ENVIRONMENTAL AND PARENTAL FACTORS THAT SHAPE CHILDREN'S TERRITORIAL RANGE

by

JANAE VLAAR

B.Sc. (Honours), Queen's University, 2016

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Population and Public Health)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

August 2018

The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, a thesis/dissertation entitled:

Environmental and parental factors that shape children's territorial range

submitted by Janae Vlaar in partial fulfillment of the requirements for the degree of Master of Science in Population and Public Health

Examining Committee:

Louise Mâsse, School of Population and Public Health
Co-supervisor

Mariana Brussoni, School of Population and Public Health
Co-supervisor

Ian Janssen, School of Kinesiology and Health Studies, Queen's University
Supervisory Committee Member

Mieke Koehoorn, School of Population and Public Health
Additional Examiner

Additional Supervisory Committee Members:

Supervisory Committee Member

Supervisory Committee Member

Abstract

Children's independent mobility (IM), their freedom to move about their neighbourhood without supervision by adults, has been in steady decline in recent decades. Previous research has linked perceptions of the environment with various measures of IM, but recently concerns have been raised regarding inconsistency in measuring IM. This study used various measures of IM and aimed to address how parental perceptions of the neighbourhood environment are associated with children's territorial range – their actual spatial mobility – as well as how this relationship is mediated by IM parenting practices. Territorial range was derived from GPS, accelerometer, and activity diary data and IM parenting practices measured by license for independent mobility (LIM), roaming allowance, and parental boundaries. Path analysis was used to investigate the direct and indirect effects of these relationships.

Some parental perceptions of the neighbourhood environment were significantly associated with IM parenting practices (LIM and roaming allowance). IM parenting practices were significantly associated with children's territorial range. Direct effects of parental perceptions of the neighbourhood environment on children's territorial range were variable, and only roaming allowance was found to mediate this relationship. Results indicate that IM parenting practices directly affect children's territorial range to varying degrees. Parental perceptions of the neighbourhood environment have mixed effects on IM parenting practices and children's territorial range. These findings suggest that future interventions to increase children's IM should focus primarily on behavior change among parents since they are setting restrictions or allowances for children's IM.

Lay Summary

Children's independent mobility (IM) is the freedom that children have to travel and play in their neighbourhood without adult supervision. IM has been decreasing in recent years, but is an important way for children to be physically active and engage with their peers and environment, aiding in development and well-being. This study looked at how parent's perceptions of their neighbourhood influenced children's territorial range, a measure of children's IM. Additionally, this study examined how this relationship was affected by parenting practices such as what parents allow their children to do and where parents allow their children to go without supervision.

Parental perceptions of some aspects of the neighbourhood environment were related to IM parenting practices and children's territorial range. IM parenting practices were significantly associated with children's territorial range. This suggests that future interventions to increase children's territorial range should focus on attitudinal changes among parents rather than environmental changes.

Preface

This thesis contains the work from a study conducted by the candidate, Janae Vlaar, under the supervision of Dr. Louise Mâsse and Dr. Mariana Brussoni with guidance from Dr. Ian Janssen. This research used the primary data of the *State of Play: Socio-ecological perspectives on children's outdoor play* study which was conducted under the supervision of Dr. Mariana Brussoni and Dr. Louise Mâsse with other research staff at the British Columbia Children's Hospital Research Institute and affiliated institutions.

Sections of this thesis will be submitted for publication in peer reviewed journals.

The state of play: Socio-ecological perspectives on children's outdoor play was approved by the Behavioural Research Ethics Board at the University of British Columbia (#H15-02190).

Table of Contents

List of Tables

List of Figures

List of Symbols

α	Cronbach's alpha
km	Kilometres
N	Number
r	Pearson's correlation coefficient
%	Percent
p	Significance level

List of Abbreviations

AT	Active Transportation
BC	British Columbia
DV	Dependent Variable
GPS	Global Positioning System
ICC	Intraclass Correlation Coefficient
IM	Independent Mobility
IV	Independent Variable
LIM	License for Independent Mobility
LIMS	License for Independent Mobility Scale
MV	Mediating Variable
NEWS	Neighbourhood Environment Walkability Scale
NRS	Neighbourhood Relations Scale
OP	Outdoor Play
PA	Physical Activity
PALMS	Personal Activity and Location Measurement System
SC	Standardized Coefficient
SD	Standard Deviation
SDPS	Social Danger Perception Scale
SES	Socioeconomic Status
UK	United Kingdom
US	United States

Acknowledgements

This thesis would not have been possible without the support and guidance of many people. First, thank you to my amazing thesis supervisor, co-supervisor, and committee. Louise- thank you for providing guidance when I needed it most, challenging me to enrich my knowledge and push my boundaries, and supporting me through to the end of this journey and seeing me into the next. Mariana- thank you for engaging me in different opportunities throughout this process and for continually encouraging me to think critically and consider different perspectives. Ian- thank you for always being available to answer questions and for your invaluable feedback and advice.

I would also like to thank my family and friends who have offered their continual encouragement, who were patient while I struggled with my research, and who celebrated when it went well. Thank you to my Squamish fam, lab mates, and SPPHomies for always checking in and being up for adventures however big or small, whether biking, ice cream, or potlucks. To my sister who I look up to- thank you for your love, laughter, and endless support from the other side of the country. To my amazing mom who always has my back- thank you for teaching me to love and appreciate my education and for always encouraging me to stay joyful and be open to new experiences. To Will- thank you for always being here for me (even when I decide to finish my thesis and train for Ironman at the same time) and pushing me to do what I love.

I am also thankful for the financial support that I received while completing this thesis. Funding was provided by the Canadian Institutes of Health Research (CIHR) and the University of British Columbia.

Dedication

To my mom.

