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Exploring the Health Benefits of Nature for Children in Urban, Suburban, and Rural Settings

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Abstract

A growing body of research suggests that increasing children's exposure to natural environments can have positive benefits for their overall health and well-being. Using a mixed-methods approach, this thesis uses (a) surveys and spatial analyses within a geographic information system framework to examine how individual-level and environmental factors are associated with children's health-related quality of life (HRQOL), and (b) semi-structured focus groups with children to understand how children living in a rural community define nature, experience nature, and perceive the benefits and drawbacks of nature. Results suggest that in addition to a number of important individual level variables, certain environmental characteristics were associated with higher levels of HRQOL. Qualitative findings build on these results demonstrating that children are aware of the mental health benefits of interacting with nature. The findings have implications for future research, policy makers, health practitioners, educators, and parents.

Keywords

Children; nature; mental health; health-related quality of life; mixed methods

Co-Authorship Statement

Each integrated article within this thesis will be submitted for publication in peer-reviewed journals. Below are details of co-authorship for both integrated articles.

Chapter 2 was written by Suzanne Tillmann with Dr. Jason Gilliland and Dr. Danielle Tobin as co-authors. Suzanne Tillmann performed the majority of article searches paper screening, data analyses, and is the primary author of the article. Dr. Gilliland is the principal investigator and was the main editor of the paper. Dr. Tobin conducted article searches, paper screening, and contributed to editing the paper. All authors contributed to the methodology.

Chapter 2: Tillmann, S.E., Tobin, D., & Gilliland, J.A. (2017). Mental Health Benefits of Children's Interactions with Nature: A Systematic Review.

Chapter 3 was written by Suzanne Tillmann with Dr. Jason Gilliland and Dr. Andrew Clark. Suzanne Tillmann performed analyses and is the primary author of the article. She was responsible for the STEAM North data collection, but was not present during the STEAM South data collection period, this data was collected by other members of the HEAL Lab. Dr. Gilliland is the principal investigator and conceived and designed the methodology for the STEAM study. Dr. Gilliland and Dr. Clark were involved in the development of data collection procedures and data analyses, and contributed to editing the paper.

Chapter 3: Tillmann, S.E., Clark, A.F., & J., Gilliland, J.A. (2017). Exploring the influence of individual-level and environmental factors on health-related quality of life in elementary school children.

Chapter 4 was written by Suzanne Tillmann with Dr. Jason Gilliland, Dr. Stephanie Coen, and Brenton Button. Suzanne Tillmann performed all analyses and is the primary author of the article. Tillmann, Button, and Gilliland co-developed the focus group guide, while Button moderated all focus groups. Gilliland is the principal investigator, conceived, and designed the STEAM study. Both Dr. Gilliland and Dr. Coen provided guidance and were involved in editing the final article.

Chapter 4: Tillmann, S.E., Button, B., Coen, S., & Gilliland, J.A. (2017). Children's Perceptions of Nature in Northwestern Ontario.

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Chapter 1

1 Introduction

1.1 Research Context

Recent evidence has suggested that children and families no longer prioritize spending time outdoors in nature. North American children today, on average, spend less than one hour per day outside, while dedicating almost seven hours per day to electronics (Cathexis Consulting, Zorzi, & Gagne, 2012; Driessnack, 2009). Historically, spending time in nature was seldom viewed as a tool to support children's health; however, recent declines in children's interactions with nature have brought forward a growing body of evidence which highlights the benefits nature can have on their health (Keniger, Gaston, Irvine, & Fuller, 2013; Pretty et al., 2009).

Dramatic increases in sedentary behaviour, obesity, and mental health problems have public health officials seeking ways to alleviate pressures on health care systems; these systems and policies are attempting to move away from reactionary care to preventative forms of care to better accommodate and eliminate these growing public health crises. A major part of preventative care requires developing strategies that target children, as habits developed at a young age can persist into adulthood. As such, emerging empirical evidence has explored the influence of neighbourhood settings on children's physical, mental, social, and cognitive health and development. More recently, growing evidence indicates that interaction with natural environments have the potential to positively benefit human health, particularly among children (Annerstedt & Wahrborg, 2011; Audrey & Batista-Ferrer, 2015; Keniger et al., 2013; WHO, 2016). With growing concern about "nature deficit disorder" - a phrase which refers to children's growing lack of time spent in nature - researchers from diverse disciplines, including public health, geography, environmental psychology, and urban planning are interested in assessing and better understanding the potential positive benefits nature can provide to children's health (Driessnack, 2009).

Children can interact with nature in different ways (e.g. knowing, perceiving, interacting with, living within (Russell et al., 2013)) and these interactions with nature have been shown to increase physical activity levels (Wheeler, Cooper, Page, & Jago, 2010), positively benefit mental health and well-being (Amoly et al., 2014; Balseviciene et al., 2014; van Lier et al., 2017), enhance memory and focus, reduce inattentiveness, and improve academic success in children (Artensson et al., 2009; Block et al., 2012; Dadvand et al., 2015; Matsuoka, 2010; Maynard, Waters, & Clement, 2017; Wu et al., 2014). However, numerous constraints can limit whether a child is even able to interact with nature. For example, the structure of the built environment affects children's ability to access and frequent nature (Christian et al., 2015; Jackson, Tester, & Henderson, 2008; Van Den Berg et al., 2016). When an environment does not afford enough opportunities to interact with open, green, blue, and outdoor spaces, children are more likely to be exposed to urban stressors, including congestion, pollution, and social problems (Clark, Myron, Stansfeld, & Candy, 2007; Müderrisoglu & Gultekin, 2015). Subsequently, there has been a surge in literature investigating how accessibility, exposure, and engagement with nature can shape various health outcomes of children. This research suggests that how we operationalize nature can generate conflicting conclusions about how it benefits the physical, mental, social, and cognitive well-being of children.

Given the growing evidence supporting the influence of nature on children's health outcomes, it stands to reason that greater accessibility to, and knowledge of nature is beneficial to children's health and development. This thesis aims to look at this in a full range of environments, based on urbanicity (a term used throughout this thesis to describe neighbourhood and social form as urban, suburban, or rural) to distinguish the potential differences in nature's benefits on health among children, with a focus on mental health. Furthermore, it will assess how rural children in particular define and perceive nature, with a focus on exploring what participants understand the health and mental health benefits of nature to be.

1.2 Theoretical Framework

Developing research through theory allows our way of knowing to be extended into experiences of everyday life (Aitken & Valentine, 2015). The lived experiences of

children shape our way of knowing to allow research findings to be put into a practical translation of knowledge. The knowledge translation gap between research and practice is shrinking; however, there is a need for the improvement in translation pathways to better inform practitioners on how current findings support better policies and practices (Glasgow & Emmons, 2007). The social ecological model helps close this gap by incorporating non-human agents into its model. These elements of the model are what differentiate it from theories that solely focus on human or structural agency alone.

The social ecological model was chosen to frame this thesis as it incorporates multiple variables that have been hypothesized to influence children's health, behaviours, and attitudes, such as nature. This model is built upon the idea that health outcomes are impacted by various factors at the intrapersonal, interpersonal, environmental, and policy level (Sallis et al., 2006). The model highlights how variables within each level can act as a barriers or enablers to a specific outcome, in this case children's health and their definitions and perceptions of nature (Sallis et al., 2006; Stokols, 1992).

Health promotion policies typically target individual level behavioural changes, outwardly ignoring the potential effects that both the built and natural environment can have on not only sustaining changes in behaviour but also the existence of a health issue (Stokols, 1996). The social ecological model helps to close this gap. It was also chosen on the basis that this research aims to influence change at the policy level, something that is not possible when only focusing on changing the behaviour of individuals. In doing so, these potential upstream interventions target the general population prior to the development of poor health outcomes. Preventative measures created through knowledge translation at the research-policy level are both beneficial to the individual as well as health care systems financial and functional health.

Stokols' social ecological conceptualization of health-promoting environments highlights the physical-material and social-symbolic interactions that exist in the day to day lives of individuals and how these interactions influence their emotional, physical, and social well-being (Stokols, 1992). This view of the social ecological model aligns closely with the need to further assess nature's connection to children's well-being.

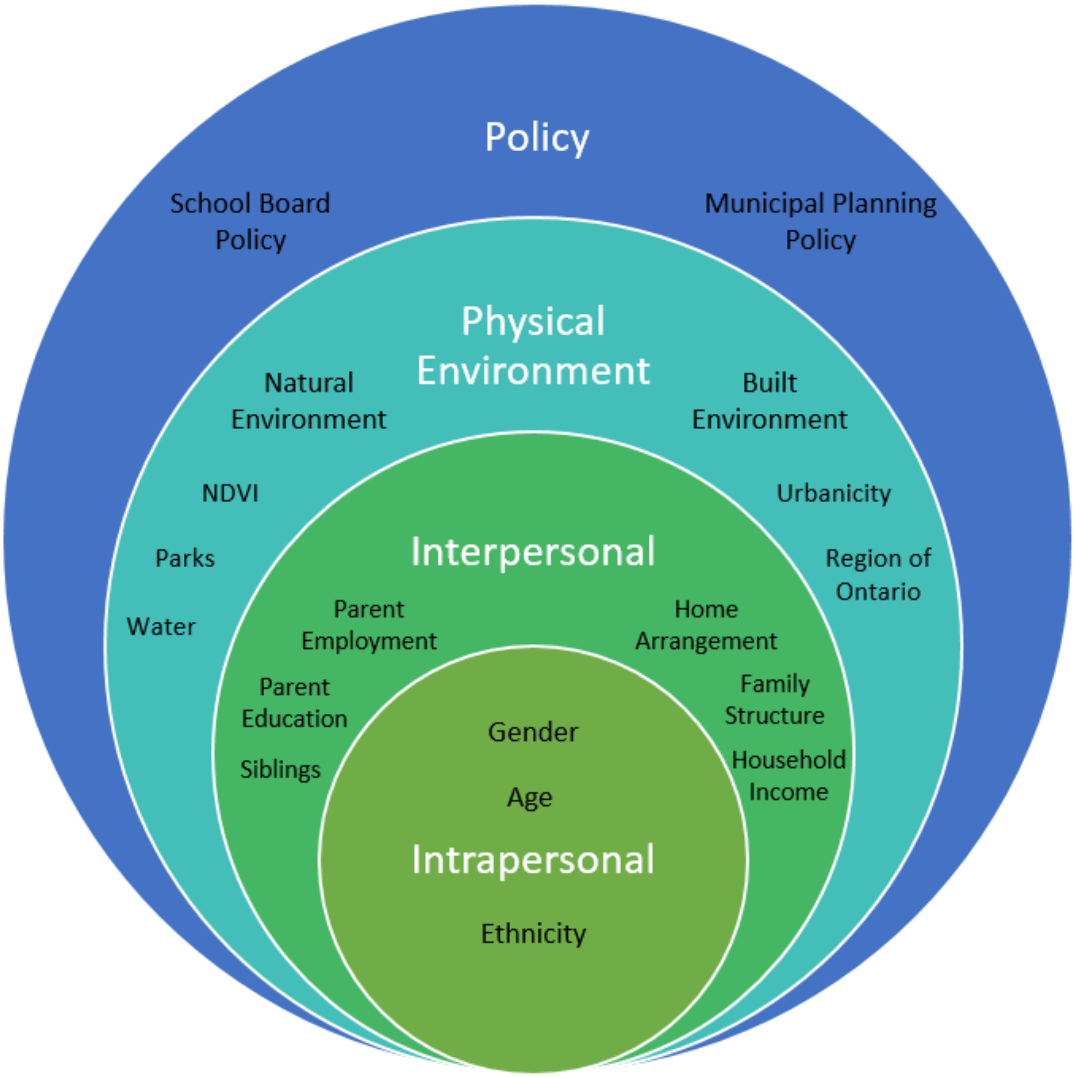

Figure 1.1 Socio-ecological model of children's interaction with their environment

This socio-ecological model acknowledges that there are multiple factors that influence the relationship between natural environments and children and ensures that multiple factors eligible are considered in the design of the studies. The inclusion of multiple factors from each level of the model avoids inferring specious relationships and also recognizes that health outcomes and behaviours and attitudes are generated by many factors at each level of the model.

1.3 Research Objectives and Questions

This thesis aims to contribute to a rapidly growing area of research that investigates how physical environments influence health outcomes. There are three key objectives to this research: (1) review existing literature assessing nature's connection to children's mental health (2) to develop a more thorough understanding of how the natural environments children experience and interact with on a daily basis influence their understanding and perceptions of nature, and (3) how these experiences and interactions may influence their health. Furthermore, incorporating comparisons between urban, suburban, and rural populations within the analysis reduces a major gap in the current literature, especially in the Canadian context.

This thesis poses the following three key research questions which I will attempt to answer in three subsequent chapters:

1. What is the current state of evidence on how children's (ages 0-18 years) interactions with nature influence their mental health?
2. (a) What is the relationship between children's accessibility to nature and their health-related quality of life? and (b) How is this relationship different for children from urban, suburban, and rural environments?
3. How do rural children define, experience, and identify benefits and drawbacks of nature?

Research question #1 will be answered by performing a systematic review of peer-reviewed articles published between 1990 and 2017. In order to answer research questions #2 and #3, I will perform quantitative and qualitative analyses of data from the Spatial Temporal Environmental Activity Monitoring (STEAM) project conducted with children aged 8-14 years from urban, suburban, and rural environments in Ontario, Canada.

1.4 The STEAM Project

The STEAM project was designed to gain a better understanding of how children's environments influence their health-related behaviours and outcomes such as physical

activity, eating habits, active transportation, screen viewing, sleep, body mass index (BMI), and health-related quality of life (HRQOL). Through the use of global positioning system (GPS) devices and accelerometers, paired with parent and youth surveys, many child-environment relationships have been examined to better understand how the environments in which children live, play, and attend school influence their behaviours and lifestyles (see www.steamproject.ca).

The project was conducted in Southwestern Ontario between 2010-2013 (hereby referred to as "STEAM South") and replicated again in Northwestern Ontario between September and December 2016 (hereby referred to as "STEAM North") (See Figure 1.2 for map of study areas). Although the same overall study design was used for both study areas, separate protocols were submitted to the Non-Medical Research Ethics Board (NM-REB) at Western University and subsequently approved (STEAM South NM-REB #:17918S; STEAM North NM-REB #:108029).

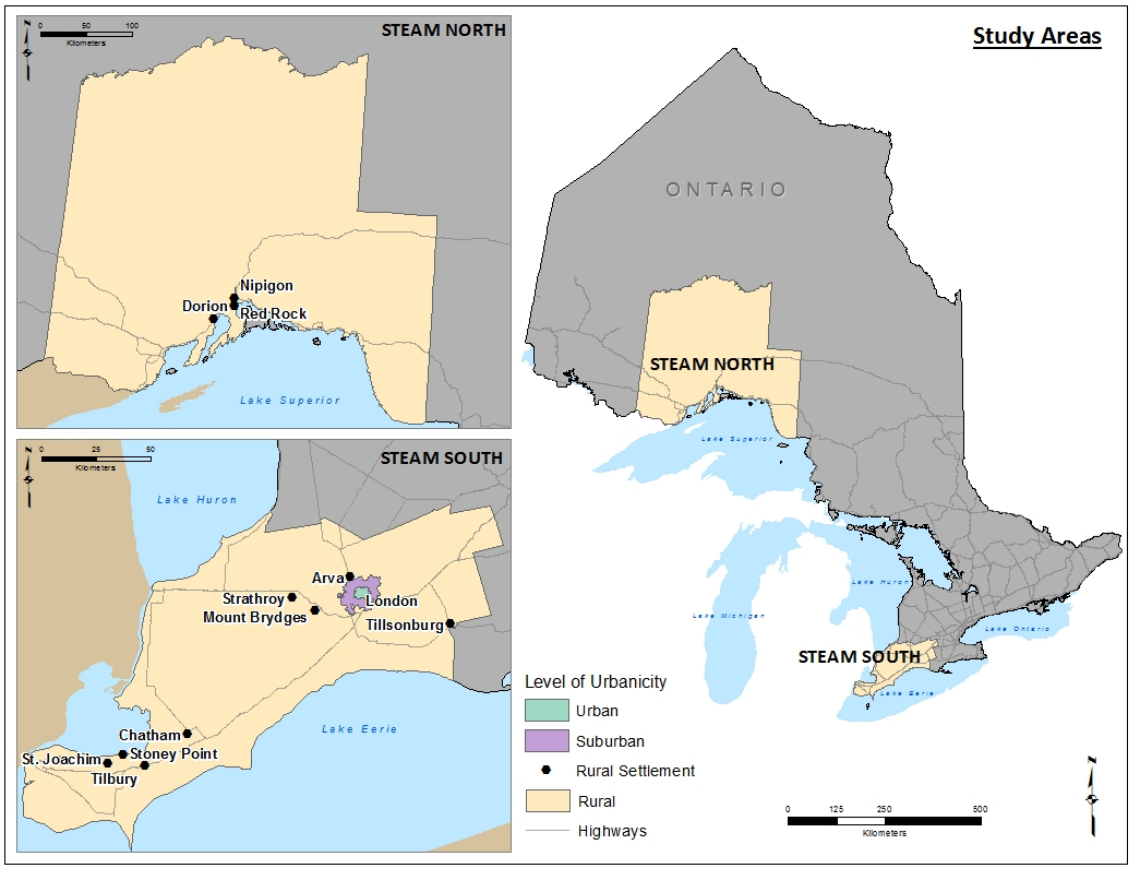

Figure 1.2 Map of study areas

STEAM South: all four school boards within the study region (Thames Valley District School Board, London District Catholic School Board, Conseil scolaire Viamonde, and Conseil scolaire catholique Providence) and a private school (Montessori Academy of London) granted permission through their own internal Research Ethics Boards/Committees to participate in the STEAM protocol. The schools selected to participate represented a broad range of environments with respect to urbanicity (urban, suburban, rural), socio-economic status (low, mid, high), and recreation and food environments (See Figure 1.3 for picture taken by STEAM South participant during the early winter). Principals were contacted and asked for permission to work with students in grades four to eight (aged 8-14). Of the schools selected 30 agreed to participate, representing populations from London (Population: 383,822), Strathroy (Population: 14,391), Tilbury (Population: 4,765), Chatham (Population: 44,676), Mount Brydges (Population: 1,834), Tillsonburg (Population: 14,933), Arva (Population: N/A), Stoney Point (Population: 1,146), and St. Joachim (Population: N/A), covering approximately 6,000 km^2 of Southwestern Ontario (Statistics Canada, 2016).

STEAM North: Principals of four schools in the Northwestern region of Ontario (Superior Greenstone District School Board and Superior North Catholic District School Board) were asked to participate in the STEAM North project. Two schools were in the town of Nipigon (Population 1,642). The other two schools were in the surrounding communities of Dorion (Population 316) and Red Rock (Population 895), 39.5km and 18.5km southwest of Nipigon, respectively, covering approximately 385 km^2 of Northwestern Ontario (Statistics Canada, 2016). The climate of the region is similar to Southwestern Ontario but with more extreme cold in the winter, lower average temperatures, and larger differences in hours of sunlight throughout the year (See Figure 1.4 for picture taken by STEAM North participant during the early winter). These two communities are actively involved with the town of Nipigon. All four schools agreed to participate.

Figure 1.3 Photo of school neighbourhood taken by STEAM South participant

Figure 1.4 Photo of school neighbourhood taken by STEAM North participant

Students received an oral presentation from one of the researchers describing their role as a researcher in the study and highlighting what would be required from each student. Students were sent home with an information package for their parents consisting of a letter of information, consent form, and optional parent survey with full contact information of the primary investigator (in case further information was required). Students who received consent from their parent or guardian were then asked to provide their own assent prior to set up to confirm their interest in participating. Students were also informed that they could withdraw from the study at any point in time. Researchers were available throughout the study period to answer all and any questions students or parents may have had.

Each child was asked to wear a portable GPS device (Colombus or VisionTac) and accelerometer (Bio-Lynx Actical) for 7 days, 5 weekdays and 2 weekends, in order to track where students go (GPS) and how active they are in these places (accelerometer). On setup day, each child was fitted with a GPS and accelerometer and asked to complete the healthy neighbourhood environments survey. The GPS and accelerometer devices were to be worn during all waking hours, except during bathing and water activities. The GPS devices were attached to a lanyard allowing students to wear the device around their neck (note: lanyard included break-free clasp to prevent choking hazard). Each accelerometer was attached to an elastic waistband worn around the hips with the device sitting on their hipbone. The survey consisted of 13 sections (153 questions) collecting information on: demographics, physical activity, eating habits, active transportation, sleeping patterns, screen-viewing, parental rules (for play, eating, screens, outdoors) and health-related quality of life. Parents had the option of completing a 12-part survey, which supplemented the child survey, as well as provided information on parental demographics and behaviours. Finally, children were asked to complete an activity diary for each day they participated in the study. The diary collected information about the types of activities they were doing, food they were purchasing, and sleep they were getting over the course of each day in order to give greater context to the GPS and accelerometer data.

The protocol of the STEAM project required researchers to enter the schools every day that the children were participating (outside of weekends). This intensive approach, although time consuming and labour intensive, allowed researchers to ensure protocol compliance, address any technological issues, and develop relationships with the participating children. Each day, every child's GPS data was downloaded and each device was checked for functionality and proper wear by each child. Activity diaries were collected and checked by researchers to ensure students were not only completing them but also providing enough information so that the data could be coded accordingly at a later date (See Figure 1.5). The value we see in conducting research with children (rather than conducting research "on" children) was conveyed to these students through the daily visits and support given by the researchers.

Figure 1.3 Researchers marking activity diaries at a STEAM school

The high level of data quality generated from both the objective and subjective measures is novel and important in confirming findings, particularly through triangulation. The multiple study locations in this project adds another layer of depth to this novelty as rural Southwestern and Northwestern Ontario are typically understudied regions, especially when researching children.

A number of graduate students have used STEAM data to investigate how children's environments influence their health-related behaviours. Topics include healthy eating (Rangel, 2013), sleep (McIntosh, 2014), active transportation (Hill, 2012; Fitzpatrick, 2013; Richard, 2014; Rivet 2016), neighbourhood mobility and activities (Loebach, 2013), and physical activity (Richard, 2014; Mitchell, 2016).

Hill (2012) used built environment variables and survey data to statistically examine the different influences of parents and children's perceptions of the built and social environment in regards to active transportation between home and school. Closely related, Rivet (2016) used built environment variables and GPS tracking of children's routes between home and school within ArcGIS to statistically examine the influence of different individual-level and environmental-level influences on mode of travel. Taking a more qualitative and participatory approach, Fitzpatrick (2013) investigated children's active transportation between home and school using child-led perception mapping and

ArcGIS analysis of children's maps to determine whether children's perceptions and use of their school neighbourhood changes based on their built environment.

In addition to assessing children's perceptions of their environments, other graduate student theses used more objective measures, such as accelerometry and/or GPS tracking to investigate children's behaviours. Rangel (2013) used street network and Euclidean buffers to examine different methodologies in characterizing children's food environments with two measures of activity spaces. Richard (2014) examined how active and inactive commutes to school affect Southwestern Ontario rural children's physical activity and bodyweight status while controlling for the home neighbourhood environment. Mitchell (2016) examined how neighbourhood opportunities and contextual environmental exposures facilitate or constrain physical activity levels.

This thesis adds to the above research using the STEAM data by focusing on how the natural environment in different settings (urban, suburban, rural) relates to children's health. Loebach (2013) examined children's perceptions of their environments through focus groups, child led tours, qualitative GIS, and GPS tracking. Chapter 4 of this thesis builds on her work in that it uses the natural environment as a measure of children's environments in children from rural Northwestern Ontario. McIntosh (2014) examined the relationship between children's accessibility and exposure to different environments including green spaces and their nighttime sleep duration. Instead of sleep as the outcome of interest, Chapter 3 of this thesis examines the relationship between children's HRQOL and accessibility to nature, using ArcGIS to characterize neighbourhood level natural environments.

1.5 Pediatric Quality of Life Inventory 4.0

There is a growing body of literature that focuses on the importance of children's well-being and quality of life along the life course (Settersten, Mcclelland, & Miao, 2014). Research topics such as physical activity, social and cognitive development, healthy eating, and mental health are at the forefront of research with children. A tool which has gained popularity in children's health research is the Pediatric Quality of Life Inventory 4.0 (PedsQL). This tool is a modular approach to measuring HRQOL in both healthy and

ill child/adolescent populations (http://www.pedsql.org/). The tool is a 23-item questionnaire that addresses four areas of children's health: physical, emotional, social, and school functioning. Each domain can be analyzed as an independent measure or as a total score. It focuses on understanding individual children's perceptions of their overall health, rather than evaluations made by clinicians or biomedical parameters (Sawyer et al., 2002). The PedsQL was conceptualized as an age appropriate patient-report outcome tool for a wide range of children (Varni, Burwinkle, & Seid, 2005). The tool is most commonly used to measure the HRQOL in children suffering from physical ailments where specific modules have been designed for chronic and acute illnesses such as asthma, cancer, diabetes, and cerebral palsy. The generic module, used in this thesis, is used in assessing healthy populations and, less commonly, populations with psychiatric disorders such as ADHD or depression (Reinfjell, Hjemdal, Aune, Vikan, & Diseth, 2008; Sawyer et al., 2002; Varni & Burwinkle, 2006).

