	6.12	0.00*
Safety			-1.02	3.32	-0.31	0.76	-1.85	0.65	-0.40	0.69
Safety	with	Social	4.08	3.59	1.14	0.26	-10.11	4.97	-2.04	0.04*

* *Indicates significant results* $p \leq 0.05$

*NOTE: "*on*" signifies a one way relationship, "*with*" signifies association between variables*

Table 5.3 Results of the mediating effect and direct relationships of urbanicity and perceptions on MVPA.

			Model 1: Girls				Model 2: Boys			
			b	se	z	*p*-Value	b	se	z	*p*-Value
Effects from Urban to MVPA										
Total			-0.95	0.84	-1.13	0.26	-2.62	1.31	-2.00	0.05*
Total Indirect			-0.10	0.18	-0.56	0.57	0.49	0.31	1.57	0.01*
Direct										
Urbanicity	on	*MVPA*	-0.85	0.84	-1.01	0.31	-3.10	1.31	-2.37	0.02*
Indirect										
Urbanicity to Neigh.	to	*MVPA*	-0.03	0.11	-0.29	0.77	0.41	0.28	1.47	0.14
Urbanicity to Social	to	*MVPA*	-0.07	0.14	-0.49	0.63	0.00	0.014	0.00	1.00
Urbanicity to Safety	to	*MVPA*	-0.00	0.04	-0.07	0.94	0.08	0.12	0.67	0.50

* *Indicates significant results* $p \leq 0.05$

*Note: "*on*" signifies a one way relationship, "*to*" signifies mediating relationship*

5.3.1 Girls

Across both Ontario study areas, a total of 316 participants identified as a girl. When analyzed within the model, four relationships remained significant. These relationships are seen in Table 5.2, Model 1. MVPA was significantly negatively related to two factors. With each year increase in age, MVPA decreased by about 2.4 minutes ($p = 0.04$). As well, with each increase in the likelihood of reporting perception of social barriers, MVPA decreased by 4.3 minutes ($p = 0.01$). With increasing urbanicity, girls were significantly less likely to report perceiving neighbourhood barriers ($p = 0.04$). Finally, girls who reported neighbourhood barriers were significantly more likely to report social barriers. These results can be visually described in Figure 5.2, where the model was broken down to represent the significant relationships only, and the positive or negative nature of the association.

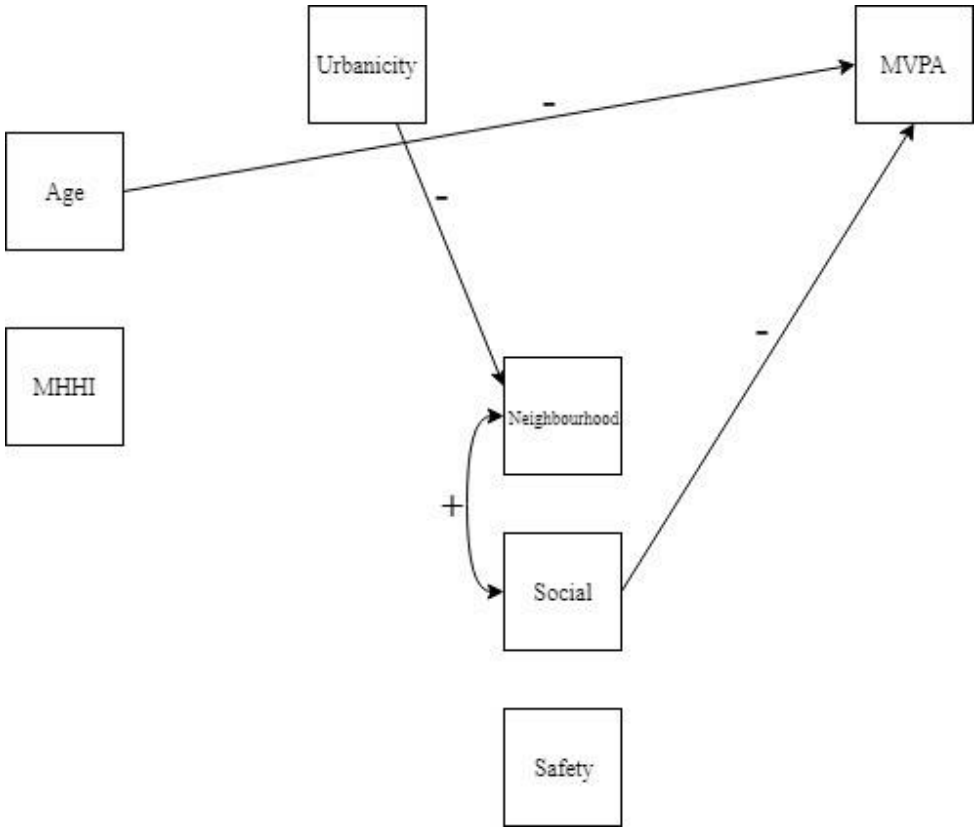


Figure 5.2 Significant positive/negative association results for model, grouped by girls.

While there are relationships between factors within the model, perceptions of neighbourhood, social and safety barriers did not significantly mediate the relationship between urbanicity and MVPA in the final model. This is demonstrated in Table 5.3, Model 1. Additionally, when controlling for all relationships (i.e. *Total* in Table 5.3 Model 1), and independent of all other factors, there was no significant relationship between urbanicity and MVPA in girls.

5.3.2 Boys

Across both study areas, the total sample included 230 participants who identified as a boy. When analyzed within the model, seven relationships remained significant. These relationships are seen in Table 5.2, Model 2. MVPA had a significant negative relation with three factors. Each year increase in age caused MVPA to decline approximately 5 minutes ($p = 0.02$). With each increase in urbanicity on the spectrum, MVPA decreased by 3.1 minutes ($p = 0.02$). As well, with increasing perceptions of neighbourhood barriers, boys' MVPA declined by 5.6 minutes ($p = 0.04$). Boys were significantly less likely to report perceptions of neighbourhood barriers as the urbanicity of their home neighbourhood increased ($p = 0.04$), and as their MHHI increased ($p = 0.02$). Reporting perception of neighbourhood barriers was significantly associated with reporting perceptions of social barriers ($p < 0.00$), as was perceiving social and safety barriers ($p = 0.04$). These results can be visually described in Figure 5.3, where the model was broken down to represent the significant relationships only, and the positive or negative nature of the association.

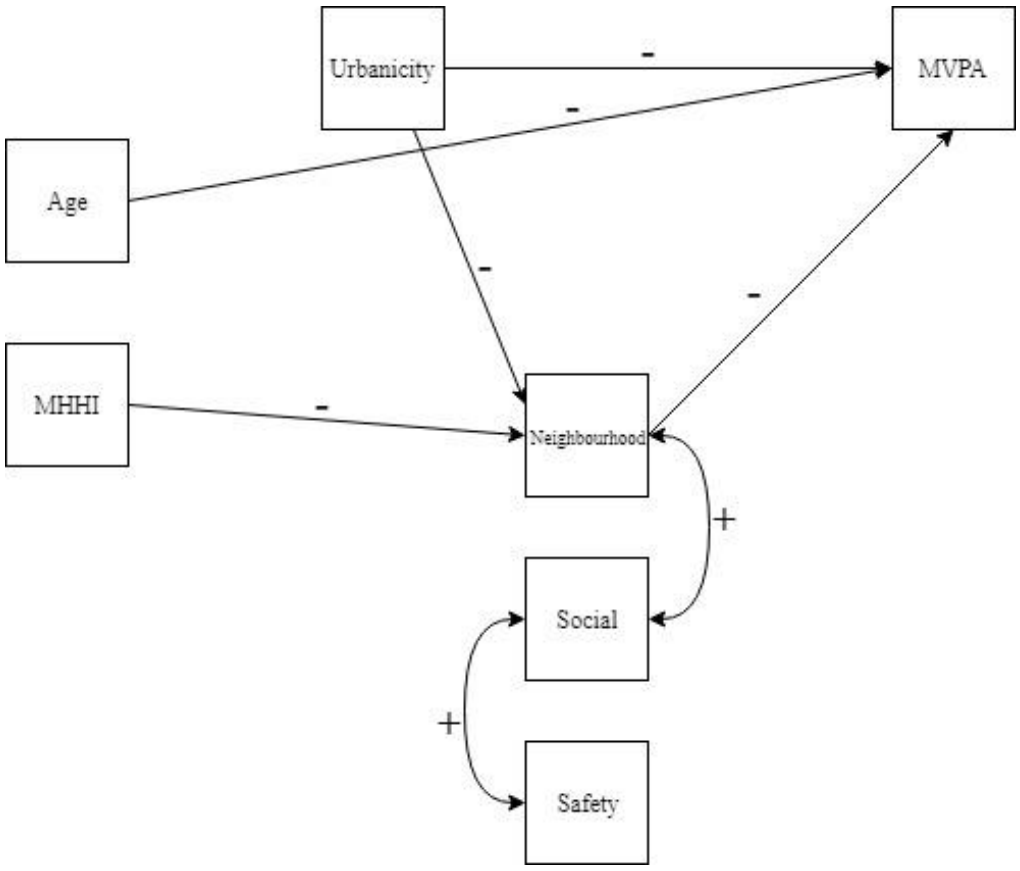


Figure 5.3 Significant positive/negative association results for model, grouped by boys.