Chapter 1: Introduction

Independent mobility (IM) – the freedom that children have to be in and move about their neighbourhood without adult supervision, either on their own or accompanied by peers[1,2] - has been linked with numerous physical, cognitive, emotional, and social health benefits.[3,4,5,6] These benefits are accumulated largely through physical activity (PA), active transportation (AT), and outdoor play (OP).[7–10] Canadian statistics indicate that a very low proportion of children are meeting PA recommendations, using AT, and spending adequate time outside, suggesting low levels of IM.[11] Given this, it is important to understand the factors that influence and interact to shape children's IM in order to develop targeted interventions to maximize children's IM. This has resulted in a growing body of literature in this area. However, as Bhosale et al. point out, it is difficult to draw comparisons between studies due to the use of different terminology and measurements.[12] Taking this into consideration, this study reviewed IM as a broad term that captures all of the different measures and alternative terms and broke IM down into different measures in analysis.

Socioecological models for active living[13] and health behaviours[14] provide a useful framework for examining influences on children's IM. A number of proximal factors, such as intrapersonal, interpersonal, and perceptual, have been found to influence children's IM to varying degrees.[15–23] Intrapersonal factors, such as child age and gender, have been studied extensively, leading to the general conclusion that children who are older and male have greater IM than children who are younger and female.[15–17] In terms of interpersonal factors, the parent-child relationship, specifically parenting practices related to IM, are important to consider when examining children's IM. Parents act as "gatekeepers" to their children's activities[24] and the allowances or

restrictions they place on their children influence their children's IM.[18] Perceptual factors, particularly parental perceptual factors relating to the neighbourhood environment, have been found to influence children's IM.[19,20] The strongest evidence for the influence of perceptual factors has been perceptions of safety, both in terms of the physical environment and the social environment.[15,21–23] These three layers of influence have been shown to influence children's IM and were considered in this study.

The purpose of this study was to examine the association between parental perceptions of the neighbourhood environment and children's territorial range (their actual IM; referred to as activity spaces, home ranges, activity ranges, or IM area in previous literature).[25] This study considered both the direct influence of parental perceptions of the neighbourhood environment as well as the mediating influences of IM parenting practices on this relationship. Children's territorial range was operationalized as the objective measurement of children's seven day IM, derived from global positioning system (GPS) location data, accelerometer data, and daily activity diaries. IM parenting practices were examined through three self-reported measures: license for independent mobility (LIM),[1,26] roaming allowance,[27] and parental boundaries (area and distance). Parental perceptions of the neighbourhood environment were assessed in terms of convenience, accessibility, attractiveness, safety, and comfort.[13] The influence of child intrapersonal factors, specifically child age and gender, on this relationship were considered as covariates.

This study examined how children's territorial range is associated with parental perceptions of the neighbourhood environment, whether IM parenting practices mediate this relationship, and

how child age and gender influence these relationships. Children's behaviours are influenced by numerous factors and exploring the interplay of these factors on children's territorial range may offer opportunities to further specify the targets of potential interventions.

Chapter 2: Literature Review

2.1 Independent Mobility

Independent mobility (IM) is, broadly, the freedom that children have to be in and move about their neighbourhood without adult supervision, either on their own or accompanied by peers.[1,2] While there has been a growing body of research on how children move in and around their neighbourhoods without adult supervision, there is a lack of consensus about how IM is specifically defined and measured.[12] IM has been used in various ways throughout the literature, so this review takes IM to encompass all of these various definitions (including activity spaces, activity ranges, neighbourhood ranges)[25] and measurements (including both spatial and behavioural self-reported and proxy-reported measures, map or location based measures, and interviews).[12]

2.2 Benefits of Independent Mobility

Research has shown that children with greater IM accumulate more PA as they are more likely to engage in AT and spend more time active in OP.[7–10] PA is important for both physical and cognitive health.[3,4] Regarding physical health, a systematic review highlighted that PA operates in a dose-response relationship to prevent chronic health issues such as high cholesterol, high blood pressure, and low bone density.[3] In terms of cognitive health, a recent review examined the effects of PA on cognitive functions and concluded that PA aids in cognitive development, by improving adaptability, stress regulation, and executive functioning.[4]

In addition, IM provides natural opportunities for environmental interactions and challenges through both AT and play. Travelling actively and playing in the neighbourhood allows children

to engage with their physical environment and develop their navigation and way-finding skills.[28] Furthermore, it also encourages interactions with peers or neighbours which afford social challenges that can foster cooperation and social relationships.[5,6] Finally, interactions with physical features of the environment during AT and play provide physical and cognitive challenges that aid in motor skill development, risk-management, and problem-solving.[6,28,29]

To summarize, IM has been shown to be associated with PA behaviours and environmental interaction through both AT and play. PA is linked with physical and cognitive health benefits [3,4] and environmental interaction can promote social, emotional, cognitive, and physical development in children.[5,6,28,29] Given the important role IM has been shown to play in healthy child development, understanding trends in and influences on IM is warranted.

2.3 Trends in Independent Mobility

Despite the many health and developmental benefits of IM, research has reported consistent declines in IM.[1,26,30] This section will review trends related to IM. Since there are no national data and limited research that tracks children's actual unsupervised neighbourhood mobility, it is necessary to examine behaviours linked to IM, specifically PA behaviours, which can suggest trends over time. Therefore, this section provides a brief overview of how current levels of PA behaviours related to IM, specifically AT and OP, have changed over time.