Many studies conducted by James Varni, the creator of the PedsQL 4.0, assess the feasibility, reliability, and validity of the tool (Bastiaansen, Koot, Bongers, Varni, & Verhulst, 2004; Limbers, Ripperger-Suhler, Heffer, & Varni, 2011; Varni, Burwinkle, & Seid, 2003; Varni et al., 2005; Varni, Seid, Knight, Uzark, & Szer, 2002; Varni, Seid, & Kurtin, 2001; Varni, Seid, & Rode, 1999). A paper published by his team in 2003 reported that items on the generic scale are rarely missed by both children and parents, implying that participants are willing to share information about their health, leading to good quality data (Varni et al., 2003). All six values that can be calculated using the tool for children ages 8-12 exceed the recommended minimum alpha coefficient standard of 0.70 for group comparisons (Varni et al., 2003). The Generic Core Scales Total Score exceeded an alpha of 0.90 for children ages 8-12, making it ideal for a summary score for the primary analysis of HRQOL outcomes in population health analysis. Both the Physical and Psychosocial Health Summary Scores were recommended for secondary analysis, and the remaining three functioning subscales can be used to examine specific areas of functioning (Varni et al., 2003).

Studies that have compared child self-reports and parent proxy reports have found imperfect agreement, or cross-informant variance in both healthy children and children

with chronic health conditions, which changes depending on the specific population being observed (Varni et al., 2003, 2002). It is recommended that whenever possible, both self and proxy reports should be used (Varni et al., 2005). Given that this tool aims to measure the individual's perceptions of their HRQOL, the need for reliable and valid child self-report instruments is of primary concern (Varni et al., 2005).

A limited number of studies have used HRQOL as a measure of mental health (Kim, Lee, & Sohn, 2016; McCracken, Allen, & Gow, 2016), however, each of the sub-scales represent variables that are known to contribute to a child's mental health. A child's ability to easily and properly function physically, emotionally, socially, and in school can all be factors that influence mental health outcomes such as self-esteem, anxiety, depression, ADD, ADHD, resiliency, and many more. This tool allows the opportunity to easily assess various aspects that can contribute to the overall mental health of a child. Reinfjell et al. (2008) used the PedsQL tool to assess the associations between depressive symptoms and HRQOL in young adolescents. Their findings showed that the tool could be useful in both research and clinical practice (Reinfjell et al., 2008).

There is growing interest in research analyzing how various independent variables such as children's environments influence healthy children's PedsQL scores. A study by Mansour et al. (2003) highlights how there are noted differences in HRQOL scores in children from urban centres. The study found that urban children have a poorer quality of life in comparison to other large-scale studies conducted on healthy populations of children as well as children with known chronic physical health conditions (Mansour et al., 2003; Varni et al., 2001). Understanding how children's environments, both built and natural influence HRQOL is important in developing strategies to support children's mental health.

The confidence in this tool as published by many researchers supports its use for this research as well as the need to grow the literature base that uses the tool as a reflection of children's mental health.

1.6 Thesis Format

Through an integrated article format, this thesis presents a systematic review and two complementary manuscripts attempting to assess and understand nature's connection to children's health. The two empirical studies include children from the STEAM project within Southwestern and Northwestern Ontario. Each study has a similar overarching objective of understanding nature's effects on children; however, they address this objective in different ways. Each thesis chapter is described below.

Chapter 2 systematically reviews the existing body of quantitative evidence about how children's interactions with nature – as defined by accessibility, exposure, and engagement – can influence their mental health. Mental health was conceptualized using a number of related outcomes, including emotional well-being, Attention Deficit Disorder (ADD)/ Attention Deficit Hyperactivity Disorder (ADHD), mental health, self-esteem, stress, depression, resilience, and health-related quality of life. This review shows that there is an inconclusive evidence base to support the hypothesized relationship between children's interactions with nature and their mental health, justifying the need for the research presented here.

Chapter 3 examines how children's health-related quality of life is affected by accessibility of nature around their home. This chapter also explores whether changes in urbanicity (i.e., urban, suburban, rural) influences the magnitude of associations between HRQOL and accessibility to nature. The results from this study highlight differences according to where children live and their HRQOL, and how preventative health strategies need to therefore be tailored to specific built environments.

Chapter 4 investigates how rural children define, experience, and identify benefits and drawbacks of interacting with nature through semi-structured focus groups. This chapter examines how rural children perceive their own habitual natural environments, and whether they view nature as beneficial to their health. The results from this study seek to inform policy and practice supporting preventative strategies for rural children's health and well-being.

Chapter 5 synthesizes and discusses the findings from the three research studies. This chapter also discusses the contributions of this thesis in relation to the existing body of evidence that was reviewed in Chapter 2; drawing important conclusions for future research, policy, and practice while recognizing study limitations.

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Chapter 2

2 Mental health benefits of children's interactions with nature: A systematic review

2.1 Introduction

Although the term 'mental health' is often used in reference to mental disorders associated with impaired brain or emotional functioning (Waddell, Mcewan, Peters, Hua, & Garland, 2007), the World Health Organization offers a broader definition, maintaining that "Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (World Health Organization, 2016). This definition of health supports the notion that good mental health during childhood is also associated with emotional well-being, reaching developmental milestones, learning healthy social skills, developing sound family and peer relationships, developing a sense of identity and positive self-esteem, and learning resilience and how to cope with stress (Avison, 2010; Maller & Townsend, 2006; Mantler & Logan, 2015; Reed et al., 2013; Ritchie, Wabano, Russell, Enosse, & Young, 2014; Waddell et al., 2007). Mental health is dependent on a wide range of biological, socioeconomic, and environmental factors, and is not limited to the absence of a mental illness. While studies on children's mental health most commonly use individual level factors to assess mental health outcomes, researchers also recognize the importance of examining potential external influences on children's mental health, such as children's home, school, and neighbourhood environments. Furthermore, issues developed at a young age have the potential to persist into adulthood, continuing the burden on the individual, family, friends, and the health care system (Bardone et al., 1996; Eaton et al., 2008).

This systematic review considered various forms of children's interactions with nature. The evidence to support the connection between nature and children's mental health is extremely diverse, dispersed, and difficult to interpret. Therefore, there is an overwhelming need to critically review and synthesize what evidence currently exists to make appropriate recommendations that can effectively support future research, policy, and practice. Previous systematic reviews that focus on the relationship between

environments and aspects of mental health have focused solely on adult populations, have tended to lump children in with adults, or focus on unique sub-populations (e.g., indigenous youth) (Annerstedt & Wahrborg, 2011; Audrey & Batista-Ferrer, 2015; Brussoni et al., 2015; Christian et al., 2015; Clark et al., 2007; Gascon et al., 2015; Hoven et al., 2009; Lee & Maheswaran, 2011; Thompson Coon et al., 2011a). This review specifically focused on relevant literature that examined the benefits to children's (ages 0-18 years) mental health from interactions with nature. This systematic review will also inform the basis of this thesis to support the growing need for evidence supporting children's mental health and interactions with nature.

2.2 Methods

Following methods identified by Petticrew and Roberts (2006) and verified by research librarians, the systematic review began with a scoping review to help determine appropriate search terms related to nature, mental health, and children (Petticrew & Roberts, 2006). Search terms were identified by the authors and finalized by an advisory panel of subject experts (See Appendix G). This review used ten bibliographic databases: PubMed, Scopus, PsycINFO, Geobase, ProQuest, SPORTDiscus, Sociological Abstracts, Leisure and Tourism Database, Physical Education Index, and EMBASE. Within each database, all English and French documents were screened from January 1, 1990 to March 1, 2017. This period was chosen as it represents approximately one generation of the literature.

2.2.1 Review Process

The review process was divided into three major steps: title screening, abstract screening, and document screening. Findings were reported following PRISMA guidelines. Title screening involved reviewing the outputs from each database search and downloading all titles that appeared relevant to the subject into a citation manager (Mendeley v1.17.10). Of the 227,153 titles screened, 1,731 documents were downloaded for further review. Abstracts of all 1,731were then screened and 253 documents were retained which appeared to meet inclusion criteria: quantitative in design, included children ages 18 years and under, incorporated an element of nature, and included some component of

mental health as an outcome variable. Finally, the full text of all 253 retained documents were reviewed and critically assessed using the same inclusion/exclusion criteria as the abstract screening, leaving 35 eligible papers to be included in the systematic review. Finally, the reference lists of all eligible papers were inspected for additional relevant citations; however, this search found no new papers. See Figure 2.1 for the comprehensive screening process.

2.2.2 Data Extraction

Relevant data from the 35 full-text articles was identified and compiled into a data extraction table. This information was used to create a summary of the key characteristics and findings of each study (See Tables 2.1 and 2.2). A meta-analysis was not possible due to the heterogeneity of the papers.

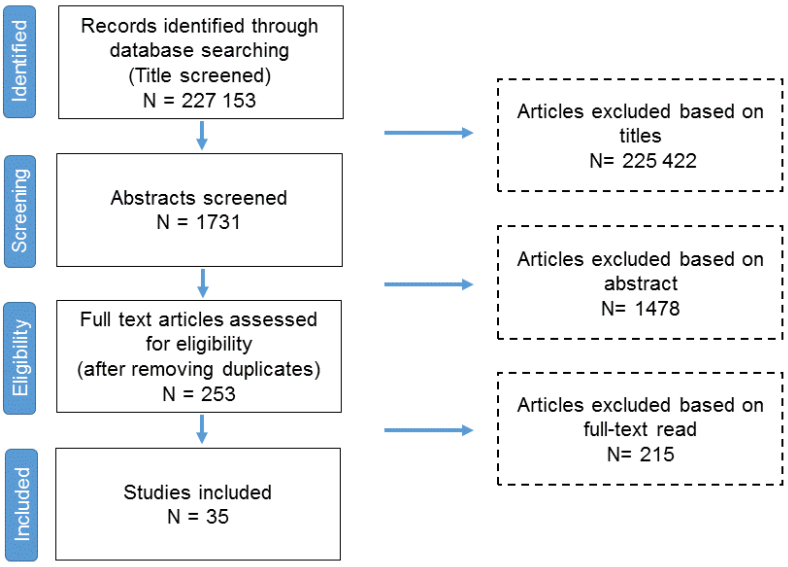

Figure 2.1 Selection process of articles

2.3 Results

Of the 35 papers meeting eligibility criteria, eleven were conducted in the United States, eight in the United Kingdom, two in Canada, and the remaining fourteen papers in other

countries. All papers focused on children ranging from 9 months to 18 years of age, with early adolescence being the most commonly studied age group. (See Table 2.1 for full study characteristics).

All of the outcomes studied in the 35 papers were assigned to one of eight categories: emotional well-being (15 papers), ADD/ADHD (10 papers), mental health (9 papers), self-esteem (9 papers), stress (4 papers), resilience (3 papers), depression (3 papers), and health-related quality of life (2 papers). Table 2.2 sorts the 35 papers by outcome, with the eight outcomes appearing in order according to number of papers studying that outcome. As some papers examined more than one outcome, the total entries in Table 2.2 is more than 35.

Within the 35 papers, there was substantial diversity with respect to the specific elements of nature under consideration. The elements under study included green space (5 papers), blue space (1 paper), greenness/greenery (4 papers), vegetation (i.e., grass, trees) (2 papers), gardens (1 paper), parks (4 papers), outdoor programs/education (8 papers), wilderness therapy (4 papers), forest schools (1 paper), and various outdoor/natural settings (i.e. schoolyards, green outdoor settings) (9 papers).

There was also considerable variation among the methods researchers used to assess children's interaction with nature. Despite the heterogeneity, a closer examination of study methods allowed us to group each study into one of three broad categories we define as 'accessibility', 'exposure', and 'engagement' (See Table 2.3 for summary of results based on nature interaction). In simple terms, accessibility refers to the ease of reaching destinations. In this case, accessibility influences the likelihood a child will encounter or interact with nature, but does not necessarily equate to direct contact or interaction. For example, in most studies reviewed here, accessibility measures are passive and opportunity-based, and tend to be operationalized in terms of distance/proximity to one or more elements of nature, or density/coverage of one or more elements of nature within an area around home. On the other hand, exposure can be defined as the condition of being presented to view, having contact with, or being subjected to some effect or influence. Exposure, therefore, implies that the child has a

direct encounter with nature, rather than mere opportunity. Nevertheless, in most studies reviewed here, exposure is a measure of incidental contact, and is operationalized in terms of “time spent in or near”, or simply “use of”, a natural area such as a park. Engagement refers to involvement or participation in an activity, and differs from the other two categories in that it implies an interaction with nature which is more direct, intentional, and sustained. For example, the most popular form of engagement described in the studies reviewed here was participation in a wilderness therapy program for days/weeks (See Table 2.2 for results of individual studies).

As displayed in Tables 2.2 and 2.3, the 35 papers reported a total of 98 individual findings on the relationship between children and mental health. Over half (53.1%) of the findings (52 out of 98) confirmed statistically significant positive relationships (i.e., mental health benefits of connecting children with nature), whereas the remaining 46.9% of findings were insignificant. Only one of the papers reported a single finding suggesting that nature had negative effects on children’s mental health.

Table 2-1 Study characteristics of papers considering nature and children's mental health

Author(s) (Ref #)	Year	Location (Country)	Ages (Years)	Sex	N	Element(s) of Nature	Nature Interaction(s)	Outcome(s)	Study Design
Amoly *et al.*	2014	Spain	7-10	M/F	2111	Green Space Blue Space Greenness	Accessibility Exposure	Emotional WB Hyperactivity Inattention Mental Health	Cross-sectional[O]
Balseviciene *et al.*	2014	Lithuania	4-6	M/F	1468	City Parks Greenness	Accessibility	Emotional WB Hyperactivity Mental Health	Cross-sectional[O]
Barton *et al.*	2015	England	8-9	M/F	52	Nature Orienteering	Engagement	Self-esteem	Intervention[O]
Bowen & Neill	2016	Australia	13-16	M/F	53	Outdoor Adventure	Engagement	Mental Health	Intervention[O]
Bowen *et al.*	2016	Australia	12-18	M/F	36	Wilderness Adventure Therapy	Engagement	Emotional WB Mental Health Self-esteem Depression Resilience	Intervention[O]
Cammack *et al.*	2002	United States	12-18*	M/F	50	Horticultural Program	Engagement	Self-esteem	Intervention[A]
Clark *et al.*	2004	United States	13-18	M/F	100	Wilderness Treatment Program	Engagement	Mental Health	Quasi Empirical[O]
Feda *et al.*	2015	United States	12-15	M/F	68	Parks	Accessibility	Stress	Cross-sectional[O]
Flouri *et al.*	2014	England	0.75, 3, 5, 7	M/F	6348	Green Space	Accessibility Exposure	Emotional WB Hyperactivity Inattention	Cross-sectional[A]

Greenwood & Gatersleben	2016	United Kingdom	16-18	M/F	120	Outdoors	Exposure	Emotional WB Attention	Intervention[A]
Gubbels *et al.*	2016	Netherlands	12-15	M/F	401	Greenery	Exposure	Depression	Longitudinal[O]
Harper *et al.*	2007	United States	13-18	M/F	221	Wilderness Therapy	Engagement	Emotional WB Mental Health	Longitudinal Case Study[O]
Hinds	2011	United Kingdom	12-15	M/F	25	Woodland Education Program	Engagement	Self-esteem	Exploratory[O]
Huynh *et al.*	2013	Canada	11-16	M/F	17,249	Natural Space	Accessibility	Emotional WB	Cross-sectional[O]
Kelz *et al.*	2015	Austria	13-15	M/F	133	Schoolyard	Exposure	Emotional WB	Pre-Post Quasi-Experimental[O]
Kim *et al.*	2016	United States	9-11	M/F	92	Urban Natural Environments	Accessibility	HRQOL	Cross-sectional[A]
Kuo & Taylor	2004	United States	5-18	M/F	452	Green Outdoor Settings	Exposure	ADHD	Cross-sectional[A]
Markevych *et al.*	2014	Germany	9.4-11.7	M/F	1932	Green Space	Accessibility	Emotional WB Hyperactivity Inattention	Cross-sectional[O]
McCracken *et al.*	2016	Scotland	8-11	M/F	276	Green Space	Accessibility Exposure	Emotional WB Self-esteem HRQOL	Cross-sectional[O]
Mutz & Muller	2016	Germany	14	M/F	12	Outdoor Adventure	Engagement	Mental Health Stress	Intervention Pilot Study[O]

Opper *et al.*	2014	South Africa	Grade 10	M	76	Outdoor Adventure Education	Engagement	Emotional WB Stress	Pre-Post Experimental Design[O]
Reed *et al.*	2013	United Kingdom	11-12	M/F	75	Park	Exposure	Self-esteem	Counterbalanced Randomized Cross Over[O]
Ritchie *et al.*	2014	Canada	12-18	M/F	73	Outdoor Adventure Leadership Experience	Engagement	Mental Health Self-esteem Resilience	Intervention[A]
Roe & Aspinall	2011	United Kingdom	11	M/F	18	Forest Schools	Engagement	Emotional WB	Intervention[O]
Romi & Kohan	2004	Israel	15-18	M/F	94	Wilderness Therapy	Engagement	Self-esteem	Intervention[O]
Soderstrom *et al.*	2013	Sweden	3-5.9	M/F	169	Outdoor Preschool Environment	Accessibility Exposure	Emotional WB	Cross-sectional[O]
Taylor & Kuo	2009	United States	7-12	M/F	17	Park	Exposure	ADHD	Single Blind Control Trial[O]
Taylor & Kuo	2011	United States	5-18	M/F	421	Grass Trees	Exposure	ADD/ADHD	Cross-sectional[A]
Taylor *et al.*	2001	United States	7-12	M/F	96	Greenness Trees Grass	Accessibility Exposure	ADD/ADHD	Cross-sectional[A]
van den Berg & van den Berg	2011	Netherlands	9-17	M/F	12	Natural (Wooded) Setting	Engagement	Emotional WB ADHD	Intervention[A]
van Lier *et al.*	2017	New Zealand	12-18	M/F	8500	Garden	Engagement	Mental Health Depression	Cross-sectional[O]

Ward *et al.*	2016	New Zealand	11-14	M/F	108	Green Space	Exposure	Emotional WB	Cross-sectional[A]
Wells & Evans	2003	United States	Grades 3-5	M/F	337	Outdoor Yard	Accessibility	Stress	Cross-sectional[A]
Whittington *et al.*	2016	United States	10-15	F	87	Outdoor Adventure Program	Engagement	Resilience	Intervention[O]
Wood *et al.*	2014	United Kingdom	8-9	M/F	25	School Field	Exposure	Self-esteem	Counterbalanced Randomized Cross Over[O]

*Survey used was designed for children ages 12-18, age of participants not specified; WB: well-being; O: study designed was originally mentioned in paper A: study design was assigned by reviewer

Table 2-2 Findings sorted by outcome of papers considering nature and children's mental health

Author(s)	Year	Nature Interaction(s)	Outcome(s)	Results
Emotional Well-being Findings: 11 PR 14 NS				
Amoly *et al.*	2014	Accessibility Exposure	Emotional Well-being	PR: More time spent playing in green spaces was associated with lower emotional symptom scores in children ages 7-10 PR: Higher residential surrounding greenness at the 500m buffer was associated with lower emotional symptom scores in children ages 7-10 NS: No significant effect of residential proximity to major green spaces on emotional symptoms in children ages 7-10 NS: No significant effect of residential proximity to blue spaces on emotional symptoms in children ages 7-10 NS: No significant effect of time spent in blue spaces on emotional symptoms in children ages 7-10
Balseviciene *et al.*	2014	Accessibility	Emotional Well-being	NS: No significant effect of proximity to city parks on emotional health in children ages 4-6 NS: No significant effect of residential greenness on emotional health in children ages 4-6
Bowen *et al.*	2016	Engagement	Emotional Well-being	NS: No significant effect from pre-post after the 10 week WAT on emotional functioning in clinical and non-clinical children ages 12-18 NS: No significant effect after a 3 month follow up from the 10 week WAT on emotional functioning in clinical and non-clinical children ages 12-18
Flouri *et al.*	2014	Accessibility	Emotional Well-being	PR: poor children with more neighbourhood green space had fewer emotional problems from age 3 to 5, relative to counterparts in less green neighbourhoods.

Greenwood & Gatersleben	2016	Exposure	Emotional Well-being	PR: Increase in positive affect after time spent in outdoor environment, reduction in positive affect after time spent in indoor environment in children ages 16-18 NS: No significant effect of environment on attentiveness in children ages 16-18
Harper *et al.*	2007	Engagement	Emotional Well-being	PR: 2 months following the 21 day WT there was a significant improvement in emotional problems in children ages 13-18
Huynh *et al.*	2013	Accessibility	Emotional Well-being	NS: No significant effect of school surrounding natural space on emotional well-being in children ages 11-16
Kelz *et al.*	2015	Exposure	Emotional Well-being	PR: Greening of the schoolyard saw a significant increase in intra-psychic balance compared to both control schools in children ages 13-15 NS: No significant effect of the greening of the schoolyard on overall wellbeing in children ages 13-15
Markevych *et al.*	2014	Accessibility	Emotional Well-being	NS: No significant effect of distance between urban green space and home with emotional symptoms in children ages 9-11
McCracken *et al.*	2016	Accessibility Exposure	Emotional Well-being	NS: No significant effect of green space use and emotional well-being subscale scores in children ages 8-11 NS: No significant effect of quantity of residential green space and emotional well-being subscale scores in children ages 8-11
Opper *et al.*	2014	Engagement	Emotional Well-being	PR: Following the 23 day OAEP there was a significant effect on mood in grade ten males PR: 3 months following the 23 day OAEP there was a significant effect on mood in grade ten males

Roe & Aspinall	2011	Engagement	Emotional Well-being	PR: There was a significant effect in all four emotional variables, with a greater change in the forest school setting, especially for the poor behaviour group, in children age 11
Soderstrom *et al.*	2013	Accessibility Exposure	Emotional Well-being	PR: Exposure to high-quality outdoor environment associated with better well-being in preschool children (ages 3.0-5.9yrs)
van den Berg & van den Berg	2011	Engagement	Emotional Well-being	NS: No significant effect of natural wooded setting on mood in children with ADHD ages 9-17
Ward *et al.*	2016	Exposure	Emotional Well-being	PR: Time spent in green space was positively associated with all measures of emotional wellbeing in children ages 11-14; even when controlled for moderate-to-vigorous physical activity
ADD/ADHD Findings: 13 PR 6 NS				
Amoly *et al.*	2014	Accessibility Exposure	Hyperactivity Inattention	NS: No significant effect of green space playing time on ADHD and hyperactivity/inattention in children ages 7-10 PR: Higher residential surrounding greenness at the 100m buffer was associated with lower ADHD and inattention symptom scores in children ages 7-10 PR: Higher residential surrounding greenness at all buffers was associated with lower hyperactivity/inattention scores in children ages 7-10 NS: No significant effect of residential proximity to major green space on ADHD and hyperactivity/inattention in children ages 7-10 NS: No significant effect of residential proximity to blue spaces on ADHD symptom scores in children ages 7-10 NS: No significant effect of time spent in blue spaces on ADHD symptom scores in children ages 7-10
Balseviciene *et al.*	2014	Accessibility	Hyperactivity	PR: Increase in distance to city parks was associated with increased hyperactivity in children ages 4-6, lower maternal education group NS: No significant effect between residential greenness and hyperactivity in children ages 4-6, higher maternal education group