In the final model, as demonstrated in Table 5.3, Model 2, there is a significant overall effect in the relationship between urbanicity and MVPA while accounting for the other relationships in the model, where urbanicity increases by one unit, MVPA decreases by 2.6 minutes (p = 0.05). There is also a significant direct relationship between urbanicity and MVPA, such that as urbanicity increases, MVPA decreases by 3.1 minutes (p = 0.02). In the final model for boys, perceptions of neighbourhood, social, and safety barriers did not significantly mediate the relationship between urbanicity and MVPA.

5.4 Discussion

This study employed SEM to examine influences of children's perception and urbanicity on MVPA. Previous research shows (including in Chapter 4) that children's perceptions significantly differ based on their varying environments (Davison & Lawson, 2006;

Moore et al., 2013). The present study suggests that these perceptions and environments affect objectively measured MVPA, but perceptions do not mediate the relationship between the physical environment and activity levels. This study contributes to the literature by furthering the understanding how urbanicity, barriers, and the interaction of the two impact children's physical activity behaviours. Furthermore, to our knowledge, this was one of the first studies in the Canadian physical activity literature to utilize the spectrum approach to assessing the urbanicity of children's home locations. With further applications, this method could prove to be a beneficial tool for assessing the heterogeneous Canadian geographic contexts.

The primary hypothesis of this research was: children's perceived neighbourhood, social, and safety barriers to physical activity would mediate the relationship of physical environment of their neighbourhood with physical activity levels. Based on the results of our models, this hypothesis was not supported. The results indicated that barriers and the physical environment have a significant interaction, and independently of each other have significant influences on MVPA, but perceptions of barriers do not mediate the relationship between the environment and physical activity in the study population. The results also indicate that barriers for MVPA differ for girls and boys.

A secondary hypothesis was that social barriers would have the strongest mediating effect between the physical environment and MVPA. While social barriers did not present a mediating relationship, they did independently have a significant effect on the MVPA levels of girls. These results demonstrate that regardless of urbanicity, girls report this barrier to physical activity. Social factors and barriers influencing physical activity, especially in girls, have been well studied in the literature (Bocarro et al., 2015; Dwyer et al., 2006; Pawlowski, Tjørnhøj-Thomsen, Schipperijn, & Troelsen, 2014; Sallis, Prochaska, Taylor, Hill, & Geraci, 1999; Spencer, Rehman, & Kirk, 2015). Qualitative research by Pawlowski et al. (2014) provides depth to this relationship, indicating girls reported having no one to play with, conflict, and peer influence were issues *why* social barriers influenced their physical activity. Given the ongoing disparities in levels of activity relative to gender, health promotion efforts must focus on alleviating social barriers in structured activity opportunities, to decrease barriers for increasing MVPA in

girls (Telford, Telford, Olive, Cochrane, & Davey, 2016). Based on the evidence of Chapter 4, these activities must be context specific.

While the hypothesis that perceived neighbourhood barriers would have a mediating effect in the relationship between urbanicity and MVPA was not supported, neighbourhood barriers were significantly associated with urbanicity and MVPA for boys. The relationship between neighbourhood barriers, urbanicity, and MVPA is complex, as each are negatively associated with each other. Higher levels of MVPA are associated with lower urbanicity and perceiving fewer neighbourhood barriers. Although perceiving issues of distance, availability, and accessibility of neighbourhood resources in rural areas may not be surprising, researchers should seek to understand why boys in these areas can overcome these barriers to achieve higher levels of PA than their urban-dwelling counterparts. Furthermore, practitioners and researchers should consider the ways in which rural boys achieve more MVPA minutes than their counterparts. This may include activities not discussed in the traditional self-report physical activity assessments (i.e. farm chores) (Davis et al., 2008). These findings could be a beneficial starting point to determining the disparities in activity minutes based on home location of boys, despite the increased number of opportunities in increasingly urban settings.

Findings related to the effect of the co-variate age on MVPA were supportive of the findings Chapter 4. In both girls and boys, as age in years increased, minutes of MVPA decreased. This echoes recent research by Colley et al. (2017) that found the same pattern in a national sample of Canadian children. While previous work determined that older children were significantly more likely than younger children to report specific barriers to physical activity, the present study did not find age significantly related to barriers when using composite scores to assess perceptions. Future work could consider examining the interplay of age in the formation of perceptions, and how this may change over time with longitudinal monitoring. In practice, it is important to develop interventions to increase MVPA in older children. As the amount of free play and physical activity during the school day decreases, health practitioners must look at strategies for engaging older children in continuation of activity habits, and provide new opportunities to continue building an appreciation for physical activity (Gilliland et al, 2015).

5.4.1 Strengths and Limitations

This study has limitations that warrant attention. Firstly, the present study only modelled MVPA behaviour. While this is the level of behaviour recommended to achieve the maximum health benefits of activity (Colley et al., 2017), recent Canadian physical activity research has suggested considering the importance of different levels of activity and sedentary behaviour (Poitras et al., 2016; Tremblay et al., 2016). Future Canadian research should consider assessing the mediating effect of children's perceptions of barriers with these multiple levels of activity to assess influences on activity achievement across the whole day. A further limitation was using dissemination area-level MHHI as the indicator for income, rather than parents' self-report information. This could have led to a potential misrepresentation of income of the study population, and a lack of significant results. This strategy was used because a large majority of parents elected not to report their income on the parent survey, and we were unable to impute this information. One final limitation is that there may have been measures within our model that were unaccounted for. Based on the complexity of relationships in the formation of MVPA behaviour, this will be an issue with any physical activity study. Our model was based on substantive evidence in the three areas and focused on a more basic hypothesis of the mitigating relationship of perceptions, to build on the gaps of previous research.

Despite the limitations, this research laid the groundwork for future research to continue to consider the complex interaction of children's perceptions, how they are formed within the environment, and their effect on physical activity. This study also has several strengths worth mentioning. For example, although we cannot make casual inferences for the mediating effect of perceptions on children's physical activity in every case, it does provide a foundation for elucidating the relationship. This is of critical importance due to the conflicting results regarding the relevance of perceptions for influencing physical activity in children (Haughton-McNeill, Wyrwich, Brownson, Clark, & Kreuter, 2006). This was a novel and rigorous approach to assessing this relationship, using a large and diverse sample of Canadian children from two geographically distinct areas of Ontario. This study also demonstrated the possibility for using an urbanicity spectrum and the value when assessing issues related to children's physical activity, accounting for the

limitations identified in the literature related to using a dichotomous rural versus urban definition of location (Babey et al., 2015; Jones-Smith & Popkin, 2010; Sandercock et al., 2010). Finally, while a mediating relationship was not statistically significant, this study filled a gap of Chapter 4, demonstrating that perceptions do have significant influence on objectively measured MVPA. This sets the stage for future research to consider these and additional barriers in diverse environments and populations, and the implications that perceptions may have on meeting the *Canadian 24-Hour Movement Guidelines* (Tremblay et al., 2016).

5.5 Conclusions

The purpose of this study was to improve efforts for quantifying the experience of children's daily activity contexts, by assessing the mediating effect of perceptions of barriers on the relationship between their environments and MVPA. These results offer insight into potential processes by which perceptions are shaped and impact MVPA and provide initial information to investigate these relationships further in future research. These findings suggest health promotion efforts will be most effective if they consider multipronged approaches directed toward place-specific experiences of barriers, especially targeting social barriers with girls and neighbourhood barriers with boys. The present study supports previous arguments that assessments of the objective environment are not enough to change children's physical activity behaviour (Orstad et al., 2017), and that researchers must improve efforts for quantifying the experience of children's daily activity contexts. This work highlighted the necessity for children's physical activity researchers in Canada to consider new ways for assessing similarities and differences in rural and urban populations. To our knowledge, this was one of the first studies in Canadian physical activity literature to utilize the spectrum approach to assessing the relationships between urbanicity and the experience of barriers. With further applications and improvements, this method could prove as a beneficial tool for objectively assessing the heterogeneous Canadian geography, its impact on children's experience of barriers, and their physical activity levels.

5.6 References

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Chapter 6

6 Synthesis

The purpose of this final chapter is to summarize and discuss the research presented in this thesis, which investigated barriers to children's physical activity in their daily environments. This thesis examined how children's perceptions and environments affected their physical activity levels and suggested strategies for alleviating these barriers to promote physical activity. The following research questions were explored:

1) How do factors of children's intrapersonal, interpersonal, and physical environments influence their perceptions of barriers to PA?

2) What are the similarities and differences in children's perceptions of barriers to PA in relation to the level of urbanicity and geographic variation of their home location?

3) Do children's perceptions of barriers to PA mediate the relationship between their physical environment (urbanicity) and their MVPA levels?

The chapter consists of six sections: Section 6.1 summarizes the two independent studies described in Chapters 4 and 5, Section 6.2 discusses the research and methodologic contributions of this thesis to the literature on children's PA, Section 6.3 outlines the limitations of this thesis, and Section 6.4 provides an overview of possible policy and practice implications. Section 6.5 provides suggestions for future research, and Section 6.6 will conclude the chapter.