The 2018 ParticipACTION Report Card on Physical Activity for Children and Youth (formerly the Healthy Active Kids Canada report card) indicates that Canadian children have a D+ in overall PA: only 35% of 5- to 17-year-olds meet the Canadian 24-Hour Movement Guidelines

for Children and Youth.[31] Based on accelerometer data, 9% of Canadian children age 5 to 17 years old engage in at least 60 minutes of moderate-to-vigorous physical activity per day at least six days of the week.[32] This small proportion of children meeting the minimum recommended amount is indicative of similar trends in two components of PA: AT and OP.[11]

Use of AT among children is low and has decreased over time. Most of the research on children's AT is related to the school journey, likely because school is a destination accessed routinely by the vast majority of children.[33] Despite this, only a small proportion of Canadian children travel actively to and from school. Among parents of 5- to 19-year-olds, 21% report that their children regularly travel exclusively by AT to and from school, compared to 63% who report exclusively inactive travel to and from school, and 16% who use both active and inactive transportation.[34] It is important to note that this proportion changes drastically when distance to school is accounted for, with data showing that the majority of children living within 1.6 kilometres of their school use AT to travel to and from school.[35] The current low levels of AT to school follow a decreasing trend over time.[36,37–39] A study conducted in Toronto compared the proportion of school trips that were made by walking in 1986 and 2006. Results showed a 10.5% decrease among 11- to 13-year-olds and a 7.9% decrease among 14- to 15-year-olds.[36] Similar findings have been reported in Spain, Czech Republic, Norway, the United Kingdom (UK), Finland, Denmark, Australia, and the United States (US).[37–41] These studies consistently report a decline in AT to and from school[37–39] and an increase in travel to school by car over time.[40,41] Furthermore, research suggests that AT to school is higher than AT to non-school destinations, indicating that if total AT was considered the figures would be even lower.[42]

Only 37% of 11- to 15-year-old Canadian children report playing outdoors for more than 2 hours per day outside of school hours[31] and 63% of parents report that their 5- to 19-year-old participates in some form of unorganized outdoor PA after school.[43] Over half of Canadian children get less than three hours of OP per week.[44] Children's outdoor free play - activity that is freely chosen and self-directed – has sharply decreased over time.[45,46] In Canada, this has been measured as a 14% decrease between 2000 and 2010 in the proportion of Canadian children playing outside after school.[47]

Cumulatively, these studies suggest that children's PA, AT, and OP in developed countries have decreased over time and are at a historic low. While children's PA, AT, and OP are not necessarily without adult supervision, data indicate a shift from unsupervised to supervised activities,[48] suggesting an overall decline in children's IM.

2.4 Influences on Independent Mobility

To gain an overall understanding of the factors that influence IM, it is useful to incorporate elements from the socioecological model to build a framework for exploring the interplay of individual child factors, parenting practices, and perceived environmental factors. Socioecological models conceptualize individual behaviours as being shaped by concentric layers of the environment, ranging from proximal to distal influences. Although IM is not strictly a PA behaviour, Sallis' ecological model of active living provides a useful starting point for conceptualizing influences on IM.[13] Sallis' model expands the socioecological model to highlight that while behaviours in various environmental settings are influenced by the individual and their environment they are also influenced by their perception of the environment.[13] As suggested by

McLeroy's socioecological model,[14] in the child context it is important to take into account interpersonal relationships that can influence children's behaviours: specifically, how parents can shape their children's IM through parental expectations. Combining these two concepts – the importance of both perceptions and expectations – leads to the consideration of parent perceptions of the environment in a socioecological model for children's territorial range behaviours. Timperio et al. highlight the importance of parental perceptions through findings that indicate that children's walking and cycling behaviours were more strongly related to parental perceptions of the neighbourhood environment than the child's own perceptions.[20]

While the socioecological model emphasizes the complexity of factors that influence children's territorial range, this study focused on the proximal factors. As denoted by the highlighted sections of **Error! Reference source not found.**, this study examined how children's territorial range is shaped by the interplay of intrapersonal, interpersonal, and perceptual factors.