Flouri *et al.*	2014	Accessibility Exposure	Hyperactivity Inattention	PR: Access to gardens was related to fewer hyperactivity problems in children at ages 3, 5, and 7 PR: Use of parks and playgrounds was related to fewer hyperactivity problems in children at ages 3, 5, and 7
Greenwood & Gatersleben	2016	Exposure	Attention	PR: Attention scores were reduced significantly more after the 20 minutes spent in the outdoor environment than in the indoor environment in children ages 16-18
Kuo & Taylor	2004	Exposure	ADHD	PR: Green outdoor activities after school and on weekends were significantly more helpful in reducing symptoms than built outdoor or indoor activities for children ages 5-18. This held for children with and without hyperactivity as well as when activity type was controlled for
Markevych *et al.*	2014	Accessibility	Hyperactivity Inattention	PR: The further the distance to the nearest green space from home was associated with a higher risk of hyperactivity and inattention problems in males ages 9-11
Taylor & Kuo	2009	Exposure	ADHD	PR: The park setting saw a significant positive effect on concentration compared to the other two settings in children ages 7-12
Taylor & Kuo	2011	Exposure	ADD/ADHD	PR: Play in both outdoor green settings was associated with less severe ADD symptoms compared to the indoor or built outdoor settings, in children ages 5-18 PR: One of the outdoor green settings, open grass, had the most significant effect on ADHD symptom severity in children ages 5-18
Taylor *et al.*	2001	Accessibility Exposure	ADD/ADHD	PR: Participation in activities in green outdoor settings were associated with better functioning in children ages 7-12 PR: The more green the play setting the less severe the attention deficit symptoms in children ages 7-12

van den Berg & van den Berg	2011	Engagement	ADHD	NS: No significant effect of natural wooded setting on concentration in children ages 9-17
Mental Health Findings: 11 PR 6 NS 1 NR				
Amoly *et al.*	2014	Accessibility Exposure	Mental Health	PR: Statistically significant decrease in total SDQ scores and green space playing time in children ages 7-10 PR: Statistically significant decrease in total SDQ scores and residential surrounding greenness at all buffers in children ages 7-10 PR: Statistically significant decrease in total SDQ scores and annual beach attendance in children ages 7-10
Balseviciene *et al*.	2014	Accessibility	Mental Health	PR: Living further from city parks was associated with worse mental health in children ages 4-6, whose mothers had a lower education NR: More residential greenness was associated with worse mental health in children ages 4-6, whose mothers had a higher education
Bowen & Neill	2016	Engagement	Mental Health	PR: Significant improvement in one measure of mental health (psychological well-being) at the 6-12 month follow up after 15 programming days during a 10-12 week outdoor adventure intervention program in children ages 13-16 NS: No significant effect on overall mental health or psychological distress at the 6-12 month follow up after 15 programming days during a 10-12 week outdoor adventure intervention program in children ages 13-16 NS: No significant effect on all measures of mental health after 15 programming days during a 10-12 week outdoor adventure intervention program in children ages 13-16
Bowen *et al.*	2016	Engagement	Mental Health	NS: No significant effect from pre-post 10 week WAT on suicidality in children ages 12-18 PR: After the 10-week WAT there was a statistically significant reduction at 3 month follow up in suicidality in children ages 12-18

Clark *et al.*	2004	Engagement	Mental Health	PR: Significant effect on clinical syndromes scales after the 21 day WTP in children ages 13-18
Harper *et al.*	2007	Engagement	Mental Health	NS: No significant effect 2 months following the 21 day WT on other components of mental health in children ages 13-18 PR: 12 months following the 21 day WT there was a significant improvement on suicidal thoughts/ideation in children ages 13-18
Mutz & Muller	2016	Engagement	Mental Health	PR: Significant increase in mindfulness from T1 to T2 after a 9 day hike in children age 14 PR: Significant increase in mean life satisfaction from T1 to T2 after a 9 day hike in children age 14 NS: No significant effect from the 9 day hike on happiness in children age 14
Ritchie *et al.*	2014	Engagement	Mental Health	NS: No significant effect on mental health scores from pre to post intervention to 1 year follow up of the 10 week OAP in children ages 12-18
van Lier *et al.*	2017	Engagement	Mental Health	PR: Participating in gardening at home was significantly associated with better mental well-being in children ages 12-18
Self-esteem Findings: 3 PR 10 NS				
Barton *et al.*	2015	Engagement	Self-esteem	NS: No significant effect from a nature based playtime intervention on self-esteem in children ages 8-9
Bowen *et al.*	2016	Engagement	Self-esteem	PR: After the 10-week WAT there was a statistically significant improvement from pre to post in 1/4 subscales of self-esteem (social) in children ages 12-18 PR: After the 10-week WAT there was a statistically significant improvement at the 3 month follow up in 1/4 subscales of self-esteem (general) in children ages 12-18 NS: No significant effect after the 10 week WAT on self-esteem overall in children ages 12-18

Cammack *et al.*	2002	Engagement	Self-esteem	NS: No significant effect of the 16 week program (64 hours) on self-esteem in children potentially ages 12-18
Hinds	2011	Engagement	Self-esteem	NS: No significant effect of the two to five night WEP on self-esteem in children ages 12-15
McCracken *et al.*	2016	Accessibility Exposure	Self-esteem	PR: Increased green space use was positively associated with the self-esteem subscale scores in children ages 8-11 NS: No significant effect of quantity of residential green space and self-esteem subscale scores in children ages 8-11
Reed *et al.*	2013	Exposure	Self-esteem	NS: No significant effect of the green setting on self-esteem in children 11-12
Ritchie *et al.*	2014	Engagement	Self-esteem	NS: No significant effect on self-esteem scores from pre to post intervention to 1 year follow up of the 10 week OAP in children ages 12-18
Romi & Kohan	2004	Engagement	Self-esteem	NS: No significant effect from the WTP on self esteem in children ages 15-18 NS: No significant difference was found between the groups before and after the WTP in children ages 15-18
Wood *et al.*	2014	Exposure	Self-esteem	NS: No significant effect for the change in self-esteem due to the environment, both natural and built in children ages 8-9
Stress Findings: 5 PR 2 NS				
Feda *et al.*	2015	Accessibility	Stress	PR: Percentage of park area within a 800m buffer of home predicted perceived stress among children ages 12-15, when controlled for SES and physical activity

Mutz & Muller	2016	Engagement	Stress	NS: No significant effect from the 9 day hike on the stress subscale of worries in children ages 14 PR: There was a significant decrease in the stress subscale of demand from T1 to T2 after a 9 day hike in children age 14
Opper *et al.*	2014	Engagement	Stress	PR: Following the 23 day OAEP there was a significant effect on stress in grade ten males NS: 3 months following the 23 day OAEP there was no significant effect on stress in grade ten males
Wells & Evans	2003	Accessibility	Stress	PR: More nature near the home was associated with significantly less psychological distress in children grades 3-5 PR: Nearby nature was found to buffer the effects of stressful life events on children's psychological distress in children grades 3-5
Depression Findings: 2 PR 4 NS				
Bowen *et al.*	2016	Engagement	Depression	PR: After the 10-week WAT there was a statistically significant improvement from pre to post in clinically depressed children ages 12-18 NS: No significant effect at the 3 month follow up from the 10 week WAT on clinically depressed children ages 12-18 NS: No significant effect from pre to post from the 10 week WAT on non-clinically depressed children ages 12-18 NS: No significant effect at the 3 month follow up from the 10 week WAT on non-clinically depressed children ages 12-18
Gubbels *et al.*	2016	Exposure	Depression	NS: No significant effect of changes of perceived greenery on depressive symptoms on children ages 12-15
van Lier *et al.*	2017	Engagement	Depression	PR: Participating in gardening at home was significantly associated with lower levels of depressive symptoms in children ages 12-18

Resilience Findings: 3 PR 2 NS				
Bowen *et al.*	2016	Engagement	Resilience	PR: After the 10-week WAT there was a statistically significant improvement from pre-post in resilience in children ages 12-18
Ritchie *et al.*	2014	Engagement	Resilience	PR: At the 1 month follow up there was a significant increase in resilience scores after the 10 day OAP in children ages 12-18 NS: At the 1 year follow up resilience scores returned to pre intervention levels in children ages 12-18
Whittington *et al.*	2016	Engagement	Resilience	PR: Pre to post participation in the OAP was associated with a significant increase in resiliency and decrease in emotional reactivity in girls ages 10-15 NS: 1 month following participation in the OAP was not associated with significant improvements in resilience in girls ages 10-15
HRQOL Findings: 4 PR 1 NS				
Kim *et al.*	2016	Accessibility	HRQOL	PR: Greater accessibility to parks and open spaces around the home (400m & 800m) was associated with the likelihood of having a higher HRQOL in children ages 9-11 PR: Larger and more tree areas in the neighbourhood was associated with the likelihood of having a higher HRQOL in children ages 9-11 PR: Further distance between tree patches was associated with a higher HRQOL in children ages 9-11
McCracken *et al.*	2016	Accessibility Exposure	HRQOL	PR: More time spent in green space was associated with a better HRQOL in children ages 8-11 NS: No significant effect of quantity of residential green space and HRQOL in children ages 8-11

Table 2-3 Findings by outcome and type of nature interaction

Outcome	Accessibility			Exposure		Engagement		Total		
	+ve	NS	-ve	+ve	NS	+ve	NS	+ve	NS	-ve
Emotional Well-being	2	7	-	5	4	4	3	11	14	-
ADD/ADHD	6	3	-	7	2	-	1	13	6	-
Self-esteem	-	1	-	1	2	2	7	3	10	-
Mental Health	2	-	1	2	-	7	6	11	6	1
Stress	3	-	-	-	-	2	2	5	2	-
Depression	-	-	-	-	1	2	3	2	4	-
Resilience	-	-	-	-	-	3	2	3	2	-
HRQOL	3	1	-	1	-	-	-	4	1	-
Total	**16**	**12**	**1**	**16**	**9**	**20**	**24**	**52**	**45**	**1**

2.3.1 Emotional well-being

Fifteen papers included emotional well-being as a dependent variable. Emotional well-being was captured through variables such as emotional health, emotional symptoms, emotional intelligence, mood, and emotional problems. Within the fifteen papers, eleven findings demonstrated a significant positive relationship between nature and emotional well-being (44%), whereas fourteen findings were deemed non-significant (56%).

2.3.2 Attention deficit disorder/Hyperactivity disorder (ADD/ADHD)

Ten papers assessed nature interactions and ADD, ADHD, or symptoms related to these two disorders (hyperactivity, inattention, and attention). Within the ten papers, there was a total of nineteen findings, with thirteen exhibiting statistically significant positive results. Increased accessibility to nature (6/9 significant positive findings) and increased exposure (7/9 significant positive findings) to nature was associated with improvements in ADD/ADHD symptoms.

2.3.3 Mental health

Nine papers looked at an overall measure of mental health in children. Six of the papers focused on how engagement with nature, through wilderness and adventure programming, can affect mental health in teenage children. Mental health was assessed through a number of measures, for example psychological well-being, psychological distress, or overall mental health. Eleven out of eighteen findings (61.1%) within the nine papers identified a significant positive relationship with nature. One study found a negative association between residential surrounding greenness and overall mental health (Balseviciene et al., 2014).

2.3.4 Self-esteem

Compared to other outcomes, self-esteem exhibited the most non-significant findings compared to significant positive findings. Nine papers measured the relationship between self-esteem and nature, with most focusing on nature through engagement. Ten out of thirteen (76.9%) findings supported a non-significant relationship.

2.3.5 Stress

Accessibility and engagement to nature were both measured in relationship to stress in four papers. Five out of seven (71.4%) findings found interacting with nature to be significantly positively associated with reduced stress.

2.3.6 Depression

The majority of findings in the three papers focusing on depression were non-significant, with four of six (66.7%) findings showing no significant relationship with nature. All three studies measured depressive symptoms through various scales.

2.3.7 Resilience

All three studies measuring resilience used a form of outdoor programming, or engagement, to assess the relationship to nature. Resilience was subdivided into measures of sense of mastery, relatedness, and emotional reactivity. It was found that adventure programs resulted in an increase in mastery (improved self-efficacy and coping skills);

and relatedness (more comfortable interacting with others) and decrease in emotional reactivity (ability to manage emotions when upset) (Whittington, Aspelmeier, & Budbill, 2016). Three out of five (60%) findings were found to show significant positive associations between resilience and nature.

2.3.8 Health-related quality of life (HRQOL)

Two papers used HRQOL as a measure of mental health. Of the five findings taken from these papers, four showed a significant positive association with nature (80%). HRQOL takes into account factors influencing mental health including physical, emotional, social, school, family, friends, and self-esteem functioning.

2.3.9 Accessibility, exposure, engagement

Engagement was the most commonly used interaction to measure the relationship between children's mental health and nature (15 papers); however, there were fewer positive significant findings than non-significant findings for this type of nature interaction (20-24). Fourteen papers measured nature through exposure, and eleven through accessibility. The largest gap in the ratio between positive significant and non-significant findings was for exposure to nature (16-9), with accessibility falling between engagement and exposure (16-13).

2.4 Discussion

As supported by many theories detailing the importance of the effect of nature on human health, there has been decades of research investigating this relationship (Kaplan & Kaplan, 1989; Kaplan, 1995; Ulrich, 1979, 1983). The 35 papers included in this review represent the state of research from 1990-2017. It has been suggested that the lack of research done in the 1990's investigating nature and children's mental health is due to the focus on the relationship to physical health (Pellegrini, 1992; Taylor, Wiley, Kuo, & Sullivan, 1998). While previous systematic reviews have found inconclusive evidence for the relationship between children's mental health and nature (Gascon et al., 2015), this review showed significant positive findings for all outcomes. However, ADD/ADHD, mental health, stress, resilience, and HRQOL were the only outcomes that demonstrated

more positive significant findings over non-significant findings. Several outcomes had a greater number of non-significant findings than positive significant findings (emotional well-being, self-esteem, depression), further supporting the inconclusive state of the evidence reported in other systematic reviews. Clearly additional research is needed with more rigorous study designs to confirm whether a significant positive relationship does in fact exist between nature and several mental health outcomes.

Framing the types of nature interactions in terms of accessibility, exposure, and engagement had an impact on the distribution of the significant positive findings. The larger gap in the ratio between positive significant and non-significant findings for exposure to nature moves the weight of the evidence to support this type of interaction as potentially the most beneficial, supporting its use in future research. Accessibility however, saw a smaller gap between positive significant and non-significant findings, potentially due to the fact that accessibility to a particular environment does not equate to use of that environment (Bell, Phoenix, Lovell, & Wheeler, 2014). The fact that more of the findings under engagement were non-significant than positive significant implies there is an inconclusive association between nature engagement and children's mental health; however, it is important to note that the majority of these studies focus on less healthy or more "at risk" populations participating in wilderness therapy or outdoor adventure programs. Further investigation needs to be made as to how those programs may benefit general *healthy* populations.

Studies of emotional well-being, although the most studied outcome, also exhibited more non-significant findings than significant positive findings (14-11). This calls for further investigation into the relationship as it is an important factor in determining overall mental health. The overall results for ADD and ADHD clearly demonstrate the benefits of interacting with nature in decreasing symptoms in children. This has important implications for educators trying to implement strategies dedicated to helping children focus in the classroom. The holistic measure of mental health was also most commonly assessed through engagement, finding an overall significant positive relationship. This positive association discovered may be due to the variation in tools used to assess mental health in each study. A more universal measure of mental health applied to accessibility,

exposure, and engagement with nature could assist in defining this relationship more clearly. The one negative significant finding was explained to be due to a number of limitations in the studies measures and population, however, it is still important to acknowledge this negative association. Self-esteem had a very large gap between positive significant and non-significant findings (3-10), the majority falling under engagement, again suggesting further research should investigate other types of interactions effects on this outcome of mental health. Stress, measured in relation to nature accessibility and engagement, also found an overall positive association. Although small, the number of findings support the beneficial outcomes nature can provide to stress in children. Finally, for those outcomes with few findings (depression, resilience, and HRQOL) it is difficult to interpret a relationship one way or the other. Therefore, more research needs to be conducted to build upon potential findings discovered here. All of the findings here suggest that more universal tools should be used to measure both outcomes of mental health as well as nature interactions, in order to more confidently conclude a relationship between children's mental health and nature.

This systematic review supports the application of these findings in various forms of policy, including official plans, public health, and school board policy. The findings presented can support policy makers in designing future plans as well as strengthening current policies that take into consideration the importance of natural environments. Furthermore, school boards can utilize these findings to prioritize school outdoor spaces as not only beneficial to the students' but to the community on a whole. By prioritizing investments of natural spaces at all levels of government as well as within school districts children have a better chance of receiving the benefits of interacting with nature.

2.4.1 Strengths and limitations

Following the protocol set out by Petticrew and Roberts (2006) this systematic review was comprehensive, searching ten databases resulting in 227,153 titles screened. Having multiple researchers assessing abstracts and participating in data extraction, strengthened the rigour used in selecting the appropriate studies. The review focused on children in general rather than a special subgroup of children, thus allowing the findings to be more applicable to a wider population. Finally, conceptualizing interactions with nature in

terms of accessibility, exposure, and engagement, was a significant advancement over previous reviews, and provides a deeper understanding as to what type, dose, and duration of nature is required to influence change in children's mental health. Chapter 3 of this thesis will position children's HRQOL as a tool to assess mental health in relationship to nature through accessibility.

Papers based on qualitative methods were not included in the current review due to the difficulties of comparing findings among studies. Despite the logic behind excluding qualitative studies, their inclusion may have provided for a more fulsome understanding of the benefits of nature for children's mental health. Chapter 4 of this thesis will demonstrate how qualitative methods can be used to understand nature's relationship with children and their mental health. We were also unable to complete a meta-analysis with the 35 studies collected due to the heterogeneity of the measures used in each study. The majority of the studies had fairly small sample sizes and were from North America or well-developed countries which can also limit the generalizability of the findings. A variety of studies rely on the perceptions of parents or guardians of the age group being analyzed, therefore, cannot necessarily be found as accounts of a child's perspective on their own mental health.

2.4.2 Future research

There is a call for more longitudinal studies in order to assess the long term affects interactions with nature have on mental health, as outcomes assessing mental health are not quantitative measures that can be assessed for change over a short period of time. Longitudinal studies would allow the assessment of the effects that different doses of nature have and how long-term these effects can be. The majority of the findings presented here illustrate that nature has some benefit to children's mental health. However, some of the contradictory findings highlight the need for greater attention on how nature's effects on children can differ between populations (i.e., children, toddlers, adolescents, etc.). Furthermore, very few studies assessed childhood depression and no studies assessed anxiety, which have more recently come to the forefront of public health issues. Therefore, more research on nature's connection to these illnesses is strongly encouraged. The majority of the studies using engagement as a measure of nature

interaction target more vulnerable or at risk populations which limits the generalizability of these study results. Studies who sample from a larger, *healthy* population could allow for more generalizable findings to inform change in policy and practice. The tools and measurements used for both nature and mental health need to become more objective and rigorous. Assessing the quality of the interaction types would create a more robust association between nature and a positive outcome on mental health. More rigorous measures would allow a more causal relationship to be defined, in order to understand what it is about nature that creates the benefit to children's mental health.

2.5 Conclusion

The primary purpose of this review was to compile the existing evidence assessing the effects that interaction with nature can have on children's mental health. The results from the studies demonstrate that there is an association between children's mental health and nature. The findings, although somewhat inconsistent or non-significant, demonstrate the need for more in depth and rigorous research. Creating a more standardized measure for operationalizing nature is necessary to make these findings generalizable. Understanding why there are differences in the findings is critical to establishing evidence-based recommendations for policy makers and planners in designing neighbourhoods and cities. This review identified the importance in promoting nature and children to support their mental health.

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Chapter 3

3 Exploring the influence of individual-level and environmental factors on health-related quality of life in elementary school children

3.1 Introduction

As seen in Chapter 2, a growing body of research has been conducted over the last decade, which assesses the relationship between nature and the physical, mental, social, and cognitive development of children. This research is vital for the development of strategies to improve the overall health and well-being of children. This chapter examines how accessibility to nature around home affects children's health-related quality of life (HRQOL), while accounting for factors at the intrapersonal, interpersonal, and physical environment levels.

HRQOL is a common measure used to assess distinct aspects of quality of life, including a child's physical, emotional, social, and school functioning (Mansour et al., 2003; Reinfjell et al., 2008); HRQOL measures provide a greater level of detail than general quality of life (Leplege & Hunt, 1997; Moons, Budts, & De Geest, 2006). These measurements of HRQOL are subjective and multidimensional as they represent the personal perception of a participant and includes a broad range of health and life outcomes (Matza et al., 2004). The multidimensional aspect of this measurement helps to explain more than one aspect of children's health, as a large majority of research measuring nature's effects on children focuses directly on one measure of health, such as physical activity (Sanders, Feng, Fahey, Lonsdale, & Astell-Burt, 2015; Wheeler et al., 2010). HRQOL tools therefore help to fill a gap in the current literature.

A tool gaining popularity in children's health research is the Pediatric Quality of Life Measurement Model, a modular approach to measuring the HRQOL in both healthy and ill child/adolescent populations (http://www.pedsql.org/). Many studies using the PedsQL are focused on solely assessing the HRQOL of children with chronic or acute physical illnesses in relation to healthy populations or other chronically ill children. However, there is growing interest in research analyzing how various independent variables such as

children's environments influence healthy children's PedsQL scores. A limited number of studies have used HRQOL as a measure to assess mental health (Kim et al., 2016; McCracken et al., 2016); however, each of the sub-scales represent variables that are known to contribute to a child's mental health. A child's ability to easily and properly function physically, emotionally, socially, and in school can all be factors that influence mental health outcomes, such as self-esteem, anxiety, depression, ADD/ADHD, and resiliency. This tool allows the opportunity to easily assess various aspects of well-being that can contribute to the overall mental health of a child. Reinfjell et al. (2008) used the PedsQL tool to assess the associations between depressive symptoms and HRQOL in young adolescents. Their findings showed that the tool is "an adequate assessment instrument regarding depressive symptoms in young adolescents, and can be useful in both clinical practice and further research as an assessment measure regarding children's mental health" (Reinfjell et al., 2008).

Nature is commonly acknowledged as being beneficial to human health (Bell, Phoenix, Lovell, & Wheeler, 2014; Driessnack, 2009; Hartig, Mitchell, de Vries, & Frumkin, 2014; Keniger, Gaston, Irvine, & Fuller, 2013; Maller, Townsend, Pryor, Brown, & St Leger, 2005); however, the type, dose, and duration associated with nature's impact on health is difficult to define (Hartig et al., 2014). How nature is operationalized is a major factor in considering the effects of the potential benefits of nature interaction on children's health. As outlined in Chapter 2, we use the term accessibility to refer to whether or not specific element(s) of nature exists within a child's environment, usually within a pre-defined meaningful distance (e.g., walking distance from home), and is often quantified as a given amount or density of the natural element(s). The term exposure is used to refer to situations where there is a direct encounter or contact with nature, and is usually operationalized in terms of time spent in or near, or simply use of, a natural area. Engagement is a third general type of nature connection, which refers to the intentional interaction with a natural environment with the purpose of being in nature, such as wilderness therapy, gardening, or outdoor adventure camps. It is necessary to distinguish the types of nature interaction if we are to determine which can be the most influential in benefiting children's health. Although researchers may not define their natural

environment variables as accessibility, exposure, or engagement, it is clear from Chapter 2 how their measures of nature fall within these three categories.

Understanding the health disparities that exist between urban and rural environments is important in building and sustaining effective policy and programs for healthy lifestyles (Eberhardt & Pamuk, 2004). Some previous research has focused on urban children or urban spaces and HRQOL (Mansour et al., 2003; McCracken et al., 2016); however, there is little evidence on rural (Stöcklin et al., 2013) and suburban children's HRQOL. Researchers agree that level of urbanicity can modify health outcomes associated with green space exposure (Flouri, Midouhas, & Joshi, 2014). Studies measuring urban green space or rural green space have come to similar conclusions of a positive relationship with health; however, the majority of these studies do not compare urban and rural, and even fewer studies consider suburban environments. The lack of comparative studies of urban-suburban-rural environments is a problem because it is extremely difficult to compare results of separate studies set in different environments due to different study designs often being used in the separate studies. Understanding how environments influence health relationships is important in developing efficient, sustainable, and effective policy and protocols to service particular populations.

This study aims to fill gaps in the current literature by investigating HRQOL in children living in a full range of physical environments: urban, suburban, and rural. It also builds upon existing literature exploring the impact of accessibility to nature on children's health. This study has two key objectives: (1) to evaluate the effect of accessibility to natural environments on children's HRQOL as a measure of mental health; and (2) to analyze how this relationship differs for children living in urban, suburban, and rural environments.

3.2 Methods

This study draws from an ongoing six-year research project called the Spatial Temporal Environment Activity Monitoring (STEAM) Project, which examines the effects of the physical environment on health-related behaviours of children ages 8 to 14 years (further details can be found in Chapter 1, and at www.steamproject.ca). The study involves two

data collection periods (eight days each) in two seasons. The present study focused on all sessions from each study location in both Southwestern Ontario (2010-2013) and Northwestern Ontario (2016). This study was approved by the Non-Medical Research Ethics Board of the University of Western Ontario (STEAM South NM-REB #:17918S; STEAM North NM-REB #:108029). All children in grades four through eight in participating schools were eligible provided they obtained signed parental consent and gave child assent.

During each eight-day collection cycle, children were asked to wear a GPS and an Actical accelerometer during all waking hours, while also completing a series of surveys and a daily activity diary. Youth surveys included demographic information for individual participants, as well as environmental perceptions and behaviours. Surveys also included the PedsQL to assess children's HRQOL. Parent surveys also provided demographic information about participants and parents themselves. The PedsQL focuses on understanding individual children's perceptions of their overall health, rather than evaluations made by clinicians or biomedical parameters (Sawyer et al., 2002). All six indices that can be calculated using the tool for children ages 8-12 years exceeded the recommended minimum alpha coefficient standard of 0.70 for group comparisons (Varni et al., 2003). The demographic surveys, PedsQL tool, and GPS tracks were used in combination to assess how accessibility to nature effects children's HRQOL.