6.1 Summary of Studies

This thesis considers the geographic variation in how children's physical activity behaviour is influenced by barriers experienced in their everyday environments. Study 1 (Chapter 4) examined children's experience of barriers to physical activity based on what their reports of what they perceived to be influential. In order to capture the context by which perceptions are shaped, the socio-ecological framework of recreational physical activity was applied to consider factors of intrapersonal, interpersonal and physical

environment when reporting barriers. The intrapersonal environment included gender, age and visible minority status. The interpersonal environment included the number of parents at home, household arrangement, maternal and paternal employment status, and family income. The physical environment included five categories of urbanicity based on the built form and population density of the participants' neighbourhoods. Binary logistic regression models and odds ratios were used to measure the relationship between children's reports of perceiving barriers with the various factors of the socio-ecological framework.

The study found at the intrapersonal level, girls were more likely to report safety and social barriers than boys. As children increased in age, they were more likely to report barriers related to safety and the neighbourhood environment. Visible minority children were more likely to report barriers in the social and neighbourhood environment. At the interpersonal level, children with employed mothers reported the most barriers. Children in low income families were more likely to report barriers than those in middle- or high-income families. At the physical environment level, children in urban neighbourhoods within large-cities, suburban neighbourhoods within large-cities, and rural areas were more likely to report barriers, however these differed relative to population size. Children in the smallest rural areas reported barriers of the neighbourhood environment such as a lack of infrastructure. Children in the highest populated areas were most concerned with social and safety barriers, such as not knowing people or worrying about strangers and crime. The results supported previous work by demonstrating that children's perceptions are formed within their environments (Babey et al., 2015; Davison & Lawson, 2006; Hume et al., 2004; Lee et al., 2015; Smith et al., 2015), and expanded on this literature by suggesting one's socio-ecologic context has an impact on the extent to which these barriers are considered influential. By demonstrating the differing impacts of the integrated social and environmental contexts in relation to the varying intrapersonal environments for different groups of children, this study advocated for tailoring approaches to best align alleviating barriers within children's contexts. This will allow for prioritizing target areas for mitigating barriers to PA in order to most effectively address the issue.

Elaborating on the insights and methods of Study 1, Study 2 (Chapter 5) sought to examine the mediating effect of perceiving these barriers in the relationship between varying geographic contexts and MVPA behaviour. This was completed using a structural equation model. Participants from Study 1 were carried over to Study 2, the only additional criteria applied for inclusion was 4 valid days of accelerometer data collection (including one weekday and one weekend day). In this study, the urbanicity scale was the exposure variable, MVPA (measured with accelerometers) was the outcome variable, three themed perception scores were the mediators, gender was the effect modifier and two variables were controlled for: age and median household income.

The results of Study 2 suggested environments and perceptions have a significant effect on the MVPA levels of boys and girls, however, the hypothesis was not supported because perceptions did not significantly mediate the relationship between urbanicity and MVPA. The results also indicate that the influence of factors affecting MVPA differ for boys and girls. Amongst boys, the primary finding of perceived neighbourhood barriers was associated with lower levels of activity, although it should be noted that this perception was more common with boys in rural areas. These boys from rural areas, however, had higher physical activity levels than their urban counterparts. Regardless of urbanicity, MVPA significantly decreased for girls when they perceived that there were social barriers to their activity. As age increased, minutes of MVPA decreased for both boys and girls. While associations between children's ability to be physically active and their surrounding physical environments have been widely examined in the literature (Ding et al., 2011; Martins et al., 2017; Oliveira, Moreira, Abreu, Mota, & Santos, 2014), there is little research regarding how the perceptions of barriers to physical activity alter the relationship between the physical environment and MVPA. This study contributes to the literature by furthering the understanding how urbanicity, barriers, and the interaction of the two impact children's physical activity behaviours. Chapter 5 highlighted the necessity for children's physical activity researchers in Canada to improve efforts for quantifying the experience of children's daily activity contexts.

6.2 Research Contributions

The present studies demonstrate the importance of considering all the factors that shape a child's context when considering the influences on their physical activity levels. Study 1 demonstrated that although there may be commonalities across environments, there are striking differences in the way that context influences what children consider barriers to their PA. This is of substantial concern because Study 2 demonstrates that perceiving barriers has a significant impact on the number of minutes of MVPA children are achieving.

Both studies emphasize the importance of factors at various socio-ecological levels for impacting children's physical activity. For example, age was consistently associated with perceiving barriers to activity. Study 2 found with a one-year increase in age, there was a 2.4 minute decrease in average daily MVPA in girls, and about a 5 minute decrease in boys. This is consistent with recent findings from Colley et al. (2017) that found that Canadian 6- to 11-year-olds achieved more weekly average MVPA than 12- to 17-year-olds did, based on the 2015 Canada Health Measures Survey. These findings highlight important implications for policy and programming related to children's health. There are multiple impacts of the integrated social and environmental contexts in relation to the varying intrapersonal environments for different groups of children. In practice, there is a need for multi-pronged approaches rather than current one-size-fits-all policies to best target how children perceive their experience of place in order to most effectively address the issue.

This thesis was one of the first studying Canadian children to consider a five-level spectrum approach to measure urbanicity rather than using an urban-rural dichotomy. This study therefore fills a gap in the literature highlighted by Sandercock, Angus, and Barton (2010), who drew attention to the need for a less simplistic comparison for classifying urbanicities, rather than a dichotomous definition of rural versus urban. This is especially important in the Canadian context where there is a wide heterogeneity of land uses and experiences related to both urbanicity and rurality. As previously stated in Chapter 2, in Ontario alone, there are five general types of rural (and northern or remote) communities: urban fringe communities, agriculture communities, cottage country

communities, Northern Ontario communities, and Indigenous communities (Markey, Lauzon, & Ryser, 2015). In Canada, this can further extend to include prairie and maritime communities (Walia & Liepert, 2012). Current policy definitions lump differing environments together under definitions that are based on population numbers and proximity to urban centers (Statistics Canada, 2015). This neglects to consider the history, geography, socio-economic status, and development trajectories of small communities.

The studies in this thesis utilized a spectrum approach to determine the impact of categorization of built form and population density at the physical environment level on children's perceptions of barriers to activity. The findings emphasized this approach as valuable for future work related to children's overall health when home location was linked as a determinate of behaviour. The present studies demonstrated that although children in rural areas were more likely to report neighbourhood environment barriers, as urbanicity increases, MVPA decreases, which is contrary to the literature (Joens-Matre et al., 2008; Springer et al., 2009, 2006). This work makes an important distinction between the needs of Canadian children in different contexts, highlighting the importance of considering variation in the experience of place; an important policy implication for health practitioners and physical activity researchers. Health practitioners must differentiate between perceived effects versus objective effects of barriers. This will help to determine whether there is a need to change perceptions of the environment or the need to make physical changes to the environment to impact physical activity behaviour, especially in rural areas (Ryan & Dzewaltowski, 2002). Given the results of the present studies, it is recommended that researchers continue to use a spectrum approach to define urbanicity. Doing so will help to better understand the differing experiences of residents in heterogeneous Canadian communities, based on the variation demonstrated in this thesis.

These findings further highlight the importance for considering the perspective of children when assessing the socio-ecological effects of the environment on physical activity. The literature review determined a need for researchers to include the voices of children in planning decisions (Lee et al., 2015). This is because, despite recognition of the influence environments have on children's physical activity, there is still a lack of

understanding regarding the relationship between the neighbourhood and children's perceptions and behaviours (Loebach & Gilliland, 2010). Furthermore, much of the research that exists uses parental reports on their children's behaviours (Ding et al., 2011), neglecting the potential differences between parents' and children's points of view. This work emphasizes the importance of gaining children's perspective as stakeholders in practice and policy, in order to effectively impact their environment for promoting health.

6.3 Limitations

The main limitations of the analysis methods in both Study 1 and 2 were the variables we could not able to account for. There are possible barriers and environmental factors we did not consider that could be mediating the relationships with perceptions or MVPA. This includes indicators for which we do not have specific measurements or data, such as socio-economic status, or objectively measured physical environment factors, including the built and natural environments. It is important to acknowledge that given the complexity of the influences on physical activity, there is no known direct cause and effect equation to increase physical activity behaviour. The research aimed to focus on more general factors to build on the gaps of previous research, as well as demonstrating the value on the use of an urbanicity spectrum. The limitation of Study 1 was addressed in Study 2 by considering the use of objective measure of MVPA specifically.

An additional limitation of Study 2 is that the use of structural equation modelling is not designed to uncover causal relationships, and measured values can change with the addition or deletion of a variable from the model. Despite these issues, the significant results of both studies provide starting points for future research to consider these issues more in depth, and the potential of additional confounding variables. These results demonstrate the value of considering children's environments from a variety of contexts, including a perspective of urbanicity, when attempting to influence their physical activity.