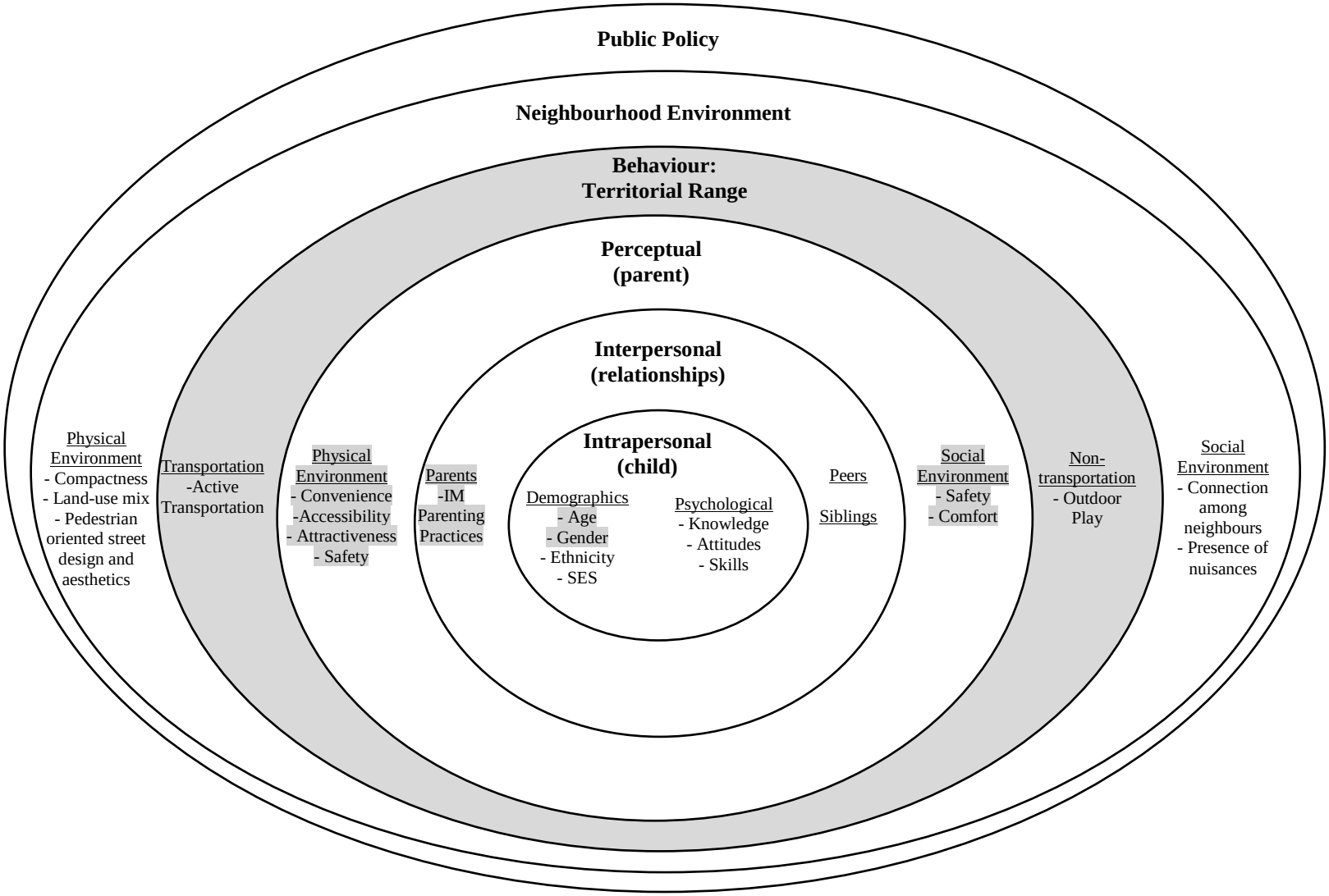

Figure 1: Theoretical framework for children's independent mobility adapted from socio-ecological models of health behaviours. [13,14]

2.4.1 Intrapersonal Factors: Child Gender and Age

Socioecological models recognize the influence of intrapersonal factors on health behaviours. These characteristics of the individual child include demographic factors such as age, gender, ethnicity, and socioeconomic status (SES) as well as psychological factors such as knowledge, attitudes, and skills. While research has shown that many intrapersonal factors influence children's IM,[24,32–38] age and gender have been studied heavily and deemed to be especially important correlates of IM[15–17] and are thus reviewed in this section.

In general, boys are believed to have greater IM than girls, but recent data suggest that this gap is disappearing. Studies in Norway,[15] New Zealand,[16] Australia,[8] and the UK,[17] all found that boys had greater IM than girls. These results seem to be echoed in trends in AT and OP.[11,20,53,54] Gender appears to have a strong influence on AT to school, with boys being more likely to travel actively than girls.[20,53,54] In terms of OP, Canadian data indicate that participation in unorganized PA after school is greater among boys than girls.[11] However, strong evidence against the common conclusion that boys have greater IM than girls is presented in a large scale study involving 16 countries. In this study, Shaw et al. found that the gap between boys' and girls' IM shrunk over time, such that in some countries, there is no gap.[50] This highlights the changing nature of gender disparity in IM and suggests that further research is needed to assess this shifting relationship.

Age may be a more important influence on children's IM than gender.[55] Regarding IM among 7- to 15-year-old children in 16 countries, those 11 and older had significantly higher IM than those 10 and younger.[50] These findings were corroborated in New Zealand and Australia, respectively,

where 11-year-old children had much greater freedom than 9-year-old children[16] and where secondary school children had more IM licenses than primary school children.[52] However, these results are complicated by findings in the AT and OP literature. One review found that age was not a consistent predictor of AT to school.[51] Some studies found that increasing age was associated with more active commuting, while other studies found that increasing age was associated with less active commuting.[51] New Zealand children aged 11 to 12 had 3.44 times greater odds of active transport to school relative to children aged 5 to 9, but children aged 13 to 14 had only 2.88 times greater odds of active transport to school relative to the 5- to 9-year olds.[56] It is suggested that while with increasing age children are increasingly allowed to walk to school, this trend reverses in the mid- to late- teen years when older siblings or the children themselves begin driving, resulting in a non-linear relationship of AT with age.[51] In terms of OP, Canadian data indicate that the proportion of children engaging in OP after school decreases with age, with recent statistics highlighting a 27% decrease in unorganized PA in 15- to 19-year-olds compared to 5- to 10-year-olds.[11] Taken together, these findings suggest that while the evidence is strong for a general increasing trend in IM with age, the type of IM, whether AT or OP, changes differently with age, and that younger children's IM may include more OP,[11] while older children's IM may include more AT.[56]

2.4.2 Interpersonal Factors: Independent Mobility Parenting Practices

McLeroy's socioecological model highlights the influence of interpersonal relationships on individual behaviours. For children, these relationships may be with parents, siblings, or peers. While siblings and peers may be important to children's IM by providing companionship for unsupervised activities,[57] parents set the stage for children's IM, acting as 'gatekeepers' for their

children's activities.[24] Ultimately, parents are the ones affording, restricting, expanding, or limiting the boundaries of their children's IM. O'Brien et al. suggest that examining familial practices is crucial for creating a context in which it is possible to better understand children's spatial mobility since children's decisions regarding their IM behaviours are bounded by limits or allowances imposed on them by their parents.[30] For these reasons, the interpersonal factors of children's IM behaviours considered in this study are parenting practices related to IM. The concepts of overprotective parenting and mobility restrictions that may influence children's IM will be reviewed here.

Hyper-parenting has become the new norm, and has drastically increased with time.[24,58–60] Hyper-parenting is the excessive involvement of parents in their children's lives in various ways including overprotection, expectation for extremely high achievement, spoiling with material goods, and overscheduling.[61] Hyper-parenting can result in children not being allowed to participate in activities that involve some aspect of risk due to safety fears,[59] or not allowing children the freedom of time or expectation to be independent. Janssen found that OP and AT were lower for children who had high "tiger mom" (extremely high expectations), "little emperor" (spoiling with material goods), and "concerted cultivation" (overscheduling) parenting scores,[61] indicating that hyper-parenting may negatively influence children's IM.