3.2.1 Sample

The sample for this study comes from the first season of each round of the STEAM Project that included the PedsQL questionnaire (n=926). Participant data was not eligible for analysis if the PedsQL was missing more than 50% of the items within each scale or if a home location was unable to be determined from each child's GPS tracks. The final sample includes 851 children. Schools in the study were distributed across urban, suburban, and rural environments, while four were from Northwestern Ontario and 30 from Southwestern Ontario. Descriptive statistics about the sample can be found in Table 3.1.

3.2.2 Measures

3.2.2.1 Dependent Variable

The dependent variables for this analysis include HRQOL and its associated domains of children's health as measured by the PedsQL 4.0: (a) Total HRQOL; (b) Psychosocial Health; (c) Physical Functioning; (d) Emotional Functioning; (e) Social Functioning; and (f) School Functioning (Varni et al., 2003, 2005; Varni, Limbers, & Burwinkle, 2007; Varni et al., 2001). The child self-report measures HRQOL in children ages 8-12. It can be broken down into four domains of HRQOL: Physical Functioning (8 items), Emotional Functioning (5 items), Social Functioning (5 items), and School Functioning (5 items). Each domain asks how much of a problem each item has been in the last month: never, almost never, sometimes, often, or almost always. Each item is reversed scored to transform the raw score (0-4) to a value out of 100: Never (0, 100), Almost Never (1, 75), Sometimes (2, 50), Often (3, 25), Almost Always (4, 0). Three scale scores can be generated by this questionnaire: total scale score (all four domains), physical health summary score (physical functioning), and the psychosocial health summary score (emotional, social, and school functioning).

3.2.2.2 Independent Variables

Using the social ecological model of health, this study identifies three groups of independent variables: intrapersonal, interpersonal and physical environment.

Intrapersonal variables are collected from the youth surveys. The models described in this study are measured for each individual child, and include:

- ***Gender***: Child self identifies as a *girl* (0) or *boy* (1). Children were also given the option to self identify as *other* but no child chose this option.
- ***Age:*** Child provides age in years, ranging from eight to fourteen; and
- ***Visible Minority***: Child self identifies as *white* (0) or *visible minority* (1). Visible minority status was derived from ethnicity categories, which included: South Asian, East Asian, Middle Eastern, Latin American, North American Indian or Metis or Inuit, Black/African/Caribbean, and Mixed.

Interpersonal variables are collected from youth and parent surveys. The models described in this study are measured for each individual child and include:

- ***Lone parent household***: child or parent survey identifies whether they live in a *two* (0) or *one* (1) parent household. This survey question also included living with one or two grandparents.
- ***Live in more than one home***: child or parent survey identifies whether they live in *one* (0) or *more than one* (1) household. Living in more than one household included splitting time equally between two homes, living in one household but regularly visits/lives in a second household, or has another household arrangement.
- ***Siblings***: child identifies the number of children living in their house including themselves, where one child represents *no siblings* (0) and any value greater than one represents the presence of *siblings* (1).
- ***Post-secondary education***: parent identifies having *no post-secondary education completed* (0) or *some post-secondary education completed* (1). Completing any education past high school was considered to be some post-secondary education.
- ***Employment status***: parent is *not employed* (0) or *employed* (1). Being employed included: employed full-time, employed part-time, seasonal employment, or self-employed. Being not employed included: at home with children, unemployed, student, disability, or on sick leave; and
- ***Household income***: parent identifies a range of household income where *low* (1) represents all values under $70,000, *medium* (2) represents $70,000-$119,999, and *high* (3) represents $120,000+.

Physical environment is measured in two ways: (1) Based on accessibility around a child's home; and (2) Based on home location, and include:

Physical environment measures based on accessibility around a child's home were calculated in ArcGIS v10.4 (ESRI, 2017). Accessibility to nature was defined using Euclidean buffers at 500m generated using GIS. Many studies using buffers to assess physical activity in an individual's environment discuss how appropriate buffer sizes largely depend on the environmental context, behaviour of interest and the group being

studied (Browning & Lee, 2017; Brownson, Hoehner, Day, Forsyth, & Sallis, 2009). The buffer size chosen for this study was based on those used in previous studies exploring children's neighbourhood environments (Gilliland et al., 2012; Kerr et al., 2006; Larsen et al., 2009). Euclidean buffers were used instead of network buffers as the natural environment is the main independent variable of interest. Network buffers often eliminate green space due to the nature of their design in that they are shaped by the configuration of the street network, which is less relevant to the way children move through nature (Bell, Wilson, & Liu, 2008). Within each of these buffers natural environment variables were attached using functions in ArcGIS.

Using land use data for park and water variables from DMTI Spatial Inc., park layers from the City of London, Middlesex County, and Chatham-Kent County, and water layers from Natural Resources Canada CanVec, we measured the ratio of parks and water to total area of each 500m buffer for each child. The two variables that were developed include: *Park* and *Water*, where each measure is defined as the percentage of each feature within the buffer area.

Normalized Difference Vegetation Index (NDVI) is commonly used as a means of measuring greenness for spatial epidemiologic purposes (Rhew, Stoep, Kearney, Smith, & Dunbar, 2011). NDVI works on the basis that chlorophyll strongly absorbs red light and reflects Near Infrared Light (NIL). For this study all images were extracted from dates according to the corresponding study period, Landsat 8 images (USGS Earth Explore, 2016), for 2012-16 participants and Landsat TM images (2011) was used for 2011 participants. Our final measures using NDVI include: *grass and shrubbery* (NDVI values of 0.2-0.6), and *dense vegetation* (NDVI values >/= 0.6) (USGS, 2015). NDVI variables were calculated from 30m resolution images, where each value within the buffer was aggregated to calculate the percentage of area within a buffer that each of the two NDVI categories covered.

Physical environment measures based on home location include level of urbanicity and region of Ontario.

- ***Level of urbanicity***: This category was divided into three levels of urbanicity: *urban* (1), *suburban* (2), and *rural* (3). Urban is defined as cities with a population greater than 100,000 and for the purpose of this study the London city boundaries in 1959. This area is based on the urban morphology of the neighbourhoods, where there is more mixed land use, larger population densities, and more grid-like street networks. Suburban is defined as the remaining area within the city of London, annexed between 1960 and 1992, classified by more isolated residential zoning, lower population densities, and less permeable street networks. Rural included all urban small towns (population greater than 10,000); rural small towns (population greater than 1000); and rural areas (remaining home locations). Urban and suburban populations were combined as one level of analysis, as the urban population was too small to be used on its own. Furthermore, the urban and suburban areas of London are similar enough that differences in the physical environment between the two would be minimal; and
- ***Region of Ontario***: was simply based on the study region where each participant came from. It is hypothesized that social differences that exist between the two regions have potential to predict HRQOL outcomes. These outcomes were categorized as *South* (0) and *North* (1). This variable was only included in the rural population analysis.

3.2.3 Statistical Analysis

Statistical analysis was performed with IBM SPSS Statistics 24 and STATA SE 13 64 bit (IBM Corp, 2016; Stata Corp, 2013). Linear regression models were used to analyze the relationship between all HRQOL scores and intrapersonal, interpersonal, and physical environment variables. The level of significance used for analysis was $p<0.1$. This level of significance was chosen due to the exploratory nature of the current study. The level of significance should be chosen based on the entire context of the study; including scientific contexts, aims, and limitations. Furthermore, there is no clear distinction between significant and non-significant results, the evidence only becomes stronger as the *p*-value becomes smaller (Dahiru, 2008).

3.3 Results

3.3.1 Descriptive Statistics

Descriptive statistics about the sample can be found in Table 3.1. The majority of participants are between ages 11 and 12 (70.7%). Of the participants, 55.5% are girls and 44.5% are boys. The majority came from a two-parent household (69.3%) and identified as white (69%). Only 15.9% of the sample lived in more than one home, where 30.6% of participants lived in a lone parent household. Mothers having some post-secondary education and employment are identical values at 61.6%. Whereas, 67.9% of fathers are employed, and only 52.3% had some post-secondary education.

The average percentage of park space within the 500m buffer around participant's homes is 7.4% (urban/suburban: 11.4%, rural: 2.5%), whereas water space is only 1.5% (urban/suburban: 1.0%, rural: 2.0%). The percentage of grass and shrubbery within the 500m buffer of home is higher than the dense vegetation index, 56.2% versus 38.4% (urban/suburban: 67.8% versus 42.1%, rural: 26.2% versus 53.3%). The majority of participants lived in suburban (45.6%) or rural areas (45.1%) and in Southwestern Ontario (84.8%).

HRQOL scores show the mean value for each index. Models are not stratified by gender due to observing a lack of significant differences between genders within all six individual HRQOL scores.

Table 3-1 Descriptive statistics of sample

	All participants		Urban/Suburban		Rural	
	N	Mean (SD) or % of *N*	*N*	Mean (SD) or % of *N*	*N*	Mean (SD) or % of *N*
Intrapersonal						
Boys	379	44.5	195	41.8	184	47.9
Girls	472	55.5	272	58.2	200	52.1
Age	851	11.1 (0.984)	467	11.3 (0.904)	11.0	(1.0)
8	6	0.7	-	-	6	1.6
9	37	4.3	10	2.1	27	7.0
10	148	17.4	76	16.3	72	18.8
11	367	43.1	205	43.9	162	42.2
12	236	27.7	138	29.6	98	25.5
13	54	6.3	37	7.9	17	4.4
14	3	0.4	1	0.2	2	0.5
Visible Minority	234	27.5	154	33.0	80	20.8
Interpersonal						
Lone Parent Household	260	30.6	112	24.0	148	38.5
Live in more than 1 home	135	15.9	69	14.8	66	17.2
No siblings	117	13.7	67	14.3	50	13.0
Mother Post Secondary	524	61.6	271	58.0	253	65.9
Father Post Secondary	445	52.3	248	53.1	197	51.3
Mother Employed	524	61.6	243	52.0	281	73.2
Father Employed	578	67.9	284	60.8	294	76.6
Household Income	480	-	245	-	235	-
Low: <$70,000	159	18.7	86	18.4	73	19.0
Medium: 70,000 to $119,999	164	19.3	86	18.4	78	20.3
High: $120,000=/>	157	18.4	73	15.6	84	21.9
Physical Environment						
Park	851	7.4 (8.6)	467	11.4 (9.1)	384	2.5 (4.4)
Water	851	1.5 (5.3)	467	1.0 (2.6)	384	2.0 (7.4)
Grass & Shrubbery	851	56.2 (20.1)	467	67.8 (12.1)	384	42.1 (18.8)
Dense Vegetation	851	38.4 (21.7)	467	26.2 (12.3)	384	53.3 (21.3)
Urban	79	9.3	79	16.9	-	-
Suburban	388	45.6	388	83.1	-	-
Rural	384	45.1	-	-	384	100
Southwestern Ontario	722	84.8	467	100	255	66.4
Health-related Quality of Life						
Total Scale Score	850	79.7 (13.2)	466	80.1 (13.6)	384	79.2 (12.8)
Psychosocial Health (/100)	851	76.3 (15.1)	467	76.9 (15.5)	384	75.6 (14.5)
Physical Functioning (/100)	850	85.9 (13.9)	466	86.0 (13.9)	384	85.8 (13.9)
Emotional Functioning (/100)	847	73.0 (20.0)	464	73.0 (20.5)	383	73.0 (19.5)
Social Functioning (/100)	847	81.7 (17.7)	465	82.9 (17.2)	382	80.2 (18.3)
School Functioning (/100)	850	74.1 (16.9)	467	74.7 (15.5)	383	73.5 (16.0)

3.3.2 Model Specification

Step-wise linear regression is used to develop predictive models based on the socio-ecological model. Three levels of independent variables are used in the regression representing intrapersonal, interpersonal, and physical environmental factors. The model used urban and suburban populations in the first analysis and the rural population in the second. The results for only the 500m buffer are presented here as this buffer size explained the most variance, with the exact same variables showing significance at additional buffer sizes. The model fit (R^2) increases as each level of variables are added. The addition of interpersonal values to the model saw the greatest change in R^2, while there was an increase in explained variance at each step, however, some are greater than others.

3.3.3 Model Results

The results of the final models from the step-wise regression are shown here for each of the six dependent variables for both the urban/suburban and rural populations. Results from each of the models are displayed in Tables 3.2 and 3.3. Only variables that are found significant when $p<0.1$ are discussed here.

3.3.3.1 Urban/Suburban Population

The results show that no intrapersonal or interpersonal level variables are predictors for ***total scale scores***. The percentage of water and grass and shrubbery index of NDVI are both negatively statistically significant at the 99% and 95% confidence level, respectively. Percentage of park space is positively associated with total scale scores at the 95% confidence level. Results from ***psychosocial health*** show that living in one home is a positive predictor at the 90% confidence level. Percentage of park, water, and grass and shrubbery are all significant predictors at the 90%, 99%, and 95% confidence level, respectively. Parks are the only positive predictor. No intrapersonal or interpersonal variables are predictors in the model for ***physical functioning***. All four natural environment variables are significant predictors of physical functioning. Percentage of park space is the only positive predictor, at the 95% confidence level. The percentage of water, grass and shrubbery, and dense vegetation are all negatively associated with

physical functioning, at the 99% confidence level for water and grass and shrubbery, and at the 90% confidence level for dense vegetation. Gender is the only statistically significant intrapersonal predictor of ***emotional functioning***, where boys have significantly higher scores than girls, at the 90% confidence level. Percentage of park space is positively associated at the 90% confidence level, and water is negatively associated at the 99% confidence level. There are no intrapersonal variables that are significant predictors of ***social functioning***. The presence of siblings and fathers having some post-secondary education show positive associations with social function, at the 95% and 90% confidence level, respectively. Percentage of park, water, and grass and shrubbery are all significant predictors at the 95%, 99%, and 95% confidence level. Parks are the only positive predictor. Results from examining ***school functioning*** show that the interpersonal variables living in more than one home and medium household income, are significant predictors, at the 95% and 90% confidence level, respectively. Living in one home is positively associated with school functioning whereas medium household income is a negative predictor. The percentage of grass and shrubbery is negatively associated with school functioning, at the 99% confidence level. Level of urbanicity is only found to be a positive significant predictor for school functioning, at the 90% confidence level for suburban children.

3.3.3.2 Rural Population

The results of the models for the rural population of the sample overall demonstrate no significant association between physical environment variables and HRQOL scores. Results from the ***total scale score*** model show that age is a significant positive predictor, at the 90% confidence level. Two interpersonal level variables, father being employed and high household income, are both significant positive predictors of total scale scores at the 90% and 95% confidence level, respectively. ***Psychosocial health scores*** are positively predicted by age, medium and high household income, at the 95%, 90%, and 99% confidence level, respectively. Only interpersonal level variables are significant predictors of ***physical functioning,*** where living in a one parent household and one home are negative significant predictors at the 90% and 95% confidence level, respectively. Again only intrapersonal and interpersonal level variables are predictors for the next

index. Gender and medium household income are both significant positive predictors of ***emotional functioning***, at the 99% and 95% confidence level, respectively. Boys have significantly higher scores than girls. ***Social functioning*** scores saw all three levels of variables to be significant predictors. Age is a positive predictor at the 99% confidence level. Medium and high household income are both positive predictors at the 95% and 99% confidence level, respectively. Both measures of NDVI, grass and shrubbery and dense vegetation, are positive predictors, at the 95% confidence level. Results from examining ***school functioning*** scores demonstrate high household income to be a positive predictor, at the 95% confidence level. Dense vegetation is also a positive predictor of school functioning at the 90% confidence level.

Table 3-2 Results of full models assessing associations between intrapersonal, interpersonal, and physical environment factors and HRQOL indices at a 500m buffer in the urban/suburban population

Variable	***Full Model*** Total Scale Score		***Full Model*** Psychosocial Health		***Full Model*** Physical Functioning		***Full Model*** Emotional Functioning		***Full Model*** Social Functioning		***Full Model*** School Functioning	
	β	*p-value*	β	*p-value*	β	*p-value*	β	*p-value*	β	*p-value*	β	*p-value*
Intrapersonal												
Boy (ref: girl)	-0.583	0.649	-0.155	0.916	-1.562	0.236	3.430	**0.080*** **	-1.690	0.300	-2.039	0.220
Age (years)	0.109	0.878	-0.070	0.932	0.347	0.634	-0.165	0.880	-0.298	0.743	0.370	0.687
Visible Minority (ref: no)	0.483	0.736	1.684	0.306	-1.834	0.212	0.801	0.413	2.192	0.229	2.101	0.257
Interpersonal												
Lone Parent Household (ref: no)	0.642	0.713	1.085	0.589	-0.125	0.944	3.639	0.171	1.379	0.534	-1.861	0.412
Live in more than 1 home (ref: yes)	3.216	0.107	3.937	**0.087*** **	1.659	0.418	4.398	0.147	1.828	0.471	5.747	**0.027** **
Siblings (ref: no)	1.950	0.287	2.630	0.213	0.637	0.735	4.415	0.116	5.281	**0.025** **	-1.675	0.481
Mother Post-secondary (ref: no)	-1.710	0.402	-1.329	0.571	-2.065	0.325	-2.154	0.488	0.442	0.865	-2.404	0.363
Father Post-secondary (ref: no)	1.604	0.406	1.790	0.418	1.506	0.447	1.176	0.688	4.828	**0.050*** **	-1.021	0.682
Mother Employed (ref: no)	-1.409	0.440	-1.316	0.530	-1.498	0.424	-3.111	0.262	-0.142	0.951	-0.768	0.745
Father Employed (ref: no)	-0.833	0.771	-0.856	0.795	-1.032	0.726	-1.575	0.718	-3.802	0.297	3.188	0.391
Household Income (ref: low)												
Medium	-0.286	0.899	-1.321	0.609	1.948	0.400	-1.401	0.682	2.077	0.468	-5.018	**0.086*** **
High	0.854	0.739	0.068	0.982	2.526	0.337	-2.287	0.558	2.516	0.441	-0.429	0.897
Physical Environment												
Park	0.188	**0.039** **	0.196	**0.062*** **	0.186	**0.047** **	0.240	**0.084*** **	0.275	**0.018** **	0.063	0.593
Water	-1.136	**0.000***	-1.093	**0.001***	-1.216	**0.000***	-1.267	**0.005***	-1.431	**0.000***	-0.578	0.135
Grass & Shrubbery	-0.287	**0.012** **	-0.278	**0.033** **	-0.321	**0.006***	-0.110	0.521	-0.317	**0.028** **	-0.403	**0.006***
Dense Vegetation	-0.157	0.170	-0.130	0.325	-0.229	**0.052*** **	0.027	0.876	-0.213	0.144	-0.190	0.202
Urbanicity (ref: urban)	2.003	0.246	2.200	0.269	1.583	0.372	1.115	0.671	1.184	0.590	4.289	**0.056*** **
Constant	98.315	**0.000***	93.466	**0.000***	109.710	**0.000***	76.579	**0.000***	103.104	**0.000***	99.038	**0.000***
R^2	0.0855	**0.0268** **	0.0748	**0.0855*** **	0.0854	**0.0273** **	0.0720	0.1176	0.0829	**0.0372** **	0.0782	**0.0602*** **

p*<0.01* *p*<0.05** *p*<0.1**

Table 3-3 Results of full models assessing associations between intrapersonal, interpersonal, and physical environment factors and HRQOL indices at a 500m buffer in the rural population

Variable	***Full Model*** Total Scale Score		***Full Model*** Psychosocial Health		***Full Model*** Physical Functioning		***Full Model*** Emotional Functioning		***Full Model*** Social Functioning		***Full Model*** School Functioning	
	β	*p-value*	β	*p-value*	β	*p-value*	β	*p-value*	β	*p-value*	β	*p-value*
Intrapersonal												
Boy (ref: girl)	1.377	0.317	1.305	0.399	1.391	0.353	6.779	**0.001***	-.314	0.870	-2.499	0.145
Age (years)	1.287	**0.050*****	1.592	**0.031****	0.661	0.353	0.971	0.325	3.098	**0.001***	0.773	0.344
Visible Minority (ref: no)	0.232	0.900	0.297	0.887	0.199	0.921	-2.933	0.293	0.302	0.906	3.518	0.128
Interpersonal												
Lone Parent Household (ref: no)	-2.490	0.150	-1.874	0.335	-3.684	**0.051*****	-2.972	0.253	-1.198	0.618	-1.484	0.491
Live in more than 1 home (ref: yes)	-0.624	0.741	1.443	0.498	-4.488	**0.030****	1.807	0.525	3.171	0.228	-0.342	0.885
Siblings (ref: no)	-1.004	0.618	-1.592	0.482	0.090	0.967	-3.591	0.236	-1.651	0.555	0.501	0.842
Mother Post-secondary (ref: no)	0.219	0.907	1.156	0.583	-1.641	0.421	0.653	0.817	1.233	0.639	1.471	0.529
Father Post-secondary (ref: no)	-0.397	0.805	-1.042	0.565	0.752	0.667	-3.086	0.203	-1.009	0.652	0.941	0.639
Mother Employed (ref: no)	-0.221	0.920	0.294	0.906	-1.155	0.631	0.800	0.809	1.024	0.738	-0.351	0.899
Father Employed (ref: no)	4.671	**0.097*****	4.729	0.135	4.822	0.116	5.750	0.174	4.227	0.279	5.064	0.156
Household Income (ref: low)												
Medium	3.451	0.124	4.922	**0.052*****	0.723	0.767	6.781	**0.045****	6.909	**0.027****	1.213	0.665
High	5.873	**0.011****	7.252	**0.005***	3.247	0.195	4.872	0.161	11.114	**0.001***	5.968	**0.038****
Physical Environment												
Park	-0.003	0.984	0.012	0.948	-0.034	0.853	0.118	0.640	-0.206	0.377	0.083	0.695
Water	0.136	0.345	0.132	0.418	0.146	0.351	-0.011	0.961	0.292	0.145	0.127	0.480
Grass & Shrubbery	0.205	0.228	0.227	0.235	0.163	0.378	-0.108	0.674	0.413	**0.040****	0.325	0.126
Dense Vegetation	0.196	0.191	0.195	0.246	0.197	0.227	-0.127	0.573	0.486	**0.047****	0.318	**0.089*****
Region of Ontario (ref: south)	0.169	0.929	0.023	0.992	0.419	0.839	1.474	0.605	-1.850	0.482	0.497	0.833
Constant	39.927	**0.021****	28.837	0.137	61.079	**0.001***	64.051	**0.014****	-8.138	0.733	26.269	0.224
R^2	0.0666	0.3804	0.0761	0.2104	0.0599	0.5287	0.0859	0.1017	0.1177	**0.0044***	0.0761	0.2131

p*<0.01* *p*<0.05** *p*<0.1**

3.4 Discussion

This study examined whether factors at multiple levels of the socio-ecological model predict children's HRQOL. Intrapersonal, interpersonal, and physical environment variables are used to predict HRQOL. Park, water, and NDVI measures at a 500m buffer around the home also proved to demonstrate a significant relationship in predicting certain HRQOL scores. Differences exist between the urban/suburban and rural populations investigated in the current study. However, these predictors may not be seen as clinically meaningful. Varni and colleagues have designated a minimal clinically meaningful difference in scale scores for each indicator of HRQOL by calculating the standard error of measurement (SEM) (Varni et al., 2003). The SEM was calculated for each of the HRQOL indices of the current study by multiplying the standard deviation by the square root of 1-alpha of each index (Cronbach alpha reliability coefficient). These important differences will be used in discussing the findings of the current study.

Table 3-4 Minimal clinically important difference for HRQOL indices

HRQOL Indices	Minimal Clinically Important Difference
Total Scale Score	4.57
Psychosocial Health	5.29
Physical Functioning	3.89
Emotional Functioning	5.83
Social Functioning	5.46
School Functioning	4.79

3.4.1 Intrapersonal Variables

Intrapersonal variables were only significant predictors in the rural population, with the exception of emotional functioning in the urban/suburban analysis. For girls, emotional functioning is associated with lower scores, while also associated with higher social and school functioning scores. However, the relationship between gender and emotional functioning in the rural analysis is the only predictor to show clinically important differences. Age is only a significant predictor in the rural population but again did not show clinically meaningful differences. Studies of children in this age group have demonstrated that HRQOL decreases, not increases, with age (Wade & Vingilis, 1999),

which also questions the positive association found with age and total HRQOL, psychosocial health, and social functioning. Being a visible minority is not a significant predictor in either population. These findings support other studies assessing HRQOL where the relationship between intrapersonal variables and the dependent variable have varied (Kim et al., 2016; Mansour et al., 2003; McCracken et al., 2016; Reinfjell et al., 2008).