Accelerometers are considered a gold standard tool for their reliability in measuring children's physical activity patterns in this field of study (Borghese et al., 2017). The devices, however, are not without limitations. When using accelerometer measurements,

there are a number of considerations that may influence comparability of results. This includes the chosen data reduction procedures and cut-points, in addition to the model type (omnidirectional or uniaxial for example) (Borghese et al., 2017; Puyau et al., 2004). None the less, we used the validated techniques of Trost and colleagues (2000) to minimize such limitations, and included four days of monitoring (reliability of 0.80) (including weekdays and weekend days) as best practice to ensure rigorous results. Secondly, accelerometers worn on the wrist are more likely to record movements that may not be intended as physical activity, because they record any body movement of the attached location (Heil, 2013). To minimize this error, participants wore accelerometers attached to band around their waist. Additionally, there may have been a slight underestimation of the children's activity levels based on two limitations. Participants were required to remove the devices during water-based activities (such as swimming), to avoid damaging the equipment. Furthermore, accelerometers more accurately measure whole weight-bearing activities (such as running) and have difficulty measuring non-weight bearing activities (such as riding bikes), activities on inclines, or when lifting heavy objects (Heil, 2013). While the inability to understand these specific contexts of activity is a limitation, the validity of the Actical accelerometer outweighs the limitations when accurately measuring children's physical activity (Heil, 2013; Puyau et al., 2004).

One potential mechanism of behaviour not assessed in these studies that may have played an influential role in the relationship between perceptions and MVPA is self-efficacy. Self-efficacy is the belief an individual holds regarding his/her ability to engage in behaviours that lead to expected outcomes, such as physical activity (Ryan & Dzewaltowski, 2002). These beliefs will then influence if physical activity behaviour is adopted and maintained (Ryan & Dzewaltowski, 2002). Previous literature demonstrated this potential relationship. In a study of rural girls by Trost et al. (1997), self-efficacy for overcoming perceived barriers to physical activity was a significant predictor of vigorous physical activity. In a sample of older girls this finding was echoed by Motl et al. (2005) who found indirect effects of perceived barriers to self-reported physical activity were accounted for by factors of self-efficacy. Self-efficacy was not measured on the survey tool used in the STEAM project. Upcoming work produced by the HEAL will incorporate new survey questions to measure the effect of self-efficacy in work related to children's

active travel, which if effective, can be applied in future work related to children's physical activity perceptions. Methods similar to those used in Study 2 could be beneficial to assess the relationship between the environment, perceiving barriers, physical activity levels, and the role children's beliefs in overcoming barriers. This could provide beneficial knowledge for program creation and policy change related to improving children's health.

A final limitation is the cross-sectional study design in both of the thesis studies. While the studies sites were stratified to be representative of the population in both Southwestern and Northwestern Ontario, the results will not necessarily represent patterns and behaviours of populations not included in the study. This points to an important finding and policy implication of the present thesis: there is a lack of generalizability related to the majority of evidence regarding relationships of children's physical activity and the environment, due to the cross-sectional nature of the field (Davison & Lawson, 2006; Ding et al., 2011). Utilizing blanket policies and taking a one-size-fits-all approach targeting health issues especially in rural areas (Canadian Rural Revitalization Foundation, 2015), does not accurately consider the variation in experiences of children in different places. This draws attention to the need for context-specific investigations and interventions.

6.4 Implications for Policy and Practice

This thesis aimed to explore how children's geographic contexts influence their perceptions of barriers to physical activity, and the influence of these factors on MVPA. To date there is a plethora of research surrounding the influence of the environment on children's physical activity (Davison & Lawson, 2006; Ding et al., 2011; Oliveira et al., 2014, Martins et al., 2017). Research has also indicated, that how children perceive their environment may be as important as the actual environment itself (Carroll-Scott et al., 2013; Hume et al., 2004). In order to understand how children's perceptions of their environments and the environments themselves influence physical activity, this thesis argues that a context-specific investigation is necessary. By focusing on population specific needs related to children's physical activity levels, there may be an opportunity to improve the efficiency of policy and practice for changing activity behaviour.

The main theme present across both studies is *context matters*. In order to understand how children engage in MVPA across Canada, future policy work needs to consider geographic variation in the determinants of behaviour (Orton et al., 2017). Health is formed in an individual's context. This is the circumstantial environment in which something takes place and including both the independent and the interplay of physical, social, cultural and structural environments. Policy makers must take into account the variety of factors that shape the formation of behaviours in daily interactions when considering the health and MVPA of children across varying environments. The studies demonstrate how the socio-ecological environments of each child affect how they perceive, and engage with their environments in pursuit of physical activity.

The *Report on the State of Public Health in Canada 2017* emphasized the need for research driven evaluations of the impact of community design on health, especially at population levels. This research has demonstrated that solutions to mitigating the low levels of MVPA in Canadian children requires community-level evaluations and approaches. For example, this thesis demonstrated the differences in experience between children in different urbanicities and how they experience MVPA as well as how they perceive barriers. This emphasized the need for attention outside of the urban context, and further attempted to fill a gap in the knowledge (Government of Canada, 2017).

Future policy work at the federal and provincial level, specifically targeting children such as the *Canadian Physical Activity Guidelines*, and elementary school curriculum must consider: 1) that context of physical activity environments varies across Canada; and 2) the importance of determining differences between subjective and objective experiences of the environment, moving away from one-size-fits-all approaches. One strategy could be through the incorporation of the spectrum approach, recognizing heterogeneous urbanicity and differing needs of individuals. This is crucial in the formation of policy and recommendations for practice, for stakeholders at downstream municipal, local health unit, and school levels. These downstream levels of policy can focus on creating best practices for assessing healthy public policy within their areas. For example, through health promotion initiatives, and evaluation tools (such as infrastructure audits), local

officials can ensure environments are catering to the needs of children within the capacity of federal and provincial recommendations.

This research demonstrates that there are many factors influencing children's physical activity, to varying degrees. Individuals working directly with children to increase their physical activity levels such as parents, and practitioners (pediatricians, teachers, and recreation programmers), should attempt to understand children's perceptions barriers to activity in their environment. By evaluating the impact of these barriers on children's activity, these groups will have better insight into how to improve activity. One way by which this could be possible is through open conversations with children, acknowledging their position as stakeholders in decision-making. This could include asking children what factors in their current situation limit their physical activity, or preferences to be active, and looking for creative strategies and choices to overcome these barriers with the children.

6.4.1 Neighbourhood Environment Barriers to Physical Activity

Both studies demonstrated that perceptions of neighbourhood barriers impact physical activity. In Study 2, perceiving neighbourhood barriers lead to a significant decrease on MVPA in boys. Study 1 found all seven barrier questions were reported as significant by children in at least one socio-ecological variable group, however, they were often significantly related to urbanicity of the child's home location. One example of a barrier in this group was "There is no or not enough equipment or activities I like," which was reported as significant by 84% of participants. While the influence of accessible parks and playgrounds on physical activity behaviour has been well established in the literature (Davison & Lawson, 2006; Ding et al., 2011; McGrath et al., 2016; Oliveira et al., 2014), the present findings suggest safe, adequate, and age appropriate accessible activities or equipment are other aspects of availability that must be considered (Tucker et al., 2009). Although children may have playgrounds close to their home, they may not be interested in using these structures if they do not have access to what they consider age-appropriate and more challenging activities (Moore et al., 2013; Sallis et al., 1992). Boys for example have a tendency to navigate towards sports and open space activities (Farley, Meriwether, Baker, Rice, & Webber, 2008). This could be a beneficial starting point for health

promoters in areas which have cross over between rural and urban locations they are responsible for (such as Middlesex-London) to investigate the ways rural boys achieve more MVPA minutes than their counterparts despite encountering barriers. These findings could aid in determining disparities influencing activity minutes based on home location of boys, despite the increased number of opportunities in increasingly urban settings, and offer an opportunity for increaseing programming.

The only neighbourhood barrier reported as significantly influential by children in rural and urban small-towns was "there are not a lot of trees along the streets in my neighbourhood." The children in this group represent 25% of participants, when measured by urbanicity of their home location. The literature review in Chapter 2 discussed evidence regarding the positive associations of neighbourhood aesthetics and promoting physical activity. This includes features such as trees along the streets. Some researchers suggest it is not the presence but the absence of aesthetically pleasing landscapes as influential to physical activity (Davison & Lawson, 2006; Jago et al., 2005; Mota, Almeida, Santos, & Ribeiro, 2005) a statement supported by the findings in both studies of this thesis. We can speculate, this may be related to children's association of poor neighbourhood aesthetics with a lack of safety, or lack of enjoyment (Loebach & Gilliland, 2010). Nonetheless, city planners and researchers should work together to consider the importance of children's perceptions in streetscapes, and determine best practices for ensuring environments are supportive to their physical activity behaviour.

While neighbourhood features have been associated with physical activity in the past, it is important to acknowledge the mixed results and measurement tools. In the systematic review by Ding et al., (2011) they found 878 comparisons of relationships between neighbourhood environment features and physical activity (including our barriers), of which the number of significant associations was higher when physical activity was measured by report (two thirds of studies), versus objectively measured. Ding et al. (2011) suggest that when a combination of objective physical activity and perception measured environment features were used, there is an inconsistency in the relationships with physical activity across papers. This includes walking/biking facilities and neighbourhood incivilities in children, and access to parks or recreation facilities in

adolescents. The conclusions by Ding et al. (2011) are supported by the differences found between results related to gender in Study 2 of this thesis. Despite the lack of significance in girls, the results demonstrate an important finding for practice. Children's perceptions of their environments are still an important factor in influencing their own reports of physical activity behaviour. While perceptions may not be linked with objective physical activity directly, there may be a role for self-efficacy and the belief children have about engaging in physical activity (Ryan & Dzewaltowski, 2002). Research related to maximizing local recreation programming and infrastructure must seek out children's perspectives on how they view their environments because assessing perceptions is an important tactic for quantifying how children experience the context of daily living (Davison & Lawson, 2006).