Studies have consistently found that concern for their child's safety is the main reason that parents restrict IM.[23,24] For example, a cross-sectional study of children (aged 10 to 11) and adolescents (aged 15 to 17) in Australia examined constrained behaviours and parental perception of risk.[62] Constrained behaviours were categorized as avoidant (preventing children

and/or adolescents from engaging in certain activities) or defensive (supervising or constantly reminding children and/or adolescents of safety during activities).[62] Among the adolescent age group, but not the child age group, perceived risk to safety was significantly associated with both avoidant and defensive constrained behaviours.[62] It is hypothesized that this relationship did not hold true for the child age group because parents prevented exposure to risky activities altogether.[62] Pacilli et al. further this point by highlighting that research has shown that it is not a lack of awareness of the benefits of increased outdoor autonomy that leads parents to restrict their children's IM.[18] Rather, they suggest that parents have to manage a balance between promoting children's independence and increased responsibility with the "social emphasis on children's vulnerability and protection",[18] a difficult mediation to manage, resulting in an increase of hyper-parenting practices.[18]

Parenting practices in relation to IM have been examined using LIM and self-reported range as ways of indicating children's allowed IM. Although LIM is a proxy for children's IM, recent research by Bhosale et al. provided quantitative evidence for a positive relationship between LIM and perceived IM area.[12] LIM are granted to children by their parents and are assumed to "reflect parental judgements about the degree of maturity and competence required by their children to cope safely with the perceived dangers that lie outside the home".[26(p6)] Each license indicates whether or not a child is allowed to do a certain thing without adult supervision. Self-reported range reflects how far from home a child is allowed to roam without an adult.[27]

Studies have shown that both LIM and self-reported range have decreased over time. In Hillman et al.'s seminal study, children's LIM in England and Germany decreased between 21% and 57%

between 1971 and 1990.[26] Twenty years later, Shaw et al. conducted a follow-up study and found that decreases were less dramatic, but continued. Similar findings were demonstrated in New Zealand, where parents had significantly higher LIM when they were children than their children.[63] In terms of self-reported IM range, evidence shows that the distance children are roaming from home is shrinking with time. For example, an intergenerational study in New Zealand found that children's average self-reported roaming distance was 50% less than their parents and 66% less than their grandparents.[64] Similar findings were reported in Australia, where just over one third of children in the study were allowed to roam more than 15 minutes from home without supervision,[27] and North America, where only 9% of 7- to 11-year-old children were allowed more than three blocks from home while 45% were not allowed further than their own yard or driveway.[55]

To summarize, IM parenting practices are an important influence on children's IM. Through the granting or restricting of LIM and allowance or limits on roaming range, parents exert some control over where and what their child is allowed to do. As overprotective parenting has increased, LIM and roaming range have decreased, highlighting the relationship between parenting practices and children's IM.

2.4.3 Perceptual Factors: Neighbourhood Environment

As highlighted in Sallis' socioecological model for active living, the perceived environment is an important component to understanding active living behaviours.[13] Research has shown that perceptions of the environment influence children's IM and related behaviours.[21,65–67] The perceived environment is important to consider because it may exert its own influence, different

from the objectively measured environment.[68] A study of bicycling environments in Portland highlights this. They found that perceptions of the environment were directly and positively associated with bicycling behaviours. They also found that while the objectively measured environment was also associated with bicycling behaviours, this association disappeared once perceptions of the environment were controlled for.[69] Similarly, among a sample of 11- to 15-year-old Canadian children, it was found that perceived neighbourhood safety was a stronger predictor of out of school PA than objectively measured neighbourhood crime.[70] This suggests that examining perceptions of the environment rather than qualities of the environment itself may be more predictive of behaviour. This section will review perceptual factors in relation to children's IM, specifically perceptions of the physical and social neighbourhood environments.

2.4.3.1 Perceived Physical Environment

Perceptions of the physical environment can be examined in terms of convenience, accessibility, attractiveness, and safety.[13] These aspects of the environment will be used to guide a review of how perceptions of the physical environment have been found to influence children's IM.

Convenience

The perceived convenience of a neighbourhood can be examined through a) the perceived availability of a broad range of service and retail destinations, and b) perceptions of recreational amenities such as fields and green spaces.[71] There is little research on perceived convenience in relation to children's IM, with most related studies using objective measures of convenience and looking specifically at children's AT.[54,65,72–78] The mixed results that arise from this body of literature can help give insight into the type and complexity of the relationships that may exist.

There is no strong evidence for the perceived relationship between convenience and children's IM. Studies using objective measures of the environment in relation to children's IM have had mixed findings, with some reporting no association[76] and some reporting gender-specific associations in different directions.[74] A more consistent finding, however, is that the availability, size, and interest of recreational amenities seems to matter more for boys than for girls.[74,76] Multiple studies have found that increasing distance to parks significantly decreases the likelihood of IM for boys, but not for girls.[74,76] Given the research above regarding overprotective parenting and gender differences in IM, it seems reasonable that the recreational amenities need to be close to home in order for them to influence IM. However, more research specifically on the perceived convenience of the environment is needed to confirm these findings.

Accessibility

The perceived accessibility of a neighbourhood can be examined through: a) perceived residential density which is the compactness of a neighbourhood or the number of people occupying a unit of land area, indicated by the mix or dominance of various housing types[79]; b) perceived street connectivity, defined as how physically well connected a neighbourhood is in order to support easy connections between people and places. High connectivity would be embodied by gridiron street networks with high intersection density and multiple available routes, compared to curvilinear and cul-de-sac networks which have lower intersection density, more dead ends, and fewer available routes[79]; c) perceived barriers to accessibility, whether

natural, built, or temporal, for example hills, highways, or poor transit schedules[71]; and d) perceived walking facilities, including the quantity and quality of sidewalks.[13]

Although there is little research tying perceptions of residential density and street connectivity with IM, objectively measured residential density and perceived connectivity have been examined in relation to AT, with results that seem to vary by country.[54,72,73,80] Two US studies on children of different age groups both found that objectively measured residential density was significantly associated with AT and noted a positive relationship between increasing residential density and increasing AT.[19,72] However, a Finnish study concluded that children in lower-density neighbourhoods were more likely to travel by AT than children in higher-density neighbourhoods.[80] Similarly, studies that have examined the relationship between perceived connectivity and AT, range from a positive association in the US,[72] to no association in Belgium,[54] to a negative association in Finland,[73] reinforcing that more research needs to be done to clarify these relationships considering that relative neighbourhood density and connectivity and the ways in which neighbourhoods are designed varies by country.