3.4.2 Interpersonal Variables

High or medium household income positively predicted five out of the six HRQOL indices in the rural population, all showing a clinically meaningful difference, demonstrating the effects household income can have on HRQOL. However, this pattern is not evident within the urban/suburban population. The finding that household income is a significant predictor of HRQOL only in the rural population demonstrates how certain factors can have a different effect on health outcomes in different environmental settings (i.e., different levels of urbanicity).

Two variables that can be considered predictors of socio-economic status are parents having post-secondary education and whether or not they are employed. Some results show negative effects on HRQOL indices when a mother has post-secondary education and is employed, while others show education as a negative predictor and employment as a positive in fathers. The mix of findings is consistent in both urban/suburban and rural analyses. Some research has shown that children whose mothers stay home have better long term educational outcomes (Bettinger, Haegeland, & Rege, 2014). Although there is not substantial research based evidence supporting better health outcomes for children who have stay at home mothers, a national survey of American parents shows 60% of parents believe children are better off when a parent stays at home (Taylor et al., 2014). Socio-economic measures such as parental employment, education, and household income, are important to include, because as described by Varni and colleagues, near-poor and poor children are approximately three times more likely to have an unmet health care need (Varni et al., 2003). Clinically meaningful differences of interpersonal variables from parent surveys may not have been detected due to lower response rates in

questions associated with socio-economic status, this may also have contributed to the mixed findings throughout.

3.4.3 Physical Environment Variables

When analyses are conducted for each of the PedsQL indices, the physical environment variables are significant predictors of every HRQOL outcome in the urban/suburban population. Interestingly, in the rural population natural environment variables were only significant for social and school functioning, showing the opposite effects in comparison to the urban/suburban population. This is potentially due to the little variation in natural environment features that exist in the rural communities. However, it is important to note that none of these significant predictors saw clinically meaningful differences in HRQOL outcomes.

Blue space in general has not been studied extensively in relation to children's health. Many studies tend to focus on how green spaces or green features of the environment affect a particular outcome. However, it is important to view nature as a more holistic measure including all forms, not just those that are considered "green". The percentage of water area around a participant's home is always a negative predictor of HRQOL in the urban/suburban population, however, is both a positive and negative predictor in the rural analysis. The inclusion of all water features within each study region could be the reason behind the negative association. Not all water features within a participant's home are necessarily "clean" or desirable locations for anyone to frequent. Parental perceptions of water areas being unsafe to play in or near could potentially effect HRQOL scores. Understanding parental perceptions of nature spaces is an important future direction of the current study. The inconsistency in positive and negative relationships in the rural population requires further analysis to provide a meaningful explanation.

The percentage of park space is a positive significant predictor in five out of six HRQOL outcomes in the urban/suburban population, although a clinically meaningful difference was never found. This supports other studies that have found significant relationships between parks and mental health outcomes (Feda et al., 2015; Kim et al., 2016; Taylor & Kuo, 2009). Using all types of parks, including densely forested areas, not just purpose

built parks, could be the reason for the inconclusive findings in the rural population. Future research should consider categorizing parks to avoid including spaces that are truly inaccessible to children.

Similar to percentage of park and water space, the urban/suburban population found significant negative relationships with five out of six HRQOL outcomes and at least one NDVI measure. In the rural analysis however, NDVI was a positive significant predictor for social and school functioning. Some studies using NDVI as a measure of green space have also come to similar conclusions of no significance to mental health outcomes (Balseviciene et al., 2014). Measures including proximity to, use of, or time spent in green space have seen more success in finding positive significant relationships (Balseviciene et al., 2014; Greenwood & Gatersleben, 2016; McCracken et al., 2016; Ward, Duncan, Jarden, & Stewart, 2016). More complex measures of nature have also found positive significant relationships with HRQOL measures (Kim et al., 2016).

All three measures of the natural environment found some relationship with HRQOL outcomes. However, the coefficients for each of these relationships are almost always less than one, demonstrating a lack of clinically meaningful differences. Therefore, these findings are not strong enough to conclude a meaningful relationship between accessibility to nature and children's HRQOL. These somewhat inconclusive findings demonstrate the need to use exposure to nature as the next step in assessing the relationship between nature and children's HRQOL. Exposure is a more accurate representation of a child's actual interactions with particular spaces, as opposed to assessing the opportunity structure around their home.

There is a significant base in the literature to support that differences in urbanicity can effect a variety of health outcomes (de Vries, Verheij, Groenewegen, & Spreeuwenberg, 2003; Smith, Humphreys, & Wilson, 2008; Verheij, 1995). In the current study, living in a suburban area is a predictor for increased school functioning scores, however, the coefficient did not meet the clinically meaningful cutoff. The region of Ontario in the rural analysis never significantly predicts HRQOL outcomes. The somewhat inconclusive findings between urbanicity and HRQOL outcomes could be attributed to the built

environment of the study region. Truly rural home locations were identified, however, some of the urban areas in the study may not reflect a truly urban area. London has significant tree coverage and natural spaces throughout the downtown core, which is considered the urban area. However, the differences that do exist between each analysis provide reason to further investigate nature's effects on these subpopulations. Using time spent in nature as the nature interaction type may further develop the exploratory findings from the current study.

3.4.4 Policy & Practice

Although the findings of the current study do not strongly support a definitive relationship one way or the other, there are recommendations that can be made for policy makers and practitioners. The small relationships found can support the development of programs that focus on getting children outdoors in nature, something that can be easily achieved through a number of avenues. School boards and public health officials can make it part of their mandate to promote and develop strategies that get children outdoors while still accomplishing other primary objectives. Outdoor learning has been shown to positively improve cognitive functioning as well as other measures of health (Dadvand et al., 2015). Simple changes in policy and practice can also help to add other streams of research opportunities in assessing children's health in relation to nature, through exposure and engagement. As established here, exposure and engagement can potentially be better measures for examining nature's effects on children. The differences that exist in the variables that significantly predicted HRQOL scores in the two populations demonstrates the potential to target certain child populations differently. Policy makers and practitioners should take into consideration where a child lives and the intrapersonal, interpersonal, and physical environment variables that contribute most to their mental health and well-being.

3.4.5 Strengths, Limitations, Future Directions

The STEAM protocol provides rich data assessing healthy behaviours of children in relation to where they live. The two data collection periods provide a longitudinal study design allowing for changes in behaviour and attitudes to be detected over time, and

specifically across seasons. The large sample size increases the generalizability of the findings to other child populations. Methodological strengths include the GPS data allowing for exact home locations of each child to be used providing a more accurate representation of their habitual environments, as opposed to commonly used postal/zip codes. In addition, multiple data sources were used to compile the most comprehensive park and water layers for natural environmental variables. Although surveys do not allow individual children's experiences and opinions to be expressed, they provide large scale data that is important for informing policy and practice (Barker & Weller, 2003). The PedsQL supports the simple collection of information that provide insights into factors influencing a child's mental health and well-being. Unlike physical health, mental health is not easily assessed, measured, and defined. Using a tool that can collect information on four key variables that contribute to a child's overall mental health creates a simple way to investigate the psychological well-being of an individual. Time, financial, ethical, and recruitment constraints do not allow for a measure of mental illness to be used in an elementary school setting. Therefore, the tool used in the current study is an effective way to assess a variety of functioning abilities of a child that influence their mental health.

It is recommended that using exposure to natural environments to assess interactions with nature be used in future research. The findings here and in other studies demonstrate that using accessibility to measure nature connections has its limitations. The inconclusive findings of the current study support that access or opportunity do not necessarily translate into use of a particular space. Findings from McCracken et al. (2016) also support this limitation of accessibility, where their results demonstrated that significant relationships were found for time spent in urban green spaces but not measures of residential green space. Time spent allows for a greater consideration of individual agency of children (Bell et al., 2014), especially when children potentially have greater limitations in accessing spaces in their neighbourhood environments.

Creators of the PedsQL strongly recommend that whenever possible the parent proxy-report be used in combination with the child self-report (Varni et al., 2005). Child self-reports commonly result in more under or over reporting of health functions, supporting

the need to include the parent-proxy report. The current study did not provide the parent proxy in the parent survey, as the STEAM project is an interdisciplinary study where HRQOL was a secondary purpose. Research funding was not directly available for a study of HRQOL. Future research should consider the utilization of both tools to confirm HRQOL scores. More time between data collection is needed in order to detect true differences in HRQOL. The current protocol did measure HRQOL at two different times (a maximum of six months apart), however, no significant changes are observed between the two data collection periods, suggesting more time is needed to see observable differences. Measuring the effects of nature on HRQOL is a passive intervention, which also supports the need for greater time between baseline and follow-up to detect changes in the dependent variables. The socio-ecological model describes a variety of variables that can effect a child's mental health and well-being. However, the current study is limited in its lack of information regarding participant's behaviours, attitudes, and limitations surrounding their HRQOL. For example, another factor that may potentially influence HRQOL is the quality of the school, as it has been shown that lower school quality can result in poor health outcomes in children (Kowaleski-Jones, 2000). Although likely impossible to assess every factor that affects a child's mental health and well-being, future research should include more independent variables influencing HRQOL found within a socio-ecological model.

Next steps include examining qualitative responses through child focus groups to bring context to the findings of the current study. The focus groups allow individuals to communicate in their own terms giving detailed examples of the different factors that influence participant's relationship with nature and the potential mental health benefits. Understanding this relationship from urban, suburban, and rural children's perspectives may allow for variables not considered in this analysis to be revealed as important in assessing nature's relationship with aspects of children's mental health in future quantitative analyses. Chapter 4 of this thesis will examine rural children's responses to exploring their relationship with nature and how it is beneficial to their health.

3.5 Conclusion

This study makes multiple contributions to the literature on children's health in relation to nature. Assessing this interaction through accessibility was the first step in understanding this relationship. Looking at children's accessibility to nature is a common way to assess this relationship and the current study demonstrates that it may not be the ideal measure. Differences that exist between urban/suburban and rural populations need to be further investigated through future research using exposure to nature as well as using qualitative methods exploring the perspectives of children on nature and health in urban, suburban, and rural populations.

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Chapter 4

4 Children's perceptions and definitions of nature in rural Northwestern Ontario

4.1 Introduction

4.1.1 The problem

North American children now spend almost seven hours a day with electronic media, perpetuating a lack of engagement with the outdoors (Driessnack, 2009). Consequently, over three-quarters (76%) of Canadian children (ages 5-17 years) exceed the recommended amount of screen time of no more than two hours per day (ParticipACTION, 2016). The lack of exposure to the outdoors has some researchers and practitioners associating today's children with nature deficit disorder (NDD). NDD is a label used to describe the growing deprivation children are experiencing when it comes to exposure to natural environments (Driessnack, 2009; Louv, 2005). Along with a lack of exposure, children's perceptions of what nature is and how it affects them is changing (Driessnack, 2009; Louv, 2005). These changes are important to investigate in order to develop necessary solutions to promote connecting children with nature to mitigate the negative impacts associated with the increased time spent indoors, being sedentary, and viewing screens.

It is well established that nature can have a positive impact on human health (Keniger et al., 2013; WHO, 2016). Research has exposed the benefits of nature on many different aspects of children's health, including physical, mental, emotional, social, and cognitive (Gascon et al., 2015; Sanders et al., 2015; Ward et al., 2016). Research commonly supports that the more time spent in and exposed to natural environments, including views from indoors, has been associated with positive health and development outcomes (WHO, 2016). The home and school environment are two major areas where this research has been focused, developing an understanding of how the two play a role in children's direct and indirect contact with nature. Although there is a substantial base of research on children's connection with nature, there lacks an understanding of how children perceive their connection with nature and what it means to them. Gaining these

qualitative perspectives enhances the wider patterns that quantitative research has identified by giving greater context and reasoning behind the findings, while also offering samples of the complexity and diversity of children's lives (Barker & Weller, 2003). Qualitative research addresses one of the key limitations of quantitative assessments of accessibility to nature, in that, mere geographic access or opportunity does not translate to use of these environments (Bell et al., 2014). Therefore, children's perspectives of nature are important to understand how they associate interacting with nature to health. Quantitative work lacks the ability to reveal the processes and experiential dimensions of how natural environments are used by children. Furthermore, these relationships can differ based on the environments in which children live (Louv, 2005). Acknowledging the differences between environments is key for understanding a variety of child populations. To date, most qualitative studies have focused on children in cities and much less is known about how children from rural and remote settings perceive and experience nature in their environments.

4.1.2 Review of literature

Foundations of the Benefits of Nature

It is widely acknowledged that nature can have a positive impact on human health. Ulrich's Stress Reduction Theory (SRT) and Kaplan and Kaplan's Attention Restoration Theory (ART) both build the foundation for understanding why these potential positive impacts of nature on human health are explored (Kaplan & Kaplan, 1989; Ulrich, 1983).

The psychophysiological stress recovery pathways that Ulrich's SRT is based upon how specific features of the natural environment influence these pathways. Nature can offer a calming, stress leaving effect on individuals through its restorative stimulus, producing an increase in positive emotions and decrease in neurophysiological excitement (Ulrich, 1979, 1981, 1983). This research is primarily concerned with a reduction of stress by understanding the components that contribute to strenuous and exhaustive states. Following stressful situations, exposure to natural environments is thought to reduce physiological arousal (Ulrich et al., 1991). Nature's ability to effect change in these types

of responses is thought to be due to the more positive experiences associated with the natural environment (Ulrich et al., 1991).

Kaplan and Kaplan's ART proposes that natural environments have the ability to offer a relief to mental fatigue (Kaplan & Kaplan, 1989). This restorative ability of nature is able to facilitate attention restoration, thus reducing increased levels of exhaustion largely caused from work in modern society (Kaplan, 1995). In *The Experience of Nature*, they popularized the term 'restorative environment', as an environment where recovery of mental energies and effectiveness is heightened, through exploring the relationship between individuals and the natural environment (Kaplan & Kaplan, 1989).

These theories build the foundation for research that attempts to understand and discover the relationships that nature has with human health. Both Ulrich and Kaplan & Kaplan's work frames the reasoning behind exploring nature's interaction with children's health.

Children and Nature

Nature deficit disorder, described by Louv (2005), has spurred international attention from professionals in many disciplines and the general public, highlighting the growing concern that declining contact with nature threatens children's healthy physical, mental, and social development. There is significant anecdotal evidence that supports nature's benefits for children, where adult and senior populations describe how their childhood was spent outdoors, and the many benefits they associate with these memories. The growing concern of NDD has led these anecdotal beliefs to be tested by researchers in order to develop empirical findings which support our hypotheses of the potentially large effect nature can have on children's health. This anecdotal evidence and theories described by Ulrich and Kaplan and Kaplan help to support the research being done involving children and nature.

Evidence suggests that contact with nature has the inherent ability to positively and perhaps substantially influence health outcomes (Bell et al., 2014; Collado & Staats, 2016; Keniger et al., 2013). Outcomes studied in child populations have shown these types of relationships, including associations with physical activity levels, mental illness,

emotional well-being, social development, cognitive skills, and attention, to be positively connected to the natural environment (Amoly et al., 2014; Balseviciene et al., 2014; Collado & Staats, 2016; Taylor & Kuo, 2006; Hartig et al., 2014; Kim et al., 2016; Taylor, Kuo, & Sullivan, 2001; Thompson Coon et al., 2011b; Tucker et al., 2009; Wells, 2000). The significance of the research to date is more important now than ever, as it is thought that children's access and desire to engage with the natural environment is diminishing (Taylor & Kuo, 2006; Kahn & Kellert, 2003).

A significant portion of the literature that studies children's perspectives on nature focuses on children's pro-environmental behaviours or environmental stewardship in order to address humans impacts on the environment (Chen-Hsuan Cheng & Monroe, 2012; Mustapa, Maliki, & Hamzah, 2015; Schultz, 2000). Other studies have created tools (Freeman, Van Heezik, Hand, & Stein, 2015) or used tools such as the Children's Environmental Perception Scale or Connectedness to Nature Scale (CNS) to quantitatively assess children's perceptions towards nature (Larson, Green, & Castleberry, 2011; Mayer & Mcpherson Frantz, 2004). Some studies have taken qualitative approaches to examine children's perceptions, attitudes, feelings, and behaviours towards nature (Aaron & Witt, 2011; Freeman et al., 2015; Lekies, Yost, & Rode, 2015). For example, Aaron and Witt (2011) investigated through interviews and child drawings urban students' definitions and perceptions of nature. They found that there were varying levels of nature awareness as defined by children's definitions/knowledge, feelings, attitudes, and behaviours of nature. Similarly, a study done by McAllister et al. (2012) found that urban children have mixed feelings and minimal contact with the natural environment. The current study expands this existing body of literature by focusing on children's definitions and experiences with nature within a rural setting, including how rural children see the benefits and drawbacks of interacting with nature.

Outside of objectively measured variables that are the basis of the nature-health relationship, individual agency is a factor that also plays a large role in influencing contact with nature. This is because although children may have geographic access or opportunity to engage with nature, it cannot be directly assumed that children are in fact

engaging with these spaces (Bell et al., 2014). The lived experiences from children themselves can build on how we understand the way children use, perceive, and define nature. Another common factor that influences children's perspectives of nature is their personal experience with this environment (Keliher, 1997). The amount that a child is exposed to a particular environment as well as their parents' perceptions of these places can dramatically influence how they perceive and identify with their natural environment (Chen-Hsuan Cheng & Monroe, 2012; Lekies et al., 2015; Louv, 2005). A child's ability to act independently varies considerably depending on these factors, and therefore, unlike adults whose individual agency is significantly less constrained, it is important to consider a wide range of intrapersonal, interpersonal, and environmental factors influencing children's behaviours.

Children's Geographies

With many studies observing how accessibility, exposure, and/or engagement with nature affects various aspects of health, a smaller portion of the literature seeks to understand how children themselves perceive and define nature. The way children perceive nature today is much different compared to previous generations, and therefore it is important to update our understanding of children's definitions and feelings towards nature (Aaron & Witt, 2011). Environmental psychologists have developed a substantial base of literature describing the self identification with nature in adult populations (Tugurian, 2014). However, social scientists have learned to realize that children interpret and experience their environments in fundamentally different ways than adults, making research on adults not applicable to child populations (Barker & Weller, 2003; Hyun, 2005; James, 1990). Knowing that children identify and understand very differently from adults is important in developing a child-centred approach to exploring children's connection to nature.

Historically, geography as a discipline has largely ignored how children's lives, experiences, attitudes, and opportunities are socially and spatially structured, focusing on adult experiences even when research questions are relevant to both subpopulations (Holloway, 2014; James, 1990). This is largely due to the idea that the spatial

distributions of children are similar enough to adults that a separate investigation of children's spaces is not warranted. However, we know this is untrue as the way children and adult's use and experience space can be different in the same environment (James, 1990; Punch, 2002). For example, children may use a park for play, while adults may use the space as an opportunity to socially engage with peers. Current acknowledgement of children in the design of spaces for children is generally limited to schools and playgrounds, although, we know that these are not the only spaces children use and experience in their habitual environments (Holloway, 2014; James, 1990). It is also crucial to emphasize a child's own agency and view them as competent and able to influence and contribute to their own lives (Barker & Weller, 2003; Holloway, 2014). Nature as a whole is a perfect example of a space that is not "designed" for accessible use by humans, but one children may frequent often. Children are also at a higher risk of negative impacts from their environments (James, 1990), which provides further reasoning into understanding how they experience certain parts of their environments. The methodology of the current study moves past describing a child's environment as different, by creating an account of these children's voices.

Over the last two decades, we have seen more researchers developing objectives that give voices to children (Barker & Weller, 2003; Holloway, 2014). However, more emphasis still needs to be placed on children as unique research subjects. Qualitative methods, such as focus groups, are one way to address methodological issues that characterize traditional methods, such as surveys, in work with children, including perpetuating unequal power relationships or children perceiving participation as intimidating or boring (Barker & Weller, 2003; Punch, 2002), a point we return to in our methods (See Methods 4.2). Focus groups present a more conversational setting where children are able to communicate without literacy barriers to facilitate speaking about their understandings and experiences of a given topic. Qualitative practices continue to move towards methods that respect and value a child's voice rather than framing the objectives with the greater assumption that adults know best (Morgan, Gibbs, Maxwell, & Britten, 2002). The methods of the current study support a growing expectation that research surrounding children should be research *with* children, not just on or for children (Mason & Watson, 2014; Matthews, 1998).

Urbanicity/Rurality

Children's connection and understanding of nature is also largely influenced by where they live (Louv, 2005; Mckendrick, 2014). Similar to the lack of evidence on children's perceptions of nature, little research seeks to explore how variation or changes in urbanicity/rurality affect these perceptions. Very few studies have compared rural and urban children to see whether their perceptions, feelings, and definitions do truly differ (Lekies et al., 2015). A study by Brehm (2007) found that two thirds of interview respondents believed that it takes a "certain type of person" to live in rural environments (Brehm, 2007), possessing characteristics such as independence. They also believed that the tradeoffs of living in a rural environment were worth the benefits of the natural environment. Although children do not manage the decision of where their family is located, they too can believe these unique qualities of living in a rural environment. These qualities can then influence how they interact, identify, and describe their relationship with the natural world (Bell et al., 2014). A variety of studies have investigated urban children's perceptions and connections to nature, as many believe the urban child has a greater disadvantage when it comes to accessing nature; including living further from dense natural environments, having larger city centres with little green space, as well as diminishing pro-nature attitudes furthering their declining access (Aaron & Witt, 2011; Freeman et al., 2015; Louv, 2005; McAllister, Lewis, & Murphy, 2012; Schultz, 2000; Simmons, 1994).

4.1.3 Summary

Exploring the potential benefits to children's health from interacting with nature continues to grow as researchers and practitioners become aware of the increasing lack of time spent in nature. The health benefits that have been explained through quantitative work are helping to promote interventions to support the necessary change in children's behaviour and environments. However, more qualitative perspectives are needed to recognize the individual perceptions that influence health outcomes. A large gap in the current literature is the lack of research involving rural children as well as qualitatively investigating children's perceptions of the benefits of nature interaction.

The purpose of the current study is to investigate how children living in a rural community define nature, experience nature, and perceive the benefits and drawbacks of nature. The intention of these findings is to inform the design and incorporation of nature within children's environments to encourage children to connect with nature and improve various health outcomes. It is hypothesized that rural children's responses will be significantly different in comparison to existing literature on urban children.

4.2 Methods

There has been a methodological agreement that children's views must be experienced firsthand in order to support the individual agency of children themselves (Holloway, 2014; James, 2010). Focus groups can be an effective way of realizing a goal of employing participatory or child-centered principles in research with children. One of the major strengths of the STEAM protocol (as outlined in Chapter 1) is that it engages participants to be a part of the research process emphasizing their role as a researcher, supporting research with children, not on children. The purpose of a focus group, as defined by Krueger & Casey (2000) is to obtain perceptions on a defined area of interest in a permissive, non-threatening environment (Krueger & Casey, 2000). Furthermore, consensus is not the goal of a focus group rather it is to develop a data corpus that holds the perceptions, attitudes, beliefs, motivations, concerns, and opinions of a targeted group of interest (Krueger & Casey, 2000). The permissive atmosphere of a focus group can allow participants to share more openly as well as be influenced by others just as they would be in an everyday situation (Krueger & Casey, 2000). All of these facets of the focus group create an optimal environment for answering the objectives of the current study.

The majority of guides use adults as a frame of reference when developing steps to undertake focus group research (Gibson, 2007). Although designing and conducting focus groups with adults is similar, those with children face different methodological issues surrounding particular forms of power relationships. It is important to critically reflect on the power relationships that exist in all forms of research with children,

participatory or not (Barker & Weller, 2003). Although focus groups do eliminate some of the barriers between a researcher and children, there are several that still exist, and that can never be eliminated from any type of child centred approach (Barker & Weller, 2003). In the current study, the moderator as an adult man from the community possesses a level of authority over the participants, especially in a school setting, where all of the focus groups took place. We purposefully selected a moderator from the community who could be attuned to the local context with the aim of creating a more comfortable focus group environment; however, having a moderator from close-to-home can also influence how and what children choose to share. The school setting also had the potential to influence children's responses; for example, in focus group discussions some students specifically referenced "out there", pointing out the window of the focus group room. In addition, school is a context where children are disciplined and subject to adult authority, which may layer particular power dynamics into our research relationships. Acknowledging this, we engaged focus groups as a way to foster a conversational and informal dialogue that allowed children to drive the conversation within our topical model. The group setting of 3-7 participants also could have contributed to participants agreeing with each other more, in order to stay socially relevant; peer dynamics and social hierarchies may have played a role in how children engaged in the discussion (Morgan et al., 2002). The focus groups were also hosted during lunch hour, potentially creating a rushed discussion, as some participants may have wanted to be outside playing during their break.