6.4.2 Social Barriers to Physical Activity

Both studies demonstrated that perceptions of social barriers have an impact on physical activity. In Study 2, perceiving social barriers had a significant decrease on MVPA in girls. Study 1 found four social barriers that children significantly reported as influential to their MVPA. One barrier in Study 1 that was reported by girls as significantly influential was "I have nobody to go with to parks/playgrounds in my neighbourhood." As discussed in Study 2, regardless of urbanicity, girls reported this barrier to activity. Social factors and barriers influencing physical activity, especially in girls, are well studied in the literature (Bocarro et al., 2015; Dwyer et al., 2006; Pawlowski et al., 2014; Sallis et al., 1999; Spencer et al., 2015), and the present result has been supported by qualitative research asking girls about the barriers they face (Pawlowski et al., 2014). Given the ongoing disparities in levels of activity relative to gender, health promotion efforts must focus on alleviating social barriers in structured activity opportunities in and out of school time, to increase MVPA in girls (Telford et al., 2016).

A 2012 review (Salvy, de la Haye, Bowker, & Hermans) found research surrounding the social relationships of children has been mostly based on parent report, and tends to focus on related aspects of the social environment such as safety and neighbourhood social cohesion. Three additional barriers related to neighbourhood social cohesion were significantly reported in Study 1. This included "There are no other kids to play with at

parks/playgrounds in my neighbourhood" (reported by children in low income families compared to middle income), "I [do not] know a lot of people in my neighbourhood" (reported by visible minority children), and "There are too many people/it feels too crowded at parks/playgrounds in my neighbourhood" (reported by children who live in one home, 84% of children). Neighbourhood social cohesion is the extent of the connectedness and solidarity in a community, and is characterized by two main features: 1) absence of latent social conflict, and 2) present of strong social bonds (Kawachi & Berkman, 2000). As explained by Utter, Denny, Robinson, Ameratunga, and Milfont (2011), when children perceive their communities as socially cohesive, there has been evidence of positive associations with their physical activity in the literature. This is influenced by a community's shared goals, collective trust and norms. Social cohesion is an area from which stakeholders in local contexts could draw on, to strengthen community ties, or to utilize already existing strong relationships to increase children's MVPA directly or indirectly. This includes local officials, parents, and health promoters. Additional research should seek out the specific mechanisms by which companionship plays a role in children's activity patterns specifically in relation to their geographic contexts.

6.4.3 Safety Barriers to Physical Activity

The literature review in Chapter 2 provided a background regarding the mixed results of the implications of neighbourhood safety on physical activity. Researchers have reported both negative associations and non-significant relationships between both subjective and objective measures of a lack of safety and children's physical activity. This thesis also found mixed results on the influence of safety. In Study 2, there were no significant relationships between barriers of safety and children's MVPA. However, in Study 1, differentiated by the independent variables, groups of children perceived all variables as important. The majority of children (based on maternal employment) and girls reported "Most drivers go too fast while driving in our neighbourhood." Older children, children in low-income families, and children in urban and suburban large-cities reported "There is so much traffic on streets near my home that it's difficult/unpleasant to bike or play on the street." Girls, older children and those in urban large-cities reported "I am worried

about being or walking by myself in my neighbourhood and local streets because I am worried about being taken or hurt by a stranger" as a significant barrier. Children in suburban large cities reported "There is a lot of crime in my neighbourhood (ex: strangers, gangs, drugs)" compared to rural small town and rural children. Despite their differing results, these papers lead to an important implication for health practitioners and policy makers.

As suggested by Beets and Foley (2008), it may not be the presence of actual environmental characteristics that directly affect safety influencing decisions to participate in physical activity, but rather the perceptions of neighbourhood characteristics that promote safety perhaps are more influential. By identifying the variety of perceptions children feel are important to their physical activity, whether or not they actually influenced MVPA objectively, this could provide insight into how children view opportunities or barriers in their communities. This may be an opportunity for local officials and health promoters to draw on strengths of their community to encourage activity in their neighbourhood. Drawing on strengths of the community such as social cohesion and working towards a common goal may be an opportunity to change their perceptions and further promote physical activity (Loebach & Gilliland, 2010).

6.5 Recommendations for Future Research

Findings from Study 1 emphasize the need for research on children's health to consider environmental context as more than just the physical surroundings. When taking a context specific approach to understanding the barriers children perceive as influential to their physical activity, researchers must consider the interplay of the intrapersonal, interpersonal, and physical environments. Based on the findings of this research, this could include investigation into the impact of parental employment on children's physical activity and the formation of environmental perceptions. Another example is understanding how children perceive crime in their communities relative to the objective crime rates, as a mechanism by which to mitigate this perceived barrier. This research in the geography discipline must extend to include indicators we did not have specific measures for such as socio-economic status and park access, or factors that could be considered at further levels of the socio-ecological model such as public policy's effect

on perceptions and behaviours. Researchers in the health sciences and psychology field should focus on understanding how perceptions of physical activity are influential in behaviour, the role of self-efficacy, and how changing perceptions may be beneficial to improving behaviour.

Findings from Study 2 support the role of both children's perceptions and varying environments play in meeting Canada's daily physical activity recommendations. Future work should continue to consider the contexts that children live as independent from previous findings, as results across settings cannot be generalized to create one-size-fits-all MVPA policy solutions. More research is needed to understand the mechanisms by which barriers and the environment impact MVPA. Specifically based on the results of the present studies, more work is needed to 1) explore how boys and girls are affected by their perceptions of barriers differently, in an attempt to close the gap between MVPA achievements; 2) continue to consider the relationships between perception formation, the environmental context, and the resulting effects on physical activity. Future work should consider using similar methods to study additional levels of activity including light and total physical activity, and sedentary behaviour. Furthermore, additional work should consider longitudinal and qualitative research approaches, to investigate intermediating mechanisms of the present findings.

Findings from both studies emphasize the importance and need for incorporating children as stakeholders in research, practice and policy that seeks to understand or will have an impact on their health. There has been little-to-no research explicitly examining children's perceptions of barriers of physical activity in outdoor spaces in the various rural communities of Canada (Lee et al., 2015). Researchers often exclude the voice of children in their studies, assuming children are unable to discuss their own needs (Loebach & Gilliland, 2010). In order to ensure conditions support physical activity, children must be valued as equal stakeholders in the research process, knowledge translation, and implementation of public policy (Faulkner, White, Riazi, Latimer-Cheung, & Tremblay, 2016).

One strategy by which this could be achieved and a final recommendation is through a focus on incorporating qualitative research through simultaneous methodological

triangulation (Morse, 1991).While surveys are often used to collect large scale data allowing for a degree of standardization and comparison of data across the study sites, qualitative methods allow for an understanding of *why* children perceive these barriers as influential. By incorporating qualitative methods such as focus groups into an integrated research design of a quantitative survey component, the quality of the resulting analysis can be more confidently accepted (Wolff, Knodel, & Sittitrai, 1993). This is because the strengths and limitations inherent to each method complement one another. Survey results will be representative and comparable between the different communities studied. Focus groups will help to provide depth and explanatory themes and categories that can explain results of the survey, specifically within the communities studied, which is important for policy development.

6.6 Conclusions and Implications

The purpose of this research was to investigate geographic variation in how children's physical activity behaviour is influenced by the experience of barriers in their everyday environments. By examining the effects of perceptions and environments on children's physical activity levels, we can begin to suggest strategies for future research, policy, and practice to help alleviate what children consider barriers to their activity. This research highlights that determinants describing each child within the socio-ecological model will impact how they perceive environmental barriers to their physical activity. These perceptions demonstrate an influence on the likelihood of being active. These papers highlight the need for context specific approaches to increasing physical activity when attempting to address disparities in children's behaviour. Both studies in this thesis highlight that children's geographies have an impact on their physical activity behaviour. This includes differences related to categorization of built form and population density, previously a gap in the literature.

Less than 35% of Canadian children are achieving the standard recommendation of physical activity each week. This number has remained relatively consistent since 2007 (Colley et al., 2017). Health practitioners, city officials, and researchers must look at tailoring approaches to address this issue given the heterogeneity of the Canadian context. The findings from this thesis will support development of policy, programs, and practices

that incorporate, encourage, and facilitate the use of children's perspectives to improve physical activity levels in their everyday environments.