Like other elements of accessibility, perceived land-use accessibility and walking facilities have been examined with respect to children's AT, with inconsistent findings, indicating no strong evidence.[19,72] To further this point, two US studies, one looking at the parent(s)' (parent of 8- to 15-year-old) perceptions of the environment and one looking at the child's (12- to 15-year-old) perceptions of the environment, concluded different things for both items.[19,72] When parents' perceptions were considered, accessibility and walking facilities were significantly associated with children's AT, but when children's perceptions were considered, they were not significantly

associated with children's AT.[19,72] These findings further the argument that research focusing on environmental perceptions with respect to children's behaviours should include parental perceptions of the environment as they seem to be relevant.[20]

Attractiveness

Aesthetics are a small but important collection of design features that can influence how friendly an environment is for neighbourhood activity.[81] Features and amenities, such as detailing on buildings, public art, street trees, benches, and street lighting can help bring things down to a human scale to increase visual interest and appeal.[81] While there is some evidence indicating that perceived attractiveness is not related to children's IM,[72,82] there is also strong evidence indicating a significant, positive association.[19,83] In a US study of 8- to 15-year-old children, positive parental perceptions of aesthetics were found to increase the odds of active commuting to school by 2.4, even when objectively measured walkability, parental concerns, and sociodemographic factors were adjusted for.[19] Furthermore, in a qualitative study of cycling for transport among children in Belgium, children themselves indicated that natural elements, clean streets, and historical buildings made it more appealing for them to cycle.[83] While some studies have found no association between perceived attractiveness and IM,[72,82] there does seem to be stronger evidence for a positive association.[19,83]

Safety

The influence of perceptions of safety in terms of the physical environment on IM is perhaps one of the more well-studied relationships, as traffic safety - including traffic volume, speed, and calming - is often cited as a major concern that limits children's IM.[15,21] There is strong evidence

that more positive perceptions of traffic safety are associated with greater IM,[20,26,67,74,75,84,85] but other studies have found no such association.[72,86,87] Qualitative studies consistently provide findings that parents express concern about traffic safety and subsequently limit their children's IM.[67,84] Quantitative studies also provide evidence for a positive association between traffic safety perceptions and IM as well as AT.[20,26,75] For example, strong evidence for the association between perceived traffic safety and AT is derived from a prospective cohort study in Scotland.[85] Pre- and post- intervention surveys were conducted with residents of a neighbourhood in which a traffic calming scheme was introduced on the main road. Results from this study indicated that residents perceived improved road safety and traffic after the intervention and that 12.5% of respondents reported that they allowed their children to walk more, and 11.6% reported that they allowed their children to cycle more.[85] Specific to IM, a study conducted in Australia showed that for 10- to 12-year-old boys and girls living on a busy road, odds of IM significantly decreased relative to children living on a less busy road.[74] However, a different Australian study on children of the same age concluded that parents' perceptions of living on a busy road were not significantly related to boys' nor girls' IM.[86] While the evidence favours a positive association between perceived traffic safety, these findings are not universal.

2.4.3.2 Perceived Social Environment

Perceptions of the social environment can be examined in terms of feelings of safety and comfort in the neighbourhood. These aspects will guide a brief review of how perceptions of the social environment have been found to influence children's IM.

Safety

Perceptions of social safety in relation to children's IM have been examined in numerous studies and it is generally concluded that fears related to crime and social dangers are prominent parental concerns that negatively influence how much, when, and where they allow their child to be independently mobile.[22,23] "Stranger danger" is frequently highlighted as a parental concern that negatively influences children's IM.[21–23,62] Other elements of social safety include perceptions of certain social groups, drug use, bullying,[88] and physical degredation[5] in the neighbourhood. A literature review by Burdette and Whitaker highlight that perceptions of these neighbourhood elements may shape parents sense of social safety much more than actual crime statistics.[5]

However, negative relationships do not always exist, and research shows that the relationship of social safety with children's IM is dependent on what aspect of the social environment is examined.[8,76] For example, a UK study of 10- to 12-year-old children found that child perceptions of less crime, bullying and noise (scored collectively as neighbourhood nuisances) were associated with higher likelihood for walking or cycling to school among girls.[87] In contrast, a recent study conducted in Australia found that among parental perceptions of social incivilities, vandalism, property crime, loitering teenagers, drunk driving, and violent crime, only loitering and drunk driving were found to be significantly associated with children's IM to certain destinations.[76] Loitering was negatively associated with IM to friends or family houses and parks or sporting fields, decreasing the odds of IM to these locations 23% and 24%, respectively.[76] Drunk driving was negatively associated with IM to school, decreasing the odds of IM by 21%.[76] However, when these variables were included in a multivariate model adjusting for child and parent sociodemographic characteristics as well as all other significant social and

physical environmental variables, the associations became non-significant.[76] This study highlights that certain aspects of social safety may be more relevant than others with regards to children's IM and the nature of IM may also play a role in the strength of the relationship.

Comfort

Perception of neighbourhood comfort is related to children's IM through social cohesion and social capital. Social cohesion is the concept that norms of trust and reciprocity are a product of strong social bonds which result in collective beliefs and expectations within a neighbourhood.[89] Social capital refers to the resources available to individuals within a neighbourhood through their relationships within that social structure.[90] Perceptions of both of these social constructs have been found to affect children's IM.