My positionality as an adult woman researcher from Southern Ontario has multiple implications for the analysis of data in the current study. Acknowledging this position helps to practice critical reflexivity throughout the research process. The social differences that exist between childhoods in the north versus the south are important to acknowledge in order to be critically conscious of the southern lens I might bring to the data. A southern lens could be described as a way of knowing certain environments, including nature, specific to the environment in which I grew up. Having been exposed to significant amounts of nature as a child, nature specific to more southern latitudes, may affect the way I assess what was said by participants. The social as well as the material aspects of the environment affect the way I engage and understand nature. However,

being physically a part of the community for an extended period through other methods of data collection provided me the opportunity to remain open to the distinct types of experiences participants discussed throughout the focus groups. This contextual understanding of participants' responses again helps to make my assumptions transparent and critically reflect on how my own personal experiences of the natural environments can influence the knowledge generated.

My position, as well as the moderator's (an adult man), influences how the data was formed and analyzed. The interactions between the moderator and participants certainly affected how the data was constructed, by influencing the nature of the dialogue. Furthermore, my position also as an adult analyzing the transcripts also affected how the results were generated. The current study attempts to take a child-centred approach, however, as adult researchers we are aware of the level of interpretation that takes place in generating these qualitative findings. We do not take for granted that we are adult researchers attempting to privilege the voices of children, and therefore, throughout the analysis kept the child-centred approach in mind by, for example, using children's own words to explain concepts relevant to the discussion of a theme. These power dynamics were also addressed through how the research project was communicated to potential participants. Children were told that they would be our partners and a researcher themselves, working as a collective team. We were conscious of the inter-generational power dynamics and thus positioned the children as 'co-workers' as part of the research design. This step was taken as a part of a child-centred approach, however, I do understand that in the end I am still the adult authority interpreting the information they have provided us.

4.2.1 Recruitment

The current study is a part of a larger ongoing project called the Spatial Temporal Environmental Activity Monitoring (STEAM) Project, being carried out across Southwestern and Northwestern Ontario since 2010. The focus groups conducted for this study come from the "STEAM North" component of the project involving students from

four elementary schools drawing from an approximately 385 km^2 square kilometre area in Northwestern Ontario, encompassing the Township of Nipigon (population 1,642), Township of Red Rock (population 895), and the Township of Dorion (population 316) (See map in Chapter 1, Figure 1.2) (Statistics Canada, 2016). The STEAM North study was approved by the Non-Medical Research Ethics Board of the University of Western Ontario (NM-REB #:108029).

After securing study approval from local school boards and principals of the participating schools, our research team posted a letter of information about our study to parents at each school through the schools official Facebook pages[1]. Members of our research team then made presentations at each school to all grade 4-8 students present on that day to fully explain what was involved in the study and to answer any immediate questions they might have about the study. After the presentation, children received a package to bring home to their parents. In order to be eligible to participate in the study, signed parent consent and child assent forms were required, including obtaining consent to audio record and transcribe verbatim all focus group material. All participants were aware that anonymous direct quotes could be used for the purpose of this research. Any child in grades 4 through 8 who was interested and had parent consent was eligible to participate. The four regional elementary schools contained a total of 194 students from grades 4-8 inclusive, of which, 136 participated in the overall STEAM North study between September and December of 2016.

Twenty focus groups were conducted across the four elementary schools. A total of 84 children participated in the STEAM North focus groups, which represented 61.8% of children participating in the larger STEAM North study, and 43.3% of all children in grades 4 through 8 in the four schools. They were held during lunch hour at school

[1] The purpose of this step was to inform parents about the project before their children, to provide them the option of blocking their child from hearing about the project before they themselves got to hear about the project, as to comply with the university's ethics board request.

during the fall and winter seasons of 2016 ranging from 3-7 participants per focus group. All participants self-identified as a boy or girl, no one identified as other. Table 4.1 outlines the demographics of participants, which were collected from surveys completed as a part of the larger STEAM Project.

Table 4-1 Demographic characteristics of focus group participants (n=84)

Demographics		n	%
Gender			
	Girls	43	51.2
	Boys	41	49.8
Age			
	9	23	27.4
	10	18	21.4
	11	18	21.4
	12	16	19.0
	13	8	9.5
	14	1	1.2
Grade			
	4	22	26.2
	5	20	23.8
	6	17	20.2
	7	16	19.0
	8	9	10.7

4.2.2 Procedure

A semi-structured focus group guide was modelled on previously employed guides used in other study sites of the STEAM project. Participants were asked questions about their physical activity habits, neighbourhoods, eating behaviours, and understandings of nature. The focus group questions for our focus on nature were designed to align with our objectives to understand children's definitions, experiences, and perspectives of the benefits and drawbacks of nature. The focus group protocol followed an outline (See Appendix H) for discussion but was flexible to allow the participants to lead the conversation to come to their own conclusions. The moderator did however, ensure that participants were staying on topic by using probing questions to return to the original discussion. Each focus group lasted 30-45 minutes and was facilitated by the same researcher who was an experienced moderator with children, and also a long-time

community member of the study area. All focus groups were audio recorded, transcribed verbatim, and double-checked for accuracy, ensuring trustworthy data. For the purpose of this paper, only the questions regarding nature were analyzed; these portions of the data represented approximately 12-15 minutes of each focus group transcript.

4.2.3 Analysis

The current study used a thematic analytic approach in evaluating the data set. This method provides the researcher the ability to identify, analyze, and report patterns within the data while also providing the opportunity to interpret the data set (Boyatzis, 1998). The flexibility and ability to provide a rich and detailed description of data is one of the key strengths in a thematic analytic approach (Braun & Clarke, 2006). Its flexibility is demonstrated through its ability to work within a number of theoretical frameworks as it is not attached to any pre-existing frameworks, which allowed us to design a coding approach that fit with our socio-ecological model and study aims (Braun & Clarke, 2006). More specific to the current study, thematic analysis is a useful method when investigating an under-researched area or views of a particular population that are unknown, in this case rural children (Braun & Clarke, 2006). Rural environments are underrepresented in Canadian health research, particularly with respect to child populations in these environments. As Braun and Clarke (2006) argue, thematic analysis enables the analysis to provide a rich description of the dataset, which is valuable when there is not a lot known about a topic or population. Finally, another advantage of thematic analysis is that it can be useful in allowing qualitative data to inform policy, which is important to our team as our end goal is to link our findings with relevant knowledge users (Braun & Clarke, 2006). Thematic analysis allows the findings to easily support knowledge translation to the general population, reinforcing participatory research principles. These strengths of thematic analysis are demonstrated in the current study through its ability to provide a rich description of the data set of a population whose views on the topic are relatively unknown, and therefore, can be used to inform research, policy, and practice.

Thematic analysis can take an inductive or deductive approach to evaluating a data set (Braun & Clarke, 2006). The current study uses an inductive, or bottom up approach, as it

is data driven, resulting in the themes being strongly linked to the data themselves. A deductive, or top down approach, was not taken for this step of the analysis process because it focuses on a more detailed analysis of a certain aspect of the data, providing a less rich description of what was said. Furthermore, inductive analysis of the data set provides the ability to identify meaning at the surface level or delve deeper into underlying ideas. However, deductive analysis was also used at the outset to develop the three main themes that guided the analysis to answer the research objectives, and within these categories, we undertook detailed inductive coding, as detailed below. For the purpose of this analysis, the themes were identified at the surface level to keep the responses close to the codes and themes to preserve the voices of children and privilege their accounts of their own experiences (Barker & Weller, 2003; Punch, 2002).

Braun and Clarke (2006) outline a systematic process of how to conduct a thematic analysis which includes familiarizing yourself with the data, generating initial codes, searching for and reviewing themes, and defining and naming themes. Prior to commencing the coding process, transcripts were read over multiple times before codes were identified to establish familiarity with the data set. We then used NVIVO Pro (Version 11) qualitative data analysis software to organize and prepare the data set for analysis (QSR International Pty Ltd., 2015). First, we extracted responses per each focus group question to group similar responses together and create an organizational structure to the data set that aligned with our study objectives (definitions, experiences, benefits/drawbacks). Then, across the data set, we used open coding to inductively identify the dimensions of children's definitions and experiences of nature, as well as their perceptions of the benefits/drawbacks of nature. Open coding allowed the data set to be broken down to understand the text in terms of the three main themes. The codes are fluid, overlapping, and inform each other allowing the full text to be represented (Cope, 2009). The moderator also acted as a second coder, reviewing the initial and final codes, to ensure significant content was not missed by the primary investigator (Baxter & Eyles, 1997). Although this step was put in place to develop reliability, reliability in qualitative research can be considered inappropriate as the meaning of rigor changes when discussing qualitative research (Smith & McGannon, 2017). Smith and McGannon (2017) identify 'critical friends', where a discussion with a colleague challenges the

original thinking about the data, as a method for ensuring rigour. This is not to achieve agreement or consensus but to foster reflexivity. The agreement upon codes was developed for consistency and to ensure as an outsider to the facilitation of the focus groups nothing was misinterpreted. However, a 'critical friend' was used to discover other possibilities in the final analysis of the results. Critical friends for this analysis included the focus group moderator as well as another researcher uninvolved with primary data collection. The recursive nature of this methodological approach allowed more subtle themes to also be identified when reading the transcripts multiple times (Braun & Clarke, 2006; Cope, 2009). All themes and subthemes were reviewed to ensure they represented the data set accurately by ensuring that after they were finalized they were inclusive of all the initial codes. Focus groups were conducted with all of the child volunteers so that everyone who wanted to participate had the opportunity to have their voices heard and thus saturation was not a determinant of data collection parameters. Saturation was observed throughout the analysis, meaning that there were clearly repetitive ideas across the focus groups. Finally, names and definitions for the themes and subthemes were created to establish accurate representation of the data set. Definitions were used as a reference to what a particular theme or subtheme was capturing to ensure that during analysis all data was placed within the proper corresponding theme or subtheme. The three major themes were "Definitions", "Experiences", and "Benefits and Drawbacks" (See Figure 4.1). There are aspects of participant responses that overlap between the three themes, allowing the three themes to be viewed as a holistic interpretation of participants' understandings and attitudes in general (Fielden, Sillence, & Little, 2011). It is important to note that these understandings and attitudes are never made up of independent concepts, rather all are relative to each other.

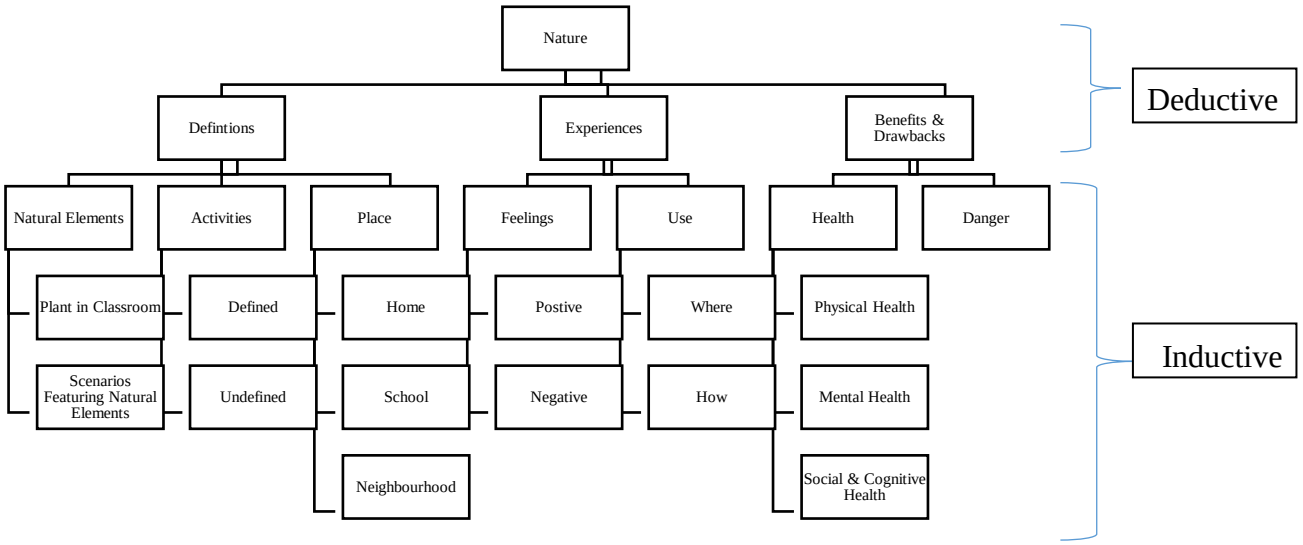

Figure 4.1 Coding framework showing deductive and inductive components

4.3 Results

4.3.1 Definitions

We identified three subthemes characterizing children's *definitions* of nature: natural elements, activities, and place. The subthemes within defining nature capture how children were able to describe and identify nature almost always describing their habitual environments.

4.3.1.1 Natural Elements

The majority of participants' definitions of nature are centred on natural elements that are commonly found in their habitual environment, as one student (boy, age 10) put it, "A lot of things are made out of wood and stuff and there's trees and grass everywhere". Animals and trees were the most common elements described, particularly bears, as another student (girl, age 11) noted, "I think of bears". When describing why they considered these things as nature most participants said it was because it is outside or because it is a part of an entire system: "cause they're outside" (girl, age 13) and "nature

is an environment, it's a whole, like, community" (boy, age 12). The concept of nature being the sum of many parts was a common response from participants, which also included what is necessary to keep it alive. A nine-year-old girl explained this as, "Because it still has the roots and it has the soil that has it outside and the dirt and all of the other things that make a plant grow and it has—you can put water on it like the trees outside with the rain". More complex definitions of natural elements were demonstrated when a single participant (boy, age 10) identified several types of trees: "like the pine and stuff make and oak and all the cedar".

When asked if they considered a plant in a classroom to be nature, the majority of participants agreed it indeed was, "because it is still a living thing. Like, it is kind of like if you have humans and you put them in the bush, they're still humans" (boy, age 12). Some, however, did not agree, instead conceiving that "nature is like a bunch of stuff. It is not just one thing in a place where it's not supposed to be" (girl, age 12). Participants' responses to this question almost always included some type of natural element describing their reasoning for agreeing or disagreeing with the posed question.

Participants often described untouched versions of the natural environment as being an important component of their definitions of nature. For example, not a single participant mentioned parks when asked about where they find nature, which may reflect the very few purpose built parks in their communities. Nature was more commonly addressed as "the bush" or by individual natural elements such as "big leaves and in the bush" (boy, age 11) and "trees and forests and bushes and animals roaming around" (girl, age 13). In Canada, as in New Zealand, Australia, Africa, and Alaska (US), the term "bush" is commonly-used to denote what is more commonly understood as a forest. Building on the theme of wild or untouched forms of nature, people were rarely mentioned, with the exception of a few participants describing anthropogenic effects on the environment:

> if people, like, carpool more often it's not really hurting the environment 'cause so- because if you don't carpool then there will be more vehicles polluting our nature and then the environment and so it will, like, like kill animals and grass and everything that's nature. (boy, age 11)

Participants most commonly used experiences from their own lives to describe nature through scenarios by themselves, with friends, or family. These scenarios often included elements of nature in combination with places and activities:

> For me, uh, I usually think of Lofquist Lake cause I swam across it a couple of times and when you go to the other side it's, like, just everything you imagine nature to be, like, there's trees, there's, like, moss, there's, like, bugs. We found a toad there one time, um, and there's, like, rocks to jump into the water, like, it's just, it's pretty cool (boy, age 13)

4.3.1.2 Activities

Outdoor activities were frequently identified within the theme of defining nature. Several activities specific to the region were common responses from all participants including hunting and fishing, as one 13-year-old student (boy) explained: "I usually think of, like, hunting and other outdoor activities like that". Participants described a range of activities that reflected a number of ways to engage nature with play, including: hunting, fishing, swimming, playing outside, climbing, exploring, building forts, running, walking, games, and simply playing. Interestingly, very few activities or sports with defined rules or ways of playing were mentioned as being a part of nature, for example soccer or basketball. Unstructured, free play, or 'made-up' activities were more common in children's responses, such as, "Twig jumping. I put twigs far away and try and jump on them" (boy, age 9). Activities at home and school often overlapped; with school activities including basic forms of play as well as unstructured sports. However, responses associated with being at home were much more diverse and complex; often providing a rich description of activities they commonly participated in:

> I take a nice walking trail and yeah, I just walk up there and bring my dog to get exercise and there's actually two trails you can take the long way it's a little bit more easier or you can take the one that goes straight up the trail but I go on, like, the long way with my dog because my dog's a little 'scaredy' cat (boy, age 13)

4.3.1.3 Place

Many participants considered their homes to be located in nature, as expressed clearly by one participant: “basically the entire town is a bunch of little houses on fields, the rest is bunch of bush with a couple of trails” (girl, age 12). This was also evident when participants referred to specific nature where they live: “nature here is pretty good” (boy, age 13) and “trees, mountains, and at my dad’s house we just have a lot of bushes” (girl, age 9). Although participants lived in a rural environment some were able to identify places outside their habitual environments as nature: “[a big city] that’s still nature” (boy, age 10). There was some disagreement over this but participants who discussed it argued that nature could be found anywhere.

The word ‘place’ itself was a reoccurring code used by participants when defining nature. The qualities associated with place varied in how participants defined nature. For example, one student saw nature as a “beautiful place where you can hunt and fish and lots of good sights and smells” (boy, age 10), while another framed nature as “carefree place for animals and people to be alike” (boy, age 11). Although children are likely remembering a particular place they have been, the lack of a specific location demonstrates a broader definition of nature that could be ‘anywhere’.

In contrast, participants also identified nature being in set locations including home, their neighbourhoods, school, and specific locations within their communities. Nature around the home was most often considered what was outside, such as “in front of my house and beside my house and behind my house” (girl, age 10); however, one participant did identify nature as being “also inside my house cause my mum really likes planting” (boy, age 11). Responses also included specific locations in participants’ surrounding neighbourhood, not just on their home property: “when we hike at the Bald Spot” (boy, age 11) and “everywhere… we’re surrounded by nature” (girl, age 12). Participants often did not readily observe nature as being on school property, remarking that there was “not too much nature” (boy, age 13) and “behind the fence” (multiple students). The nature that they did describe at school was often more simple, for example grass or trees, than the descriptions at home or where they often frequent in their neighbourhood, where they would describe detailed accounts of a particular place.

All of the responses within the theme of defining nature encompassed many different aspects of the natural environment. Participants' use of physical features, activities, and places to describe what nature was to them underscores a sophisticated knowledge of their natural environment.

4.3.2 Experiences

This theme of *experiences* is defined by participants' involvement with nature through use and feelings. The subthemes of use and feelings were reflective of participant's habitual environments.

4.3.2.1 Use

Participants discussed different ways they use nature at school, home, and in their neighbourhood. Use of nature was most often expressed through outdoor activities, however, a deeper understanding of use was translated through feelings, which builds in the second major subtheme of how participants experience nature.

A few participants described how they do not use nature at home, however, this was much more common at school as many described how they are not allowed to use nature at school: "Normally not allowed" (girl, age 12) and "sometimes but not very often only when we're doing something about nature like if we're planting trees then were allowed" (boy, age 12). This last quote describes another topic commonly mentioned by participants; they associated school work or activities with their class as another use for nature at school: "a science project" (girl, age 9).

Activities including hanging out, talking with friends, playing games, and walking were the most common responses: "I usually go with friends there and hang out there. Because it's a nice quiet place for people to hangout, talk for a little bit, so I usually go there with my friends and we talk" (girl, age 9). In line with the definitions of nature above, only a handful of participants, mostly boys, mentioned more defined activities like, "Football, or, like, soccer" (boy, age 11).

Participants spoke with very clear and definitive ideas of what they used nature for at home. This ease in discussing nature at home likely comes from their habitual

environments having more complex and dense forms of nature. Active uses including playing, building forts, walking, hiking, hunting, camping, gardening, skating, ‘quading’, and swimming were the most common and self-explanatory uses described by participants: “in the summer I’m either quading or on the trike” (girl, age 11). (Note: ‘quads’ and ‘trikes’ are colloquial names for motorized 4-wheel and 3-wheel all-terrain vehicles respectively).

Increasing access to technology, more sedentary lifestyles, opportunity to engage, and parenting styles are all variables children identified influencing their use of nature. Children discussed how technology and parenting styles were both factors influencing their use of nature: “Uh, it gets you away from electronics” (girl, age 12) and “I play in the nature all the time, once my parents get home” (girl, age 10) or “Yeah, I can’t go in the trees. My mom says it’s too far from the house when it is just in the backyard” (girl, age 8). They are aware that rules set out by their parents are something that limits their time spent in nature. However, a conflicting response from children was when many of them described scenarios where they were alone or with peers in nature: “Playing with friends” (boy, age 9) or “when I’m in nature, if I’m, like, by myself on, like, and it’s nice, like, I feel like, like, kinda, like, relieved of stuff” (girl, age 13). Participants were aware that being in nature promoted less sedentary lifestyles as commonly found in responses that included nature’s ability to encourage a more active lifestyle: “we do it for, to get exercise, to relax, to just have a picnic” (girl, age 13). Another evident barrier to participants’ use of nature was season. A variety of participants discussed how they preferred summer and it encouraged their use of nature:

> I prefer, like, summer better” (boy, age 13) and “in summer, it’s really nice ‘cause you can just walk around, you can enjoy the breeze, you can feel the sun, you can climb trees and stuff like that. In winter, it’s a little bit different, it’s hard to walk, you get full of snow, it’s cold and, like, trees are dead, everything just looks dead in winter (boy, age 13)

However, participants still frequently discussed activities and features in the winter that drew them to nature: “makes me feel happy because in the winter it’s all like white and

glistening and it's pretty pretty actually, it's pretty beautiful actually" (boy, age 10) and "I love when its winter 'cause it builds up into like a giant hill" (boy, age 9).

Less direct uses of nature that incorporated the next subtheme of feelings, included being able to get away, relax, and feel calm or better: "it's nice to have somewhere to get away from the town or city that you live in" (girl, age 13) and "It helps calm me down" (girl, age 9). Participants also used nature as a place where they could be free from any restraints: "it's where you can just express your mind" (girl, age 9). Using nature as an escape or to relax leads directly into the next subtheme of experience where these responses are expanded upon to understand how children experience nature through feelings.

4.3.2.2 Feelings

In the previous subtheme use of nature, participants described using nature to facilitate feeling certain ways. This crossover between the two subthemes supports their use in exploring uses and feelings as how rural children experience nature: "it makes me feel calmer cause its quiet" (boy, age 11) and "I feel relaxed" (girl, age 10) and "It makes me feel healthy" (boy, age 9). These responses demonstrate the restorative effects that young people attributed to nature. Participants' awareness of nature's ability to modify feelings was frequently observed.

Participants were asked if they felt better when they were in nature; there was a general consensus that being in nature made individuals feel better, however, often this was not a simple yes or no answer as there were modifying factors, such as season: "I kind of feel better but, like, it kind of depends on, like, what the environment's like" (boy, age 13). This demonstrates a complex knowledge that participants' understandings have developed through everyday experience with their natural environment. This is also evident in responses that describe specific scenarios associated with nature's ability to modify the participant's feelings: "When I'm in nature I feel kind of happy because you don't smell, well you don't smell factories at all here because we don't have any, but like pine and stuff make- and oak and all the cedar-make a kind of like a maple smell" (boy, age 10) and "Say if you and your brother are fighting and you just go outside, you feel

better" (boy, age 12). The latter quote also indicates how participants see nature as providing them with relief from everyday stresses, such as family. Each of these examples further demonstrates the health promoting context participants view nature to be.

The most common responses from participants in regards to feelings was nature making them feel happy. This response was taken one step further by some individuals when they used positive feelings, like "happy," to describe the effects of nature: "Nature makes people happy, that's what it sort of means" (boy, age 11). There were many instances when participants described a relationship between self and place: "I feel like I belong there" (boy, age 12) and "Like when I'm there no one can stop me from doing anything because yeah …, it's like it kind of makes me another world and I like own it" (girl, age 12). These emotional connections participants described demonstrates a place where they feel they have a standing or ownership, unlike many locations where certain power dynamics may exist, such as school. Adventurous, wildness, and being free were other imaginative descriptors of feelings when in nature: "Ah I feel really kind of adventurous, really happy" (boy, age 9) and "It makes me feel wild [So what do you mean by that?] I can do anything I want" (girl, age 8) and "Sense of freedom" (girl, age 12) and "makes me feel powerful" (boy, age 12). This was underscored by how participants used positive and affirmative language to describe their experiences in nature as beautiful, cool, and peaceful, this was demonstrated through many responses: "Peaceful" and "really cool and beautiful" (boy, age 10). Some participants even described feeling thankful and appreciative of what they perceived nature to provide, with one student reflecting on "how kind of lucky I am I have that spot" (boy, age 9). Not only did participants demonstrate appreciation towards their natural environments, they also demonstrated feeling protective towards nature: "I think that nature's a really good beauty but we need to treat it better than we already have" (boy, age 11) and "it should be respected more and not as much littering" (girl, age 10). These feelings of protection begin to demonstrate environmental stewardship and an emotional connection of participants with nature.