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Appendices

Appendix A: Literature Review Documents with Corresponding Number Assigned (4 pages)

#	Year	Author	Title
1	2010	Sandercock, Angus, Barton	Physical activity levels of children living in different built environments
2	2006	Davison, Lawson	Do attributes in the physical environment influence children's physical activity? A review of the literature
3	2010	Abraham, Sommerhalder, Abel	Landscape and well-being: a scoping study on the health-promoting impact of outdoor environments
4	2004	Lofshult	Getting Kids Active
5	2008	Mota, Ribeiro, Santos	Obese girls differences in neighbourhood perceptions, screen time and socioeconomic status according to level of physical activity
6	2004	Hume, Salmon, Ball	Children's perceptions of the home and neighborhood environments, and their associate with objectively measured physical activity: a qualitative and quantitative study
7	2016	Heidelberger, Smith	Low-Income, Urban Children's Perspectives on Physical Activity: A Photovoice Project
8	2015	Lee, Tamminen, Clark, Slater, Spence, Holt	A meta-study of qualitative research examining determinants of children's independent active free play
9	2016	Holt, Neely, Spence, Carson, Pynn, Boyd…Robinson	An intergenerational study of perceptions of changes in active free play among families from rural areas of Western Canada
10	2016	Faulkner, White, Riazi, Latimer-Cheung, Tremblay	Canadian 24-Hour Movement Guidelines for Children and Youth: Exploring the perceptionsof stakeholders regarding their acceptability, barriers to uptake, and dissemination
11	2009	Sherar , Gyurcsik, Humbert, Dyck, Fowler-Kerry, Baxter-Jones	Activity and Barriers in Girls(8-16 yr) Based on Grade and Maturity Status

12	2010	Loebach & Gilliland	Child-Led Tours to Uncover Children's Perceptions and Use of Neighborhood Environments
13	2002	Humpel, Owen, Leslie	Environmental factors associated with adult's participation in Physical Activity: a review
14	2005	Mota, Almeida, Santos, Riberio	Perceived Neighborhood Environments and physical activity in adolescents
15	2006	Galloway	Obesity Rates Among Rural Ontario Schoolchildren
16	2008	Bruner, Lawson, Pickett, Boyce, Janssen	Rural Canadian adolescents are more likely to be obese compared with urban adolescents
17	1999	Pate, Trost, DowdaOtt, Ward, Saunders, Felton	Tracking of Physical Activity, Physical Inactivity, and Health-Related Physical Fitness in Rural Youth
18	2004	Bauman	Updating the evidence that physical activity is good for health: an epidemiological review 2000-2003
19	2006	Warburton, Nicol, Bredin	Health benefits of physical activity: the evidence
20	2008	Grow, Saelens, Kerr, Durant, Norman, Sallis	Where are youth activeÉ Roles of proximity, active transport and built environment
21	2015	Babey, Tan, Wolstein, Diamant	Neighbourhood, family and individual characteristics related to adolescent park-based physical activity
22	2010	Aarts, Wendel-Vos, van Oers, van de Goor, Schuit	Environmental Determinants of Outdoor Play in Children A Large-Scale Cross-Sectional Study
23	2005	Burdette, Whitaker	Resurrecting Free Play in Young Children: looking beyond fitness and fatness to attention, affiliation, and affect
24	2017	Larouche, Garriguet, Tremblay	Outdoor time, physical activity and sedentary time among young children: The 2012–2013 Canadian Health Measures Survey
25	2015	Grey, Gibbons, Larouche, Sandseter, Bienenstock, Brussoni…Power	What Is the Relationship between Outdoor Time and Physical Activity, Sedentary Behaviour, and Physical Fitness in Children? A Systematic Review
26	2015	Tremblay, Gray, Babcock, Barnes, Bradstreet, Carr…Herrington	Position statement on Active Outdoor Play

27	2016	Larouche, Garriguet, Gunnell, Goldfield, Tremblay	Outdoor time, physical activity, sedentary time, and health indicators at ages 7 to 14: 2012/2013 Canadian Health Measures Survey
28	2012	Reed, Hooker	Where are youth physically active - a descriptive examination of 45 parks in a southeastern community
29	2011	Kacztnski, Walch, Stanis, Besenyi	Variations in Observed Park Physical Activity Intensity Level by Gender, Race, and Age: Individual and Joint Effects
30	2016	Clark, Scott	Barriers to Walking: An invesitigation of adults in Hamilton (Ontario Canada)
31	2016	Mitchell, Clark, Gilliland	Built Environment Influences of Children's PhysicalActivity: Examining Differences by NeighbourhoodSize and Sex
32	2016	Ou, Levy, Peters, Bongiovanni, Garcia-Soto, Medina, Scammell	A walk in the park: influence of urban parks and community violence on physical activity in Chelsea MA
33	2014	Fitzpatrick	Examining Children's Perceptions and Use of Their Neighbourhood Built Environments: A Novel Participatory Mapping Approach
34	2009	Ries Voorhees, Roche, Gittelsohn, Yan, Astone	A Quantitative Examination of Park Characteristics Related to Park Use and Physical Activity Among Urban Youth
35	2013	Alexander, Huber, Piper, Tanner	The association between recreational parks, facilities and childhood obesity: A cross-sectional study of the 2007 National Survey of Children's Health
36	2012	Gililand, Rangel, Healy, Tucker, Leoback, Hess…Wilk	Linking Childhood Obesity to the Built Environment: A Multi-level Analysis of Home and School Neighbourhood Factors Associated With Body Mass Index
37	2010	Carson, Kuhle, Spence, Veugelers	Parents' Perception of Neighbourhood Environment as a Determinant of Screen Time, Physical Activity and Active Transport
38	2011	Larson, Green, Cordell	Children's Time Outdoors: Results and Implications of the National Kids Survey

39	2017	Nykiforuk, Atkey, Brown, Caldwell, Galloway, Gilliland…Raine	Promotion of Physical Activity in Rural, Remote, and Northern Settings: A Canadian Call to Action
40	2013	Participaction	2013 Active Healthy Kids Canada Report Card on Physical Activity for Children and Youth
41	2015	Canadian Rural Revitalization Foundation	2015 State of Rural Canada report
42	2012	Walia, Liepert	Perceived facilitators and barriers to physical activity for rural youth: an exploratory study using photovoice.
43	2006	DesMeules, Pong, Lagacé, Heng, Manuel, Pitblado…Koren	How Healthy Are Rural Canadians? An Assessment of Their Health Status and Health Determinants
44	2009	Yousefian, Ziller, Swartz, Hartley	Active Living for Rural Youth: Addressing Physical Inactivity in Rural Communities
45	2013	Moore, Brinkley, Crawford, Evenson, Brownson	Association of the built environment with physical activity and adiposity in rural and urban youth
46	1997	Trost, Pate, Saunders, Ward, Dowda, Felton	A prospective study of the determinants of physical activity in rural fifth-grade children
47	2000	Matthews, Taylor, Sherwood, Tucker, Limb	Growing-up in the countryside: children and the rural idyll.
48	2011	Public Health Agency of Canada	Physical Activity
49	2014	Smith, Troped, McDonouh, DeFreese	Youth perceptions of how neighborhood physical environment and peers affect physical activity: a focus group study

Appendix B: Literature Review Results Demonstrating Similarities and Differences Children's Perceptions of Barriers and Facilitators to Physical Activity between the Urban and Rural Children (2 pages)

Intrapersonal								
	Perceived Safety		Preference for Weather		Perceived Aesthetics /Quality		Preference for Activities	
	+	-/NS	+	-/NS	+	-/NS	+	-/NS
Facilitators n= 12	23, 44, 3, 12, 20, 21				14, 3, 12, 23		8, 20, 42	
Barriers n= 19	1, 9, 12, 20, 23, 36, 38, 44, 39, 6, 21	37	7, 11, 38, 39		14		38, 42	
Interpersonal								
	Social Factors		Accessibility (transportation)		Parents Perceptions/Rules			
	+	-/NS	+	-/NS	+	-/NS		
Facilitators n= 14	14, 23, 32, 42, 5, 6, 12, 22		42, 20, 36, 37,		42			
Barriers n= 17	14, 32, 42, 39		4, 38, 42, 44, 39, 32		4, 9, 12, 42, 44, 8, 32			
Institutional								
	Socio-economic Circumstances		Planned/Structured Activities					
	+	-/NS	+	-/NS				
Facilitators n= 4	42		42, 44, 5					

Barriers n= 7	12, 42, 44		2, 12, 42, 44			
Community						
	Facilities & Amenities		City Planning/Design		Access (proximity/ distance/availability)	
	+	-/NS	+	-/NS	+	-/NS
Facilitators n= 13	14, 44, 3, 5, 6, 20		3, 37, 42		20, 21, 42	32,
Barriers n= 22	12, 14, 20, 44, 39, 8		9, 44, 39, 32, 36		2, 8, 4, 11, 12, 20, 38, 42, 39, 32, 44	32

Appendix C: Research Ethics Approval Forms for Use of Human Participants STEAM Southwestern Ontario (Redacted)

Re-Issued

Research Western

Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Jason Gilliland
Review Number: 17918S
Review Level: Delegated
Approved Local Adult Participants: 1200
Approved Local Minor Participants: 1200
Protocol Title: Identifying casual effects on the built environment on physical activity, diet, and obesity among children.
Department & Institution: Social Science\Geography, University of Western Ontario
Sponsor: Canadian Institutes of Health Research
Heart and Stroke Foundation of Canada

Ethics Approval Date: June 08, 2011 **Expiry Date:** August 31, 2014

Documents Reviewed & Approved & Documents Received for Information:

Document Name	Comments	Version Date
Other	Revised Healthy Neighbourhood Survey for Parents.	
Other	Revised Health Neighbourhoods Survey for Youth	
Other	Revised Activity and Travel Diary for School Days and Weekend Days.	

This is to notify you that The University of Western Ontario Research Ethics Board for Non-Medical Research Involving Human Subjects (NMREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the applicable laws and regulations of Ontario has granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above.