In developed countries, perceived friendliness in the neighbourhood is often cited as significantly associated with more IM among children.[74,86,91,92] For example, in a study of 10- to 12-year-old children in Australia, parental perception of neighbourhood friendliness (adults walking in the neighbourhood, children walking in the neighbourhood, neighbourhood is a nice place to walk, neighbourhood is friendly) was associated with a 66% greater odds of IM for boys and a 71% greater odds of IM for girls.[86] Similarly, a study of school children in the US, found that social modelling (the presence of people in the neighbourhood walking or biking often) was found to be significantly associated with children's active commuting to school, indirectly through their perceived self-efficacy.[91] Finally, a Canadian study of grade 5 and 6 students in Toronto concluded that parental perception of people being "out and about, talking and doing things with one another" significantly increased the odds of children's IM.[92]

The concepts of informal social control and social norms have also been examined as a component of social comfort, and yielded more mixed results with regards to an association with children's IM.[76,86] Informal social control is the belief that the community is able to supervise the activity of its residents.[93] In the context of IM, this would mean looking out for children and intervening in cases of bullying, disrespect, traffic danger, or interaction with strangers.[86] An Australian study found that while parents' perceptions of informal social control had no effect on girls' IM and was weakly positively associated with boys' IM, any relationship was attenuated when adjusted for environmental factors.[86] Similarly, no association was found in another Australian study looking at the relationship of collective efficacy (shared responsibility for mutual wellbeing) with IM.[76] This study did find, however, that parenting social norms were significantly associated with children's IM.[76] It reported that when parents perceived that the social norm among parents negatively viewed allowing primary school age children out unsupervised, the odds of children's IM to all destination types was significantly reduced by 30 to 46%.[76]

The strength of social cohesion and social capital in neighbourhoods can affect sense of comfort in allowing IM by restricting negative behaviours and reinforcing positive ones and fostering a sense of community, social norms, and "eyes on the street".[94]

2.4.4 Summary of Influences

In summary, the influences on children's IM can be examined from a socioecological perspective. Intrapersonal factors, such as child age and gender, interpersonal factors regarding

the parent-child relationship, such as IM parenting practices, and perceptual factors, specifically parental perceptions of the neighbourhood environment, are all associated with children's IM to varying degrees.[8,15–17,21,23,24,30,41,49–52,62,65–68] Given the importance of IM to children's development and the mixed findings regarding various intrapersonal, interpersonal, and perceptual factors, the influence and interaction of these factors on children's territorial range warrants further research.

2.5 Purpose

The purpose of this study was to examine the association between parental perceptions of the neighbourhood environment and children's territorial range, specifically how this association is mediated by independent mobility parenting practices.

2.6 Aim and Hypotheses

Main Research Aim: To examine how parental perceptual factors, specifically perceptions of the neighbourhood physical and social environment, influence children's territorial range and whether these associations are mediated by IM parenting practices (Figure 2).

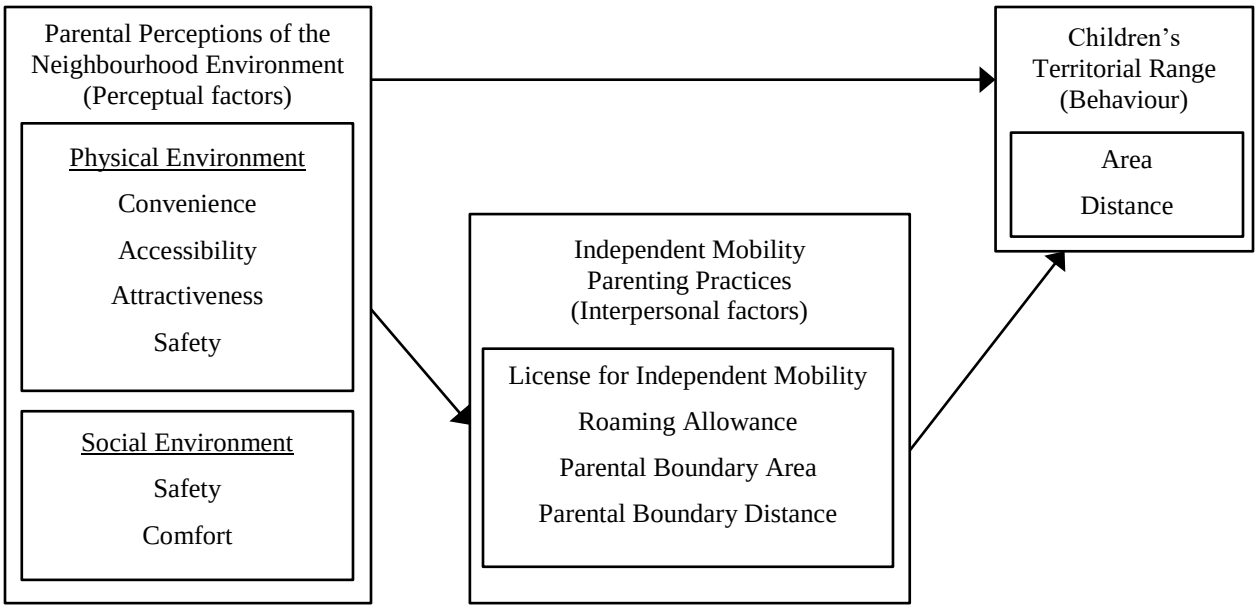

Figure 2: Influence of parental perceptions of the neighbourhood environment on children's territorial range, mediated by independent mobility parenting practices.

Hypothesis 1: Positive parental perceptions of the physical and social neighbourhood environment - greater perceived convenience, accessibility, attractiveness, safety, and comfort - will be associated with LIM, roaming allowance, and parental boundary area and distance.

Hypothesis 2: LIM, roaming allowance, and parental boundary area and distance will be positively associated with children's territorial range (area and distance).

Hypothesis 3: a) Children will have a larger territorial range (area and distance) when parents have more positive perceptions of the neighbourhood environment - report greater convenience, accessibility, attractiveness, safety, and comfort. b) These relationships will be mediated by parenting practices related to IM.