In contrast to the positive nature of the former findings, many participants did also identify negative feelings with experiencing nature. Participants associated feelings of

being unsafe, scared, or nervous almost exclusively due to animals (bears) or inclement weather: “Kind of safe and kind of not because I am with people but there are a lot of animals” (girl, age 8) and “scared, ‘cause you know, bears” (girl, age 10) and “I also feel nervous because of scary animals and storms and stuff” (girl, age 10). Fear of strangers was never mentioned. Feelings of loneliness and the uncertainty of being on your own were also negative feelings participants described: “Kind of lonely” (boy, age 12) and “when I’m in nature, if I’m, like, by myself on, like, and it’s nice, like, I feel like, like, kinda, like, relieved of stuff but, like, when I start walking around I kinda just get, like, scared because, like, I’m by myself and I don’t know if there’s actually animals” (girl, age 13). Some of these quotes also signify how responses describing negative feelings were mixed with positive ones, demonstrating that negative feelings were not the emphasis of participants’ responses.

4.3.3 Benefits and drawbacks

Finally, we examined how participants understood the general *benefits and drawbacks* of nature. The benefits identified, all focused on how nature can positively influence health-related outcomes. Feelings and experiences were the most common ways in which participants identified the benefits and drawbacks of nature.

4.3.3.1 Health

The theme of health was subdivided into several dimensions of health including physical, mental, social, and cognitive. Participants had clear and definitive responses involving the benefits associated with their health.

Physical Health

Participants predominantly focused on aspects of their physical health and well-being. Their definition of a physical health benefit focused on physical activity and getting fresh air. Physical activity was operationalized through exercise, getting active, having energy, and being fit: “to get exercise” (boy, age 12; girls, ages 8 and 13) and “It’s good because you get fresh air, and you get active” (girl, age 10) and “fit” (girl, age 10) and “Makes you energized” (girl, age 11). These understandings of physical health might result from

being told by adults that being outdoors promotes physical activity and is ‘good for you’. Getting fresh air was associated with being able to breathe better and not feeling congested: “To help-, helps you breathe better and, and then you like outside more” (boy, age 11). Discussing nature’s ability to promote physical activity lead many other participants to describe nature as making them healthy.

Other elements of physical health discussed included sleep and getting a break from technology. These benefits were described by individual participants, however, they were key in describing the understandings participants had in relation to their physical health: “you don’t get Wi-Fi so you’re not looking at a screen so you’re not damaging your eyesight” (girl, age 10) and “and it’s like, it’s going to be, like, dark so you’d be going to, like, bed earlier so you’d get a better sleep” (girl, age 11). Finally, an important idea supporting physical health that was described was nature’s ability to provide people with medicine and food: “Um, well we can get medicines from nature” (girl, age 11) and “It makes a lot, it provides us like a lot of things. And lets us use wood and it also gives us food” (boy, age 10).

Mental Health

During the focus groups the term ‘mental health’ was never explicitly mentioned, however, participants did describe several features that encompass their mental health. Features of participants’ mental health emerged through responses categorized as stress, self-esteem, and emotional well-being. Stress was typified through discussions of relaxing and being calm or worried. Nature had the ability to alter participants’ feelings by simply being there: “it relieves stress. It’s nice to get out of town and have, and be able to quit worrying about stuff” (girl, age 13) and “It’s like area where you can rest your mind” (boy, age 14) and “To calm the mind” (boy, age 12) and “I feel relaxed” (girl, age 10).

Self-esteem was another dimension of mental health that was identified by participants as a benefit of nature, again described as an interaction. These responses were often associated with feelings, which again demonstrates the overlapping of themes throughout

the data set: “it makes me feel good” (boy, age 12). One response particularly references the self-esteem of children which supports the child-centred approach used in the current study: “It makes kids feel good about themselves and happy” (girl, age 9).

Participants could identify the direct interaction with nature as being beneficial to their emotional well-being. Responses were associated with both feelings of happiness but also being able to remedy negative feelings: “Nature makes people happy, that’s what it sort of means” (boy, age 11) and “Sometimes emotional. Because usually when you are sad you run somewhere” (boy, age 10) and “If I’m having a bad day, then, like, maybe I’ll go outside and feel better” (girl, age 11). All three dimensions of mental health described here were clear throughout the data set and accurately describe the mental health benefits participants saw in interacting with nature.

Social and Cognitive Health

Throughout the discussions participants showed a high degree of importance placed on interacting with their peers in nature. Nature’s ability to facilitate social interactions was a key benefit identified by the majority of participants: “I usually go with friends there and hang out there. Because it’s a nice quiet place for people to hang out, talk for a little bit, so I usually go there with my friends and we talk”. However, there were exceptions, with two participants finding nature isolating or boring “Kind of lonely” (boy, age 12) and “Bored” (girl, age 8).

Participants also indirectly associated interacting with nature as beneficial to their cognitive functioning. The attribution of cognitive functioning with nature was clear through a number of responses: “it makes my brain work on things that I think about” (girl, age 12) and “It’s like area where you can rest your mind” (boy, age 14). Participants’ responses also demonstrated a more imaginative association with cognitive functioning: “inside you’re kind of confined by your four walls but outside you’re maybe a little more imaginative” (boy, age 14) and “it’s where you can just express your mind” (girl, age 9). Not only did participants describe nature’s benefit to cognitive function, they also described their cognitive development through learning outdoors: “I’ve been

trying to convince teachers to let us go outside and take a lesson since grade three" (girl, age 12). Although these responses do not directly mention that learning outdoors is beneficial they want to learn in a natural setting and are aware they can do so.

4.3.3.2 Danger

The evidence presented here represents a consensus of most participants outlining a single drawback of nature. As mentioned previously, some responses are unique to the geography of these rural children. The subtheme of danger is another example specific to the study region. Participants' fear of animals, particularly bears, was the one major drawback of nature identified: "you never know if there could be a bear or some sort of animal that could like hurt you" (girl, age 9). However, as described by one participant, the presence of bears is something that is a normal part of their environment, again speaking to the specific geography of the study region: "in Dorion then there's always gonna be bears…it's Dorion you just have to get used to them" (girl, age 12). Other drawbacks associated with danger included feeling unsafe due to inclement weather, time of day, and getting lost: "I also feel nervous because of scary animals and storms" (girl, age 10) and "sometimes it makes me feel nervous…especially if it's a bit later in the day" (girl, age 9) and "Sometimes I feel unsafe 'cause it's, like, big and then you could get lost in it" (girl, age 11). These associations with danger are situation specific and therefore, may be considered not to be a consistent drawback participants' associate with nature.

Other participants gave less specific or direct examples of the danger of being in nature: "it makes me feel scared" (boy, age 9) and "It kind of makes me nervous because it is close to animals and dangerous stuff" (girl, age 11). Conflict existed with these perceptions of danger in that many participants used the word safe when describing how nature made them feel. However, there was little expansion on why it made them feel this way and therefore, cannot be directly compared to the above examples.

4.4 Discussion

The purpose of the current study was to identify children's definitions, experiences, and perceived benefits and drawbacks of nature. This was achieved through exploring participants' knowledge and experiences of nature. Overall, rural children's

understandings of nature are clear and definitive with little to no difference between boys and girls throughout all themes explored. The understandings discovered here help to generate a knowledge base missing in the current literature by focusing on rural children and nature. Based on the findings, we argue that we need to reconceptualise the notion that children are unware of the benefits they receive from being in nature. Rural children in our study demonstrated a developed and sophisticated understanding of nature grounded in their local environments. These findings help to move towards using children's knowledge to facilitate the design of interventions that fit with what they see as the major benefits of interacting with nature.

The results of this study are consistent with those of similar studies in that, regardless of level of urbanicity, children's understandings of nature are predominantly mediated by their habitual environments and interaction with nature. Studies investigating perceptions of urban children often find that participants associate nature with danger from animals, strangers, fear, and uncleanliness (Aaron & Witt, 2011; Burgess & Mayer-Smith, 2011; Emmons, 1997; Keliher, 1997; Simmons, 1994; Wals, 1994; Wilhelm & Schneider, 2005). Contrary to findings on urban children (Aaron & Witt, 2011), fear of strangers was never mentioned among these children from rural Northwestern Ontario. Another study found that urban children rated wilderness as the lowest of their preferences of place, as well as conveyed negative feelings towards the natural environment, in particular wild nature (McAllister et al., 2012). However, unlike previous studies done on urban children, in this study with rural children, there lacked a strong presence of negative responses associated with a dislike or fear of nature (Adams & Savahl, 2015; McAllister et al., 2012). Beyond the negative associations children in urban populations attribute to nature, there are also many positive perceptions of nature described in the literature, including happiness, adventure, relaxation, and freedom, which were also common in the current study (Aaron & Witt, 2011; Bonnett & Williams, 1998; Burgess & Mayer-Smith, 2011; Lekies et al., 2015; Simmons, 1994). The positive relationship participants generated when defining nature supports the concept that an increased prevalence of NDD is not caused by a growing dislike for nature, rather a variety of behavioural and environmental factors (Driessnack, 2009; Louv, 2005).

The substantial knowledge of natural environments that the majority of participants possessed contrasts with studies in urban populations where there is a significant range of knowledge levels (Aaron & Witt, 2011). The deep knowledge of these children can be attributed to the large area that natural environments cover where they live, resulting in constant exposure through all types of interactions. Furthermore, participants in the current study classified nature with similar descriptors from previous studies, with the exception of nature being not the city or a separate aspect of their regular lives, as well as many more complex descriptions of activities and places they frequent (Lekies et al., 2015). The undefined or unstructured types of activities participants described as being nature demonstrates children's participation in unstructured activities or sports as an important part of their engagement with nature. Using nature as an outlet for activity is important in recognizing existing tools in local environments to promote healthy behaviour. This is further supported by participants lack of mentioning purpose built parks, which may be reflective of the local context where other than parks attached to two municipal arenas (i.e., indoor ice rinks) and a single public park in one of the study area communities, the only purpose built parks are on school grounds.

Many did not believe they could find nature at school, as their definitions of nature are a more complex version of what they could find at school. In comparison, in a study done by Simmons (1994) the school site settings were the most highly preferred grouping of nature photographs in urban children (Simmons, 1994). This difference in preference may be attributed to rural children's opportunity to access more complex nature, and therefore why their responses regarding nature at home included many more examples. These findings have significant implications for the future design and implementation of infrastructure on school grounds.

The findings also suggest children's knowledge goes beyond supporting their ability to define nature, to understanding its benefits to their health. Very few studies have explored what children understand as potential benefits of interacting with nature. Perceptions, attitudes, definitions, and environmental stewardship of nature are the most common variables explored using the theme of nature in the literature. In the current study, responses were clear and definitive in explaining the benefits of interacting with

nature by almost all participants. The physical, mental, social, and cognitive benefits identified by participants highlight the in-depth understanding participants have of their own well-being, as well as in relation to nature. This was established through the detailed descriptions of how it makes them feel, act, and live. They understand that nature has the ability to influence the they feel and affect their behaviours, such as physical activity levels. Their indirect descriptions of mental health benefits, through discussions of stress, self-esteem, and emotional well-being emphasize the deep understanding and awareness children have of themselves and others. It is important to consider that knowledge does not necessarily predict behaviour, so although these participants had a very good understanding of the health benefits associated with nature interactions, it does not necessarily mean that they act on this knowledge specifically; a variety of reasons motivate their engagement with nature.

The methodological approach taken to privilege children's first hand experiences with nature is important because it allows conclusions to be drawn about how children's environments affect *them.* Many researchers support the use of children in qualitative research in order to foreground the lived experiences of children. However, there seems to be contradiction in the knowledge translation of findings, as they often do not reach back to the children directly. It is clear from these findings that children have the ability to be independent social actors capable of participating in discussions of their environments. If children's geographies and other disciplines continue to incorporate the voices of children, the dissemination of results must also reflect this model. On top of the knowledge translation that will inevitably happen with policy makers and practitioners, these findings should and can be shared with children themselves. Based on the findings from the current study it is clear that children have their own expertise and can speak to their experiences with nature. Therefore, children informing children would be a future direction of research *with* children. Allowing participants to review the results of this investigation and share what we have found with other children leads to a more participatory method. It is important to see this research evolve further along these lines to investigate if there is a significant difference in the way research findings impact children based on delivery.

4.4.1 Policy and practice

Practitioners need to take advantage of the complex knowledge that children possess to facilitate the use of nature as a tool for health-promotion (Pretty et al., 2009). If children view nature as being beneficial to their health on their own terms, they are likely to respond more positively to encouragement of interacting with nature. There has been some encouragement from practitioners to incorporate nature as a tool to better health (Driessnack, 2009), but there is a need for it to become mainstream throughout a variety of practices. Policy also needs to consult with children over the development of policies that affect them (Barker & Weller, 2003). The findings here enable policy makers to include examples of a rural child's perspective on their natural environment when building policy surrounding children's interactions with nature.

Rural communities are known to have less access to and development of health promoting infrastructure, such as recreation centres or bike lanes, and resources, including physicians, specialists, programs, services and technology (Boehmer, Lovegreen, Haire-Joshu, & Brownson, 2006; Smith et al., 2008; White, 2013). Features of rural environments such as long distances, lower population densities, and widely dispersed populations are all features of these communities that contribute to lack in accessibility (White, 2013). On the other hand, rural environments have greater access to nature compared to their urban and suburban counterparts (Aaron & Witt, 2011); therefore, the results of this study support policy and programs targeted towards nature being incorporated as an effective tool to promote and make changes in children's overall health. Policy and practice needs to incorporate the strengths of nature in rural environments in order to close this gap. These findings also encourage the continuous promotion of nature to children as perceptions of natural environments tend to be most strongly developed between the ages of seven and eleven with perceptions sustaining into adulthood (Chen-Hsuan Cheng & Monroe, 2012).

A substantial part of the literature has described numerous benefits to children's health from exposure to nature. More specifically, research has shown that green schoolyards have many benefits to academic achievement, focusing in a classroom, reduced stress, relationship skills, self-management, and physical activity levels (Barton, Sandercock,

Pretty, & Wood, 2015; Bell & Dyment, 2008; Chawla, Keena, Pevec, & Stanley, 2014; Roe & Aspinall, 2011; Wells et al., 2015; Williams & Dixon, 2013). Our responses from children as to whether a plant in a classroom constitutes nature were mixed, which demonstrates the need to assess whether there is value in putting nature in the classroom in the first place, or if it needs to be where they most commonly perceive it to be, outside. Furthermore, the majority of children in the current study did not define their schoolyards as being very natural places. This creates opportunity for practitioners in naturalizing schoolyards by developing more complex forms of nature on school grounds. Although rural children tend to have greater access to nature in their habitual environments, it is important to develop school grounds that children perceive as having large amounts of nature due to the significant portion of outdoor time that happens during school hours. This potential exposure to more complex forms of nature is supported by acknowledgement of the numerous health benefits described by participants when in nature.

4.4.2 Strengths and Limitations

One of the major strengths of this study is the spatial perspective these findings provide through rural children's understandings of nature. Rural children are a generally understudied population; these participants' understandings of nature build significantly on the current literature regarding children and nature by providing a unique set of children's understandings of nature's influence on health. The timeliness of the current findings supports the continuation of studies looking to understand how children define, perceive, and interact with nature. Another strength of the findings is that they support the conception of children as independent social actors. Just like the establishment of methods supporting research with children, these findings also support research with *different* children, emphasizing that there are potentially significant differences in children's understandings based on their environment. It is important to highlight that although the findings here focus on shared themes of participants there was attention given to exceptions demonstrated by individual participants.

Limitations of this study are largely based upon the geographical location of the participants. It focused on northern latitudes with a particular regional biodiversity. More

research is needed into children's experiences in nature in other types of rural and remote environments. Limitations also existed in the methodology of the study. Only one moderator was present during each of the focus groups, making it difficult for additional notes to be taken during each focus group. Nevertheless, given the small size of some of our focus groups, we did not want to over-represent adult presence with an additional note-taker. Finally, although participatory principles were used to guide the methodology of the study, a fully participatory research design was not used due to the constraints of working within the school environment and timelines.

4.4.3 Future Research

Future research should compare these results with urban populations as well as other rural communities to determine if these findings differ with experiences elsewhere. Even if the understandings of different populations are similar, their frame of reference and how and where they place importance may differ (James, 1990). Secondly, more information should be collected on participants' actual behaviours to supplement what they said in the focus groups, as we know knowledge does not necessarily predict behaviour. Future research could also be more directly involved with policy and practice to ensure findings are making the impact they are intended to make. By having policy makers and practitioners involved in the process, responses from children could be more effectively used to help design and facilitate change in interventions, infrastructure, and policy. Finally, future research could employ a true participatory research design by incorporating children in each step of the research process from the conception of the research questions to the disseminating of the results.

4.5 Conclusion

The current study provides contextual and detailed evidence with the potential to inform planners, practitioners, health professionals, school boards, parents, and children in promoting and facilitating children's interaction with nature. Children in a rural environment demonstrate a developed and sophisticated understanding of nature grounded in their local context and are aware of the benefits nature can provide to their physical, mental, social, and cognitive health.

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Chapter 5

5 Synthesis

5.1 Summary of Studies

The two original studies included in this thesis examined various factors influencing children's health, more specifically mental health. Through quantitative and qualitative methods, sub-populations representing different levels of urbanicity were used to examine differences in the relationship children have with nature. Each study took different approaches to measuring children's interaction with or perception of nature to explore its effects on their mental health.

As outlined in Chapter 2, different types of interactions with nature can be operationalized as accessibility, exposure, and engagement. The first study (Chapter 3) focused on quantitative measures of accessibility to nature to examine the relationship between children's HRQOL as a measure of mental health. A secondary objective was to identify whether or not levels of urbanicity (urban, suburban, rural) affect this relationship. Survey data was collected from 851 children, focusing on their demographics and HRQOL. All natural environment variables were measured according to accessibility within a 500m buffer around each participant's home. Logistic regression was used to explore individual level and environmental factors that are considered predictors of HRQOL stratified by level of urbanicity. Findings from study 1 (Chapter 3) were somewhat inconclusive as there were very few clinically meaningful significant relationships identified at the intrapersonal, interpersonal, and environmental level. However, differences in which variables predicted HRQOL outcomes were evident between the urban/suburban and rural populations. Natural environment variables were significant predictors in the urban/suburban populations more often than in the rural population. That being said those environmental variables that were significant, had opposite effects in each population. Using accessibility as the independent measure of nature was the first step in understanding the relationship between children's mental health and nature's potential beneficial effects. The findings support the use of different ways of operationalizing connections to nature, such as measuring exposure to nature

through ‘time spent in’ or ‘use of’ natural areas in future research to explore whether or not these types of measures are a more accurate depiction of actual use of these spaces.

Part of the purpose of using a mixed-methods approach in this thesis is to allow each study to support the other. The somewhat inconclusive findings from study 1 were motivation to explore whether or not children do see nature as being beneficial to their health, as well as to gain a better understanding of their perceptions of their natural environments. The second study (Chapter 4) explores the relationship children have with nature by employing qualitative research methods through focus groups. Twenty focus groups, with 84 participants were facilitated in Northwestern Ontario. The focus group guide was designed to gain perspectives of rural children’s understanding of what nature is, how they experience it, and their perceptions of the benefits and drawbacks of nature. Qualitative methods were used to allow children’s voices to be truly represented, while also attempting to soften the existing power relationships found in research facilitated by adult researchers. These methods facilitate discussions that allow children to communicate in their own terms providing valuable insight for researchers, practitioners, and policy makers. The findings from study 2 demonstrate how rural children are very aware of their natural environments and have a deep understanding of the benefits associated with nature interaction. Their definitions and understandings of nature were different from those described in studies done with urban children, underscoring the importance of the environmental context. They also demonstrate through their own experience the physical, mental, social, and cognitive benefits associated with nature interaction. Having only identified topics within health as the benefits associated with being in nature, emphasizes the role children support nature having on their health and well-being. This environmental context plays a large role in the results found here which can be used to support improvements to health promoting infrastructure and programs in rural communities. Rural environments are known to have less access to opportunities that improve and support healthy lifestyles (Boehmer et al., 2006; Galloway, 2006). The findings of this study can help to facilitate changes in the accessibility to health promoting interventions by taking advantage of a rural community’s natural environment.

5.2 Research Contributions

This thesis contributes to the fields of geography and children's health by adding a substantial amount of quantitative and qualitative data exploring Ontario children's health as effected by nature. The combination of both quantitative and qualitative methods allows for the collection of both large-scale data as well as the lived experiences and perceptions of children themselves. As outlined in Chapter 2 of this thesis there is a considerable amount of research that has focused on children's mental health and interacting with nature. However, specific physical environment features (urbanicity, region of Ontario) and the inclusion of multiple individual level variables is a unique contribution to the current body of literature on children's health and nature. Chapter 3 improves upon the literature outlined in the systematic review in three major ways. First, participants were classified as living in an urban, suburban, or rural environment. Identifying different levels of urbanicity within a single study has yet to be done when investigating HRQOL. Second, the rural locations included in this thesis represent under-researched regions of Ontario and help to build the base of literature surrounding children's mental health. Finally, the large sample size (n=851) of survey data allows for important translation of large scale findings for policy and practice (Barker & Weller, 2003). Chapter 4 shares these strengths in contributing rural children's perceptions to the existing small evidence base, but also adds research contributions to qualitative methodologies. Furthermore, applying the socio-ecological model allows for the investigation of outcomes at multiple levels (intrapersonal, interpersonal, physical environment), where much of the current literature does little to capture predictors at each of these levels. Incorporating these predictors at the individual level allows an exploratory approach to be taken generating a greater amount of knowledge to be obtained. Future research does, however, need to include policy level factors, as they have the ability to influence the outcomes being studied here.

One of the largest challenges in doing research investigating the relationship between nature and children's health is the difficulty in assessing the dose, type, and duration of nature that is required to see significant changes in the outcomes of interest. The systematic review in Chapter 2 classifies all types of nature interactions into three

categories (accessibility, exposure, and engagement) in order to examine the evidence based on the type of interaction being measured. These classifications help to alleviate some of the difficulty in assessing nature's relationship with children's health outcomes due to the heterogeneity of the types of nature interactions. These three categories represent ways researchers' measure children's contact with nature. Through this systematic review the weight of the evidence suggests that exposure to nature, through time spent in, or use of, natural environments, demonstrates significant positive changes in children's mental health. Chapter 3 of this thesis uses accessibility as a measure of children's interaction with nature to build upon the existing evidence reviewed in Chapter 2, as well as test the assumption that greater accessibility to nature will be associated with significantly higher HRQOL scores among children. The somewhat inconclusive findings suggest that more research is needed to further clarify the strength of the relationship between HRQOL and nature. However, they also emphasize conclusions made in Chapter 2, which suggests that exposure to nature is the ideal type of nature interaction. The concern with using accessibility as a measure of children's interaction is confirmed here, in that it does not account for spaces that are inaccessible or simply that children do not use. The presence of a particular space in a child's environment does not equate to the use of that space. Therefore, the combination of findings from Chapters 2 and 3 suggest that although accessibility is commonly used and was the first step in assessing this relationship, it is not the ideal measure of nature interaction. Therefore, its use should be cautioned in future research exploring children's mental health.

Findings from study 2 show that children are saying nature does matter to their health, including their mental health. The qualitative responses provide a spatial perspective through rural children's understandings of nature. When the findings were compared with qualitative work in the literature with urban children, it emphasized that there are significant differences in children's understandings of nature based on the environment they live in. Another contribution these findings offer is the treatment of children as independent social actors, able to make connections between particular environments and their mental health. These findings continue to support research *with* children not *on* children.

The timeliness of the current findings from both studies support the continuation of research looking to understand how nature affects children's mental health. The findings help support many avenues of research, exposing factors that influence children's mental health as it relates to nature and emphasize the need to further explore this relationship through other measures.

5.3 Limitations

In study 1, many intrapersonal, intrapersonal, and physical environment variables showed no relationship with children's HRQOL, depending on level of urbanicity. This is potentially due to using accessibility as the measure assessing nature interaction, where accessibility or opportunity to a particular environment does not automatically equate to use of that environment. Using accessibility potentially does not allow for the consideration of individual agency of children (Bell et al., 2014). The inclusion of GPS data and survey data resulted in some sample size issues. A number of participants were lost due to lack of GPS data or complete PedsQL data (n=75). Researchers attempted to mitigate these losses by verifying children had completed their surveys properly as well as visiting the schools every day to ensure they were wearing and using equipment properly. However, sufficient locational data may not have been recorded due to a number of technical and user issues. Majority of participants did come to school with their device; however, the internal battery was often dead or about to die. These limitations often rely on compliance of participants, thus are most often unavoidable. Furthermore, due to survey length constraints, the parent proxy report of the PedsQL was not included in the parent survey. Varni and colleagues recommend that whenever possible both the proxy and self-report should be administered (Varni et al., 2005). This limitation does not allow cross-informant variance to be accounted for, as children can under or over report their responses (Varni et al., 2005).