This approval shall remain valid until the expiry date noted above assuming timely and acceptable responses to the NMREB's periodic requests for surveillance and monitoring information.

[redacted] who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussions related to, nor vote on, such studies when they are presented to the NMREB.

[redacted] is Dr. Riley Hinson. The NMREB is registered with the U.S. Department of [redacted] under the IRB registration number [redacted]

[redacted]

Ethics Officer to Contact for Further Information

[redacted] Grace Kelly	Janice Sutherland [redacted]

This is an official document. Please retain the original in your files.

The University *of* Western Ontario
Office of Research Ethics
Support Services Building Room 5150 • London, Ontario • CANADA - N6G 1G9
PH: 519-661-3036 • F: 519-850-2466 • ethics@uwo.ca • www.uwo.ca/research/ethics

Appendix D: Research Ethics Approval Forms for Use of Human Participants

STEAM Northwestern Ontario (Redacted)

Western Research

Research Ethics

Western University Non-Medical Research Ethics Board
NMREB Annual Continuing Ethics Approval Notice

Date: July 26, 2017
Principal Investigator: Dr. Jason Gilliland
Department & Institution: Social Science\Geography, Western University

NMREB File Number: 108029
Study Title: Spatial Temporal Environment and Activity Monitoring Project: Understanding the environmental influences of health in rural and remote communities

NMREB Renewal Due Date & NMREB Expiry Date:
Renewal Due -2018/07/31
Expiry Date -2018/08/16

The Western University Non-Medical Research Ethics Board (NMREB) has reviewed the Continuing Ethics Review (CER) form and is re-issuing approval for the above noted study.

The Western University NMREB operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans (TCPS2), Part 4 of the Natural Health Product Regulations, the Ontario Freedom of Information and Protection of Privacy Act (FIPPA, 1990), the Ontario Personal Health Information Protection Act (PHIPA, 2004), and the applicable laws and regulations of Ontario.

[redacted] who are named as Investigators in research studies do not participate in discussions related to, nor vote on such studies when they are presented to the REB.

The NMREB is registered with the U.S. Department of Health & Human Services under the IRB registration [redacted]

EO: Erika Basile___Grace Kelly___ Katelyn Harris___ Nicola Morphet___ Karen Gopaul___ Patricia Sargeant___

Appendix E Research Ethics Letter of Information for Parents (3 pages) and Research Ethics Parent Consent Form (1 page)

Western

Examining the Influence of the Neighbourhood Environment on Children's Health and Well-Being

Dear parent or guardian,

We would like to invite you and your child to participate in a study aimed at understanding how the neighbourhood environment around your child's school affects his or her health. The study involves grade 5, 6 and 7 classes at elementary schools across South Western Ontario.

What is being studied?
Our research team is studying the various places or facilities in their neighbourhood that children use (or intentionally don't use) on a regular basis for recreational or physical activities, including the way they travel to these places – for example, how they travel to and from school each day. We are also interested in looking at some of their eating patterns, especially the locations in their neighbourhoods where they might eat or purchase food. In addition, we'd like to learn more about how children feel about their local environments, and how this may affect the activities they do, or how and where they travel around their neighbourhood.

What will happen in this study?
If you and your child agree to participate in our project, **your child will be asked to:**

1. **Complete the *Healthy Neighbourhoods Survey for Youth***. This survey primarily asks children about how they feel about their neighbourhood environments, the local facilities (such as parks) that they use for activities, places they may go to eat or buy food, and how they travel around their neighbourhood. Surveys usually take about 20-30 minutes to fill out and will be done in their classroom at a time decided by their teacher. (Note: students not filling out the survey will be given quiet activities by their teacher to do at their desks). Our research team will be on hand to help children fill out their surveys and to answer questions. All children will be given as much time as they need to complete the survey.

2. **Wear two small pieces of equipment each day during the hours they are awake, for two 7-day periods about 6 months apart – once during their Gr.5 or 6 year (Spring) and again in their Gr.6 or 7 year (in the Fall).** The lightweight 'GPS Logger', worn on a collapsible neck strap, maps out the general places the child visits in the neighbourhood and they routes taken to get from place to place. The tiny 'Accelerometer', worn on a thin elastic belt around the student's waist (can be worn under clothes), is like a pedometer that counts steps but it can also tell how 'intense' the activity of the student is. These tools will help us to see patterns in children's neighbourhood activities and travel. Because students will wear the tools during two different weeks we can also better understand how children's activities change over time.

3. **Complete a short activity diary for each day** they wear the 2 pieces of equipment, briefly telling us about their activities and any food purchases that day.

4. **OPTIONAL** – If they would like, participating students can also meet together with the researchers and classmates for a **group discussion** to talk more about how they feel about their neighbourhood and how their local environment helps or prevents them from enjoying the recreational activities they like, or easily buying the foods they want, or travelling easily around the neighbourhood. There will be about 10-20 students in a group. The discussion will take place either at lunch recess or outside school hours, and will last about 1 hour. It will be held at the school or another community location. Participation is completely voluntary; a child can decide not to join in the group discussion and still be allowed to join in Steps 1-3.

As the child's parent/guardian, **you will be asked to:**

1. **OPTIONAL - Complete the *Healthy Neighbourhoods Survey for Parents***. The survey asks many of the same questions as the Youth survey, as well as questions about your home and family and your own feelings about your neighbourhood. It usually takes about 15-25 minutes to fill out. The Parent Survey is completely voluntary – your child can still join the study themselves even if you decide not to fill it out. However, it gives us valuable information from the point of view of parents so we would really appreciate your participation.

2. **OPTIONAL** - Parents of participating students will also have a chance to meet together with the researchers and other local parents for a **group discussion** about your neighbourhood environment and how it helps or prevents you and your family from doing the activities you like, buying the foods you need, or travelling easily around your neighbourhood. There will be about 8-12 parents in each group. The discussion will take place at a time outside school hours, and will last about 1-1.5 hours. It will be held at the school or another nearby community location. Participation in the group discussion is completely voluntary; a parent can decide not to participate and their child will still be allowed to participate in their own part of the study as outlined above.

Do we have to participate in this study?
Your participation in this study is completely voluntary. You and your child do not have to participate. You can each refuse to answer any survey questions, and can choose to leave the study at any time. Your decision will not affect your child's academic record in any way.

What are the benefits and risks if my child participates?
Recent research shows that our health is not only related to our personal lifestyle, such as the food we eat or physical activity we undertake, but also to the characteristics of the neighbourhood(s) we live in. This study will help us to better understand the links between our neighbourhoods, our activities, and our health. The results may help local municipal planners and school boards make decisions that will help plan healthier local communities.

There are no costs to you or your child for participating in this study. However, during each 7-day periods in which they participate, your child will receive $2 each day from the research team when your child hands in their completed activity diary for the previous day and data from their equipment is collected. Your child will receive an additional $1 on the last day when they return all their equipment. The total for EACH completed 7-day period is $15.

The equipment in this study is easy to use, and the researchers will spend time with your child to make sure they understand how to use and care for the equipment. But, if any pieces of equipment break or become lost during the time your child is using them, we will give them a replacement unit right away without any cost to you or your child.

There may be risks to your child if he/she participates in this study. Getting tired or becoming disinterested in continuing with the project for the full 7 days are considered the largest risks. However, each piece of equipment weighs less than 60g (0.12 pounds) and should not be difficult for a child to carry. And a child can decide to quit the project at any time. The height and weight of your child will also need to be measured before they start in order to properly set up the accelerometer. These measurements will be taken in a private room at the child's school in the presence of a trusted adult (e.g. school nurse or teacher); no other children or people outside of the research team will be present. The equipment used to measure a child's weight also has no visible display - the measurements are automatically sent wirelessly to a laptop and so will not be visible to either your child or anyone else in the room.

There is little risk that you or your child will be identified or identifiable in any of the documents related to the study. All of the information collected in this study is kept strictly confidential. You and your child will be assigned a unique identification code – your name or personal information will not appear on any materials or data files. Also, materials and data files will ONLY be viewed by members of the research team and will be stored in a locked filing cabinet or on a password protected computer in a secure room at the University of Western Ontario. Parents and children who participate in the group discussions will be asked to keep everything they hear confidential and not to discuss it outside of the meeting. However, we cannot guarantee that confidentiality will be maintained by other participants in the focus group. Children can ask to see the maps of their own travel patterns and to change any information that feel is incorrect. However, to protect the privacy of each child, parents will not be able to view children's data or maps.

If you or your child decides to leave the study at any time (even up to 30 days AFTER the study has been completed), any of personal data collected from you or your child will be immediately destroyed and excluded from the study analysis.

You do not waive any of the legal rights you would otherwise have as a participant in a research study.