2.7 Rationale

This study examined the influence of parental perceptions of the neighbourhood environment on children's territorial range in relation to IM parenting practices. Territorial range was derived from GPS location data, accelerometer data, and daily activity diaries and IM parenting practices contained LIM, roaming allowance, and parental boundary area and distance. This is important for the following reasons: 1) studies that have examined the relationship between IM parenting practices and children's territorial range have typically used LIM as an indicator of restrictions on children's IM. LIM indicates whether or not a child is allowed to do certain things without supervision, providing certain behavioural boundaries, rather than spatial boundaries. Bhosale et al. suggest that measurement techniques like LIM capture only one dimension of children's IM and may not give a good understanding of children's overall spatial mobility.[12] Comparing spatial boundaries to spatial territorial range while including LIM may give new insights to this relationship; and 2) few studies have examined children's objectively measured territorial range, often using self- or parent-reported data instead.[12,25,95] This is subject to recall bias and assumes that children actually go where they or their parents report they go. As Kyttä points out, it is important to distinguish the degree of mobility license and actual mobility as children do not necessarily passively obey mobility restrictions imposed on them by their parents.[95] Using objectively measured territorial range as well as LIM, roaming allowance, and parental boundaries will provide a more in depth understanding of how children's territorial range relates to measures of allowed IM.

Chapter 3: Methods

3.1 Research Design

This study was a secondary analysis using data collected from 2016 to 2017 for *The state of play: Socio-ecological perspectives on children's outdoor play*. *State of play* is a mixed-methods study co-led by Drs. Brussoni and Mâsse, designed primarily to examine patterns of children's outdoor active play. It was approved by the Behavioural Research Ethics Board at the University of British Columbia (#H15-02190). This study was a quantitative analysis of children's IM which is not the focus of the primary study.

3.2 Participants

Children aged 10 to 13 and their parent(s) were recruited from different neighbourhoods in Metro Vancouver, British Columbia (BC). Families were recruited via Facebook ads (N=42) and word of mouth (N=53). In order to be eligible for participation in the study, children had to reside in one of the catchment areas - Grandview-Woodland, Steveston, or Lonsdale - and have English literacy. Children were excluded if they had any disability or health condition that limited their participation in PA, if they had psychiatric problems, or if they required learning assistance. Sampling was purposeful to include children whose parents allow them different levels of IM, and include an even distribution of age and gender among the child participants. There was an even distribution of child participants among Grandview-Woodland (N=30), Steveston (N=32), and Lonsdale (N=33).

The final sample included N=95 children and N=124 parents (Figure 3), of which 29 children had two participating parents and 66 children had one participating parent. Among the children

who had two participating parents, 22 had both parents participate in the entire study procedure, and 7 had one parent participate in the entire study procedure and the other parent complete the demographic questionnaire only.

For children who had one participating parent (N=66), that parent's scores for perceptions of the neighbourhood environment were used. For children who had two participating parents (N=29), the demographic and questionnaire data for the parent who initially contacted the study team was used. For children who had two parents complete the interview portion of the study (N=22), both parents maps were used. T-tests and Pearson chi-square tests were conducted to test for significant differences between the parent participants who were included and those who were not. Parents who were not included in the study were significantly more likely to be male, but did not differ from included parents by age, education, employment status, LIM score, roaming allowance score, or any of the perceived neighbourhood environment variables.

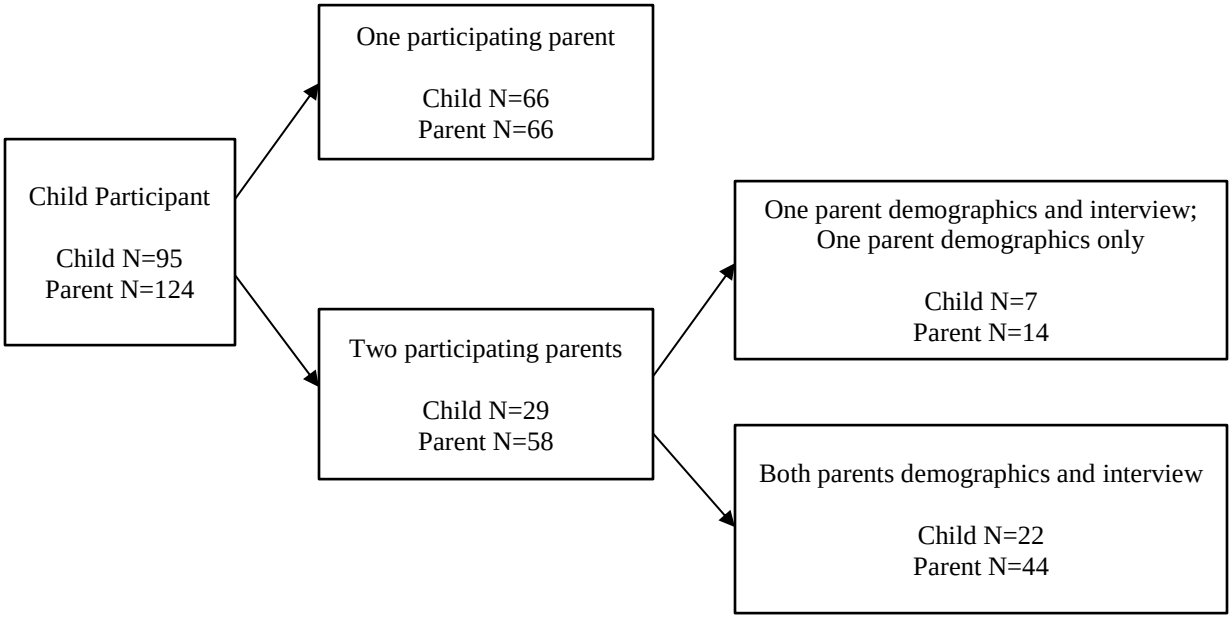

Figure 3: Breakdown of participation.

3.3 Setting

Participants resided in one of three neighbourhoods in