Study 2 attempted to address some of the limitations of study 1 by using qualitative methods, allowing children to communicate in their own terms. Surveys do not always allow for a child friendly communication, ignoring finer levels of detail (Barker & Weller, 2003). Focus groups can allow children to share more openly their individual attitudes, beliefs, and opinions. Although focus groups do eliminate some of the power

relationships found in quantitative methods, they still exist. This also limits the ability to have a fully participatory design. Although focusing on a rural population in these focus groups can be seen as a major strength, it is also a limitation. Study 1 attempted to assess nature's effects inclusive of all levels of urbanity; however, due to time constraints focus groups could not be analyzed in STEAM South populations.

5.4 Implications for Policy and Practice

The aim of this thesis, in part, was to allow the findings to help support knowledge users with additional evidence demonstrating the beneficial effects nature can have on children's mental health. A significant amount of research has supported nature's beneficial effects on a variety of health indicators in children, including physical activity, mental health, social skills, and cognitive development (Amoly et al., 2014; Artensson et al., 2009; Balseviciene et al., 2014; Block et al., 2012; Dadvand et al., 2015; Matsuoka, 2010; Maynard et al., 2017; Taylor & Kuo, 2009; van Lier et al., 2017; Wheeler et al., 2010; Wu et al., 2014). Findings from both studies in this thesis provide evidence that nature in part influences children's mental health.

Nature's influence over children's mental health is complex and therefore, difficult to provide specific doses or types of nature that are responsible for the change in mental health. Findings from study 1 support the continuation of developing and implementing programs that expose children to natural environments. If having access to it does not show strong positive impacts on a measure of mental health, exposing and engaging children could be the more effective interactions; for example, outdoor learning has been shown to improve cognitive functioning in elementary school children (Dadvand et al., 2015). This change in how we get children to interact with nature is supported by the findings in the focus groups. Children do believe nature matters to their health, providing the necessary evidence to continue to encourage nature as part of a variety of practitioners and policy maker's mandates. There has been some acknowledgment by practitioners and policy makers of the importance of nature in children's daily lives (Driessnack, 2009), however, there needs to be dedication by multiple parties to continue the encouragement of interacting with nature as beneficial to children's mental health. Children who view nature as being beneficial to their health on their own terms are more

likely to respond to efforts made by policy makers and practitioners. Therefore, the continued consultation of children in the development of programs and policies is essential (Barker & Weller, 2003).

Findings from this research help to identify areas which school boards and public health officials can make targeted improvements to children's environments, therefore, facilitating improved mental health outcomes. Previous literature has shown that naturalized schoolyards facilitate positive outcomes in academic achievement, focusing in a classroom, reduced stress, relationship skills, self-management, and physical activity levels (Barton et al., 2015; Bell & Dyment, 2008; Chawla et al., 2014; Roe & Aspinall, 2011; Wells et al., 2015; Williams & Dixon, 2013; Paddle & Gilliland, 2016). Developing strategies to improve schoolyards for the benefit of children's mental health allows for the promotion of children to be outdoors while still accomplishing other primary objectives. Rural children identifying school grounds as not very natural places also supports the implementation of green schoolyards in order to develop the more complex forms of nature that children describe as being beneficial. School grounds are critical areas to focus on, as this is where they are spending most of their outdoor time during a typical day. The importance of schoolyards as subjects for intervention is further reinforced by where these views of school grounds are coming from. Rural environments typically have greater access to nature in comparison to their urban counterparts, if rural children believe their school environments to be lacking nature it demonstrates the importance of these spaces becoming naturalized in all environments. School boards should also be dedicated to introducing daily interactions with nature as a part of curriculum to serve as points of intervention in helping to improve long term mental health and well-being of students.

Where children live was also a key variable tested within this thesis. Findings from both studies demonstrate differences based on level of urbanicity. Intrapersonal and interpersonal variables were more important in predicating HRQOL outcomes for rural populations, whereas the natural environment level variables were more evident in the urban/suburban analysis. Further exploration in study 2 also demonstrates potential differences within these environments based on a comparison of the findings with current

literature on urban children's perceptions of nature, where there were substantial differences within the findings. This is relevant to many policy makers and practitioners as literature states inequality exists in accessing health promoting infrastructure, programs, and services based on levels of urbanicity (Boehmer et al., 2006; Smith et al., 2008; White, 2013). Features unique to urban and rural environments should be incorporated into the development and implementation of health promoting infrastructure, programs, and services. A rural environment's abundant access to natural environments is an example of a strength that policy makers can take advantage of when attempting to close the inequality that exists in these types of environments. The results from the qualitative findings support infrastructure, programs, and services being targeted towards using nature as a promotion tool for children's physical, emotional, social, and school health.

Children's daily interactions with their habitual environments have significant influence over their health and well-being. The findings from this thesis support the continuation of multi-disciplinary efforts to incorporate nature and ecological planning into decision making processes of spaces that greatly affect children in urban, suburban, and rural environments. Planners and designers need to build safe, accessible parks and naturalized spaces within neighbourhoods to allow all children equal opportunity to nature and the health benefits it can provide. Renewal or renovating existing natural spaces is also encouraged to make these spaces more attractive to users, which can facilitate greater use. These green planning strategies can be facilitated in all types of environments and encourage exposure and engagement to nature. Without having to alter existing space, it is also crucial that health practitioners who work with families on a regular basis emphasize the beneficial effects that being in a variety of natural environments can have on children's mental health. The use of the findings here serves many policy makers and practitioners, but also parents. Most simply, these findings help to educate and motivate parents to continue to encourage their children to be outdoors in nature whenever possible. The knowledge translation of the current findings is important in allowing the relevant users to make informed decisions when designing new policy, programs, and infrastructure that can effect children.

5.5 Future Research

The results of this thesis emphasize the need for more research to support the relationship that nature has with children's mental and overall health.

Findings from study 1 emphasize the need to use a more accurate measure of children's actual interactions with nature on a daily basis. Accessibility is a common interaction type used in assessing nature's influence on children's mental health, however, it may not be the most accurate representation of their true interactions, as accessibility does not equal use (Bell et al., 2014). Future research with this data will use time spent in nature, from GPS tracks of STEAM participants, to more accurately assess the actual exposure participants have to natural environments. More accurate measures of children's interactions with nature can be more firmly associated with relationships to HRQOL and differences based on level of urbanicity. This will also potentially allow for the exposure of more predictors at the intrapersonal and interpersonal level. Research done by McCracken and colleagues supports that time spent or use of nature results in significant findings in comparison to measures of accessibility (residential green space) (McCracken et al., 2016). More time may also be needed to detect changes in HRQOL indices. The passive nature of assessing the natural environments effects on HRQOL may require more time between data collection periods than was given. Changes in mental health measures tend to not be observed over short periods of time. More time between data collection periods would also allow for potential differences in season to be accounted for. The majority of research done in this area does not take into account seasonality when measuring the association between children's mental health and nature. However, dramatic changes in climate, particularly in more northern latitudes, has the potential to change a child's state of mental health and well-being. This also calls for future research to develop intervention and control groups in order to create a comparison for observable differences.

Findings from study 2 support that changes in urbanicity influence how children interact and understand their environment. The next step for this data is to compare it to focus groups done on STEAM South urban/suburban and rural children. This comparison will allow for a more accurate comparison to urban populations understanding of nature as

well as again add to the lack of qualitative research on rural children's perceptions of nature. Exploring these differences is also important as children's frame of reference and how and where they place importance on natural environments may differ (James, 1990). Beyond the STEAM data set, future focus groups should delve deeper into the benefits children associate with interacting with nature in order to specifically target health-promoting tools that emphasize differences in children's natural environments. The findings from Chapters 3 and 4 help to fill a significant gap in the current literature, assessing rural children's environments. However, future research should continue to assess the relationships explored in this thesis, as there is a need to grow the literature base that examines children's health outcomes based on all levels of urbanicity.

Future research should also focus on collecting more information, both quantitative and qualitative, on participants' actual behaviours to supplement the findings discovered in this thesis. This is built upon the idea that accessibility does not necessarily equal use and knowledge does not necessarily predict behaviour. Data should also be collected on parents' perceptions, or children's perceptions of their parents' beliefs and attitudes, as evident in a substantial amount of research being done currently focuses on reminding parents that risky outdoor play is safe and should be encouraged. Developing a better understanding of the barriers that children face accessing or using nature is important in allowing findings of primary research to be made applicable to policy and practice. Furthermore, although the socio-ecological model was used in developing the variables measured in each study, policy level measures were not included. Future research should include independent measures that assess the policy environment impacting children's mental health.

Finally, moving towards a true participatory research design, incorporating children in each step of the research process would build upon the idea that children are more likely to act upon healthy choices if they can come to those conclusions themselves. This would include having participants be included in each step of the research process from the design of the questions themselves to the knowledge translation of the findings.

5.6 Conclusion

The purpose of this research was to investigate the relationship between nature and children, specifically their mental health and individual perceptions. Assessing children's interaction with nature through accessibility is the first step in understanding its relationship to their HRQOL. Using accessibility to nature in a child's environment is a common way to assess this relationship and the current study demonstrates that it needs further exploration through other measures including time spent in nature. When exploring children's definitions, experiences, and perceptions of the benefits and drawbacks of nature, findings show that rural children have an in depth understanding of nature and can easily identify a variety of health benefits associated to interacting with the natural environment. Both studies highlight the importance of interacting with nature as well as the potential differences that exist between urban, suburban, and rural populations. As mental health increasingly becomes of greater concern for governments, public health systems, educators, researchers, and individuals, these findings can help guide strategy and development of programs for supporting children's mental health. Furthermore, the findings from this thesis support developing policy, programs, and practices that incorporate, encourage, and facilitate children's active participation with nature.

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Appendices

Appendix A Research Ethics Approval Form for use of Human Participants STEAM South (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.

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

[redacted]

Ethics Officer to Contact for Further Information

Grace Kelly	Janice Sutherland
[redacted]	[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 B Research Ethics Approval Form for use of Human Participants STEAM North (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.

Members of the NMREB 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 number IRB 00000941,

[redacted]

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

Western University, Research, Support Services Bldg., Rm. 5150
London, ON, Canada N6G 1G9 t. 519.661.3036 f. 519.850.2466 www.uwo.ca/research/ethics

Appendix C Parent Letter of Information

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

Principal Investigator: [redacted]

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 is being conducted with grade 4 to 8 classes at various elementary schools across North Western Ontario.

What is being studied?

Our research team is conducting a project which will study the various places or facilities in your neighbourhood that your child uses (or intentionally don't use) on a regular basis for recreational or physical activity, including how they typically travel to these places – for example, how they travel to and from school each day. We are also interested in examining their dietary patterns, in particular, the locations in the neighbourhood at which they typically eat or purchase food. In addition, we'd like to learn more about how children perceive and feel about their local environments, and how this may influence their neighbourhood activities or travel.

What will happen in this study?

If you and your child agree to participate, **your child will be asked to:**

1. Complete the *Healthy Neighbourhoods Survey for Youth* (typically takes 30 minutes to write) about their perception and use of their neighbourhood environment and its facilities for activities and/or food consumption. Surveys will be filled out by all participating students in their classroom at a time made available by their teacher. Members of the 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 needed to complete the survey.

2. Wear two small pieces of equipment - a lightweight GPS logger and a loonie-sized accelerometer – each day during their waking hours for two 7 day periods – once in the Fall (September or October) of this and again in the winter (November or December) of the same year. The GPS logger, worn on an armband or collapsible neck lanyard, only maps the general places the child visited in the neighbourhood and the routes taken to get there - it has no display or orienteering capabilities and the data cannot be seen in 'real time'. The tiny accelerometer, worn on an unobtrusive elastic belt around his or her waist (can be worn underneath clothes), is similar to a pedometer but instead measures intensity of activity (e.g. running is registered as a more intense activity than walking or sitting). These tools will help us to understand children's travel and activity patterns within their neighbourhoods. By having children participate for 2 periods approximately 2 months apart we can also better understand how children's behaviours and activities change with the weather. Researchers will be coming into the schools on a daily basis during school hours to make sure the equipment is functioning and study procedures are being followed .

3. Complete a short activity diary for each day they wear the 2 pieces of equipment, briefly outlining their activities that day.

4. Participating children will also be given the opportunity to meet with the researchers in a focus group to discuss their feelings about their neighbourhood and to help clarify how the built environment of the neighbourhood helps or hinders their ability to engage in various recreational activities, to eat healthy foods, or to travel easily to the places they would like, such as parks. The focus group will typically involve 4-6 youth, will take place either at lunch recess or outside of school time, last about 30-60 minutes, and will be held at the school or another community facility. Participation in the focus group is completely voluntary; a child can decide not to participate in a focus group and still be allowed to participate in the rest of the study. All focus groups are audio-recorded and transcribed verbatim, as it is not possible to audio-record some participants and not others. Therefore, if you do not wish your child to be audio-recorded they will not be able to participate in the focus groups. We as researchers cannot guarantee what is said in the focus group won't be shared by classmates, but we always remind all students not to share what they have heard.

5. Children are welcome to participate in any of the 4 stages of the study. We only ask that if they did not participate in the survey AND the GPS/accelerometer/activity diary portions they do not participate in the focus groups, as we would like to link the findings.

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

1. Complete the *Healthy Neighbourhoods Survey for Parents* (takes 20-25 minutes to write) about household demographics as well as parent/guardian perceptions about your neighbourhood. The survey will be used to understand the various types of households participating within each school neighbourhood, as well as local parents' perceptions of the neighbourhood and their child's use of this environment. The Parent Survey is completely voluntary and doesn't disqualify your child from participating in the study themselves, but provides us with valuable information from parents' perspectives. We would greatly appreciate your participation.

2. Parents of participating children will also be given the opportunity to participate in a parents' focus group with the same aims as those with the children. The focus group will take place outside of school time, last approximately 45-60 minutes, and will be held at the school or another nearby community facility. Participation in the focus group is completely voluntary; a parent can decide not to participate in a focus group and their child will still be eligible to participate in the study as outlined above. All focus groups are audio-recorded and transcribed verbatim, as it is not possible to audio-record some participants and not others. Therefore, if you do not wish to be audio-recorded you will not be able to participate in the focus groups. We as researchers cannot guarantee what is said in the focus group won't be shared by other parents but we always remind all participants not to share what they have heard.

Do we have to participate in this study?

Your participation in this study is completely voluntary. You and your child are under no obligation to participate, you can refuse to answer any questions, and can choose to withdraw from the study at any time. Your decision will not affect your child's academic standing in any way.

What are the benefits and risks if my child participates?

Recent research has shown 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) within which we conduct our daily activities. Reviewing the information collected from this study will help us to better understand the links between our neighbourhood environments, our activities, and our health. The study results may be useful for local municipal and school board planners and decision makers who require input on how best to plan design healthy communities.

There are no costs to you or your child for participating in this study. However, each participant will earn $2/day for each day they are enrolled in the study and $3 for returning the equipment in each season. If children do not wear the GPS or return the diary for any given day, the $2 will be withheld until the following day when they are able produce their GPS and diary.

The equipment in this study is easy to use, and the research team will spend time with your child to make sure he or she understands how to use and care for the equipment. However, if any pieces of equipment break or become lost during the time they are in their possession, we will immediately provide them with a replacement unit without any cost or consequence to you or your child.

There may be risks to your child if he/she participates in this study; fatigue or disinterest on the part of the child in continuing with the study for the full 7 days are considered the largest risks. However, each piece of equipment weighs less than 60g (0.12 pounds). The height and weight of each participating child will also need to be collected, strictly to properly set up the accelerometer. Measurements will be taken in a private area at the child's school in the presence of a trusted adult (e.g. school nurse or teacher); no other children or persons outside of the research team will be present. The equipment used to measure a child's weight has no visible display; measurements are sent wirelessly to a nearby laptop and therefore will not be visible to anyone except research team members.

There is no risk that you or your child will be identified or identifiable in any study materials or publications. All of the information collected in this study will remain strictly confidential. Anonymity will be assured by assigning you and your child a unique identification code so that names or personal information will not appear on any survey or data file. Also, completed surveys, focus group transcripts (audio and written), and any detailed maps created from the GPS data, 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. Teachers and other students do not have access to ANY of this information and it is only made available to the participant themselves and the research team. Focus group members are 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 group members. Participating children will be able to review maps of their individual travel patterns on request for authentication purposes and to modify any information that they feel does not accurately reflect their experience. However, to ensure participation while protecting the privacy of each child, data or maps made from GPS units will not be made available to parents or guardians. We will inform the participants that the GPS unit is equipped with an "on/off" button and they can turn off the unit if ever there is an occasion where they wish not to be recorded. While we do our best to protect your information there is no guarantee that we will be able to do so. If data is collected during the project which may be required to report by law we have a duty to report.

If you or your child chooses to withdraw from the study at any time, up to 30 days after the completion of the project, any of your/their personal data collected to date will be immediately destroyed and excluded from the study analysis.

You do not waive any legal rights by signing this 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, University of Western Ontario. Pho[redacted]
email [redacted]

Representatives of The University of Western Ontario's Non-Medical Research Ethics Board may require access to your study-related records to monitor the conduct of the research. If you have any further questions regarding your rights as a study participant, please contact the Office of Research Ethics at [redacted]

Research Team
Dr. Jason Gilliland, Department of Geography, University of Western Ontario
Dr. Piotr Wilk, Department of Epidemiology, University of Western Ontario
Brenton Button, Department of Geography, University of Western Ontario

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

Western

Appendix D Parental Consent

Examining the Influence of the Neighbourhood Environment on Children's Health and Well-Being
Parent / Guardian Consent Form

Principal Investigator: Dr. Jason Gilliland, Dept. of Geography, University of Western Ontario [redacted]

Regardless 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!

A. Parent Involvement

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

☐ 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 with signed consent form*)

☐ I am interested in being contacted about participating in a parent focus group (***optional***). Please provide either phone or email contact information _____

B. Child Involvement:

☐ I agree to let my child _____ ***(child participant's name – please print)*** participate in the full 14 days (two 7-day periods within the next 2-3 months) of monitoring as outlined above.

OR

☐ I agree to let my child _____ ***(child participant's 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.

C. If you are providing consent for your child to participate in this study, please answer the following questions:

☐ I agree to allow my child to participate in an optional focus group at the end of the study.

☐ I am aware that unidentified direct quotes from the focus groups could be used in future publications.

☐ Please check if your child has *health issues* which restrict their ability to walk/exercise or otherwise participate in this study.

_____ Parent/Guardian Print Name

_____ Parent / Guardian's signature

_____ Date

Appendix E Child Letter of Information

HEAL
HUMAN ENVIRONMENTS ANALYSIS LABORATORY

Western

How healthy is the Environment in Your Neighbourhood?

Letter of Assent- Student

Principal Investigator:
Dr. Jason Gilliland, Department of Geography, University of Western Ontario
[redacted]

Hello! We are researchers from the University of Western Ontario and we are doing a study in your neighbourhood! We need students in Grades 4-8, 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 facilities that you have and use in your neighbourhood also help to keep you healthy. You will not be tested! We want to collect this information so we can share our results with you and others who can help make your environments healthier.

What would you have to do?

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

1. Wear 2 small pieces of equipment every day for a week this Fall, and again in the Winter. A small GPS unit will help us to make a map of all the places you visit every day. You would also wear a 'loonie'-sized piece of equipment called an accelerometer 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 during both sessions.
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 both during the Fall and Winter sessions. It takes about 30-45 minutes.
4. Then you would wear the equipment and fill out the diary again for a week later this Winter.

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

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. This will take place at your school. We would like to audio record our talk. All focus groups are audio-recorded and transcribed word for word, as it is not possible to audio-record some participants and not others.

Therefore, if you do not wish to be audio-recorded you will not be able to participate in the focus groups. We as researchers cannot guarantee what is said in the focus group won't be shared by your classmates, but we always remind all students not to share what they have heard.

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. We only ask that if you did not participate in the survey AND the GPS/accelerometer/activity diary portions of the study that you do not participate in the focus groups.

This letter is yours to keep for future reference.

Appendix F Child Assent

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

AND please choose whether or not you would like to participate in a focus group:

☐ Yes, I would like to participate in the audio-recorded focus groups OR
☐ No I do not want to participate in the audio-recorded focus groups

If you answered YES to participating in the focus groups:

☐ Please check this box if you are aware that anonymous direct quotes from the focus groups could be used in future books or published papers.

_____
Print First and Last Name

_____	_____	_____
Signature	Age	Date

_____	_____
Signature of Person Obtaining Assent	Date

Appendix G Systematic Review Team

Expert Advisory Panel for Systematic Review:

1. Dr. Jason Gilliland, Professor, Geography, Health Sciences, Paediatrics, Western University; Director, HEAL, Western University
2. Dr. William Avison, Emeritus Professor, Sociology, Paediatrics, Epidemiology & Biostatistics, Western University
3. Dr. Elizabeth Hayden, Associate Professor, Psychology, Western University
4. Dr. Leia Minaker, Scientist, Propel Centre for Population Health Impact, University of Waterloo
5. Dr. Trish Tucker, Assistant Professor, Occupational Therapy, Western University

Appendix H Semi-Structured Focus Group Guide

Welcome:

- Thank you guys for coming to talk about your physical activity habits nature, and healthy eating with us. My name is _____ and my name is _____ (note taker).

Guidelines:

- Our chat today will be audio recorded to make sure we don't miss any important information you tell us. Is everyone ok with that? We will keep everything we discuss in this group between us.
- (Note taker's name) will also be taking notes to make sure we don't miss anything. When we are finished, we will review what we've talked about and give you guys the chance to add anything before we go.
- I will be asking a few questions and we will be done in about 30 minutes. It's important that each of you **talk one at a time** and we would like to **hear from all of you**, however if there is a question you don't want to answer that's fine.
- We are just interested in your thoughts and opinions. I am sure you guys can help us to understand what makes you active.

Getting Started:

- To get started lets go around the group and I want each of you to say your name and your favourite thing to do in your spare time.
    - The moderator will start

Questions for nature portion of focus group:

1. What comes to mind when you think about nature?
    a. Probe:
        i. Why they consider these things nature?
        ii. Would you consider a plant in a classroom nature?
2. Where do you find nature in and around your a) school b) home?
    a. Probe:
        i. What do you use these spaces for?
        ii. How do you feel when you are in these places?
3. What are the benefits of nature?
    a. Probe:
        i. Do you feel better or worse in nature?

Appendix I Initial Focus Group Codes

Trees/grass/moss, animals, activities, a place/outside, flowers/plants/leaves, feelings, water, mountains/rocks/sky, scenarios, other,

Living things, food, oxygen, forest/bush/ecosystems/ habitats, permanent/untouched/not man-made, don't know, other

Yes, no, unsure

Off school property, on school property, outside, feature of nature, inside, everywhere

Playing/running/exercise, hanging out with friends, playground, everything, short cuts, walks, aren't allowed/don't use/don't know/not often/not allowed

Bush, outside, feature, inside, home property, trails, neighbourhood, other

Play/exercise, forts/treehouses/building, walks/hikes/climbing/exploring, hunting/camping/fishing/gardening/skating/snow machine/quading/dirt bike/swimming, don't use, short cuts, relax/escape, specific season, other

Happy, scared/nervous/unsafe, peaceful/calm, physical health, thankful, fun/adventurous/wild/free, season/temperature, better, safe, negative, good for you, other

Oxygen/air/breathing, activities, electronics, active/exercise, plants/trees, animals, medicine, food/water, feeling, other

Curriculum Vitae

Name: Suzanne Tillmann

Post-secondary Education and Degrees:
Queen's University
Kingston, Ontario, Canada
2010-2014 B.Sc. (Honours) Life Sciences

The University of Western Ontario
London, Ontario, Canada
2015-2017 (Expected) M.Sc. Geography

Related Work Experience:
Teaching Assistant
The University of Western Ontario
2015-2017

Research Associate
Human Environments Analysis Laboratory
2015-Current

Conference Presentations:
Oral Presentation
Tillmann, S., Tobin, D., & Gilliland, J. *A Systematic Review of Nature's Connection to Children's Health and Development*
American Association of Geographers
Boston, Massachusetts, April 2017

Poster Presentation
Tillmann, S., Button, B., & Gilliland, J. *Children's Perceptions and Definitions of Nature in Rural Northern Ontario*
Children's Health and Environments Workshop and Symposium
London, Ontario, June 2017

Poster Presentation
Button, B., Tillmann, S., Goodbaum, A., Clark, A., & Gilliland, J. *Examining Seasonal Differences in Children's Physical Activity Behaviours in Rural Northwestern Ontario*
Children's Health and Environments Workshop and Symposium
London, Ontario, June 2017

Oral Presentation
Gilliland, J., Tillmann, S., & Tobin, D. *Benefits of Connecting Children with Nature: A Systematic Review*
Children's Health and Environments Workshop and Symposium
London, Ontario, June 2017

Oral Presentation
Gilliland, J., Tillmann, S., & Tobin, D. *Benefits of Connecting Children with Nature: A Systematic Review*
Presentation to the Geographical Sciences Committee, National Academies of Science, Engineering, Medicine
Washington, DC, October 2017