Follow Up
As the study involves a second round of participation this coming Fall (approximately 6 months after the first round this Spring), we may need to contact you at your home by phone or email in order to find out if your child changed schools between Spring and Fall. **We would therefore ask that you include one or both of these pieces of information on the attached consent form.**

Who do I contact if I have any other questions?
Should you have any questions or concerns about participating in this project, you can contact the lead researcher, Dr. Jason Gilliland, at the University of Western Ontario. Phone: (519) 661-2111 ext. 81239 or email: jgillila@uwo.ca

If you have any further questions regarding your rights as a study participant, please contact the Office of Research Ethics at 661-3036 or at: ethics@uwo.ca

Research Team
Dr. Jason Gilliland, Department of Geography, University of Western Ontario
Dr. William Avison, Department of Sociology, University of Western Ontario
Dr. Harry Prapavessis, Department of Health and Rehabilitation Sciences, University of Western Ontario
Dr. Paul Hess, Department of Geography and Planning, University of Toronto
Dr. Kathy Speechley, Department of Paediatrics, University of Western Ontario
Dr. Piotr Wilk, Department of Epidemiology, University of Western Ontario
Dr. Colleen Gobert, Division of Food & Nutrition Sciences, Brescia University College
Mr. John Fleming, Director of Planning, City of London

This letter is for you to keep. Please return the attached Parent/Guardian consent form. You will also be given a copy of this consent form once it has been signed.

Western

Examining the Influence of the Neighbourhood Environment on Children's Health and Well-Being

Parent / Guardian Consent Form

<u>Regardless</u> of whether you are consenting to let your child to participate in this study, we would ask that you return this form to school with your child, sealed in the envelope provided. Envelopes will be collected by your child's teacher. Thank you!

Consent: I, _____ ***(name of parent/guardian- please print)***, have read this letter and have been given the opportunity to ask questions. Any questions I had have been answered to my satisfaction. (Check all boxes that apply):

☐ I agree to participate by completing the *Healthy Neighbourhoods Survey for Parents* (***optional***; *if yes, please seal the survey in the envelope provided and return <u>with</u> signed consent form*)

☐ I am interested in being contacted about participating in a group discussion for parents (***optional;*** *if yes, please provide either phone or email contact information below)*

Please select one of the following 2 options:

☐ I agree to let my child _____ ***(child's full name – please print)*** participate in the full 14 days (two 7-day periods within the next 6-8 months) of the project as outlined. ***REQUIRED: My child <u>has</u> health issues which restrict their ability to walk/exercise or otherwise participate in this study*** ☐ ***YES*** ☐ ***NO***

<u>OR</u> if your child is not interested in the full project but would still like to participate in the survey

☐ I agree to let my child _____ ***(child's full name – please print)*** participate **ONLY** by way of completing the *Healthy Neighbourhoods Survey for Youth* (to be administered at child's school) rather than the full study.

_____ _____

Parent / Guardian's signature Date

If your child IS participating, please provide a phone and/or email address (both is preferable) so that we may contact you this Fall to confirm whether or not your child has changed schools since the Spring. This information will be kept strictly confidential.

_____ _____

Parent/Guardian Email Address Home or Cell Phone

Appendix F: Research Ethics Child Assent Form

How Healthy is the Environment in Your Neighbourhood?

Hello! We are researchers from the University of Western Ontario and we are doing a study in your neighbourhood! We need students in Grades 6, like you, to help us with this project!

What are we going to study?

We all know that getting lots of exercise and eating the right foods can help keep us healthy. We'd like to know if the places or services that you have and use in your neighbourhood also help to keep you healthy.

What would you have to do?

If you agree to be in the study there are 4 things we would like you to do:


Equipment looks like this!

1. Wear 2 small pieces of equipment every day for a week this Spring. A small GPS unit will help to make a map of all the places you visit every day. You would also wear a 'loonie'-sized piece of equipment on an elastic band around your waist that will tell us when you are doing physical activity, like running or playing sports. Both pieces of equipment are very light and easy to use. We will also come to your school every day in case you need help.
2. Fill out a short 1-page diary everyday about the activities you did that day.
3. Fill out a short survey on what you think about your neighbourhood. You will fill this out one day at school with your classmates. It takes about 20-30 minutes to finish but you can take as much time as you need.
4. Then you would wear the equipment and fill out the diary again for a week later this Fall when you are in grade 7 (even if you are then going to a different school).

After both weeks are done, you could also join in a group discussion with some of your classmates to talk to us about where you like to go in your neighbourhood and the activities you like to do. You do not have to join in this group activity. The talk will take place at your school. We would like to audio record our talk.

To work some of the equipment we'll need to measure your height and weight. We'll do this in a private room at your school. Your teacher can be in the room. We won't share the information with anyone else.

Do you have to join this project?

No – you will only join if you would like to. You can also decide at any time that you would like to stop. We will never share your information with anyone else, even your parents, but you can ask to see it at any time. You can ALWAYS talk to your teacher or the researchers if you have any questions or worries.

I want to participate in this study!

If you would like to join this study in some way, choose one of the following two options:

☐ I want to participate in the full 2 week study **OR** ☐ I only want to complete the in-class survey

_____
Print First and Last Name of Child

_____ _____ _____
Signature of Child | Age of Child | Date

_____ _____
Signature of Person Obtaining Assent | Date

Appendix G: Relevant Survey Questions from STEAM Project Assessing Perceptions used in this Research (2 pages)

J : Barriers to activity in your neighbourhood parks/playgrounds

Please tell us whether this stops you from going to a park/playground in your neighbourhood.	No	Sometimes No	Sometimes Yes	Yes
1. It is too far from my house or takes too much time to get there	☐	☐	☐	☐
2. There is no or not enough equipment or activities I like	☐	☐	☐	☐
3. There is not enough room from the activities I like to do	☐	☐	☐	☐
4. There are no other kids to play with there	☐	☐	☐	☐
5. There are no adults there to supervise	☐	☐	☐	☐
6. It feels unsafe there because of crime (ex: strangers, gangs, drugs)	☐	☐	☐	☐
7. I get bullied or teased when I go there	☐	☐	☐	☐
8. I have nobody to go there with	☐	☐	☐	☐
9. There are too many people there / feels too crowded	☐	☐	☐	☐
10. There is too much garbage or graffiti	☐	☐	☐	☐
11. Other reason? _____	☐	☐	☐	☐

K : Streets in my neighbourhood

	I strongly disagree	I disagree a little bit	I agree a little bit	I strongly agree
1. There are enough sidewalks on the street in my neighbourhood.	☐	☐	☐	☐
2. There are walking trails in or near my neighbourhood that are easy to get to.	☐	☐	☐	☐
3. There are bicycle lanes or trails in or near my neighbourhood that are easy to get to.	☐	☐	☐	☐
4. There are lots of trees along the streets in my neighbourhood.	☐	☐	☐	☐
5. I know a lot of people in my neighbourhood.	☐	☐	☐	☐

L : Safety in my neighbourhood

	I strongly disagree	I disagree a little bit	I agree a little bit	I strongly agree
1. There is so much traffic along the streets near my home that it is difficult or unpleasant to walk.	☐	☐	☐	☐
2. There is so much traffic along the streets near my home that it is difficult to ride my bike or play on the street	☐	☐	☐	☐
3. Most drivers go too fast while driving in our neighbourhood.	☐	☐	☐	☐
4. There is a lot of crime in my neighbourhood.	☐	☐	☐	☐
5. It feels unsafe to walk by myself around my neighbourhood during the day.	☐	☐	☐	☐
6. It feels unsafe to walk with friends or siblings around my neighbourhood during the day.	☐	☐	☐	☐
7. I am worried about being or walking by myself in my neighbourhood and local streets because I am afraid of being taken or hurt by a stranger	☐	☐	☐	☐

Curriculum Vitae

Name: Leah Taylor

Post-secondary Education and Degrees:

Western University
London, Ontario, Canada
2016-2018 M.Sc. Geography

Western University
London, Ontario, Canada
2012-2016 BHSc
(Honours Specialization, Health Promotion) *with Distinction*

Honours and Awards:

Children's Health Research Institute Fellowship
2017

Western University Graduate Research Award
2018

Canadian Institute for Health Research, Community Support Grant
2018

London Health Research Day, Poster Competition Award
2018

Related Work Experience

Research Associate
Human Environments Analysis Laboratory
2016 – Present

Youth Review Committee Member
Open Access Journal: Youth Engagement in Health Promotion
University of Toronto
2015 – Present

Teaching Assistant
Western University
2016-2018

Health Promotion Student: Chronic Disease and Injury Prevention
Niagara Region Public Health
2009 – 2016

Conference Presentations:

Oral Presentation
Poster Presentation
Taylor, L.G., Clark, A.F., Wilk, P., & Gilliland, J.A. *Assessing relationships between Ontario children's environments, experience of*

barriers, and moderate-to-vigorous physical activity: a structural equation modelling approach.
Annual meeting of the Canadian Associations of Geographers
Université Laval, August 6-10, 2018

Poster Presentation
Context Matters: Examining children's perceived barriers to physical activity across varying Canadian environments.
Annual meeting of the Canadian Associations of Geographers
Université Laval, August 6-10, 2018

Oral Presentation
Context Matters: Examining children's perceived barriers to physical activity across varying Canadian environments.
Canadian Public Health Association, Public Health 2018
Montreal QB, May 29, 2018

Poster Presentation
Context Matters: Examining children's perceived barriers to physical activity across varying Canadian environments.
2nd Place: Poster Competition Award
London Health Research Day
London ON, May 10, 2018

Oral Presentation
Context Matters: Examining children's perceived barriers to physical activity across varying Canadian environments.
Annual meeting of the Canadian Associations of Geographers Ontario Division
Queen's University, October 20-21, 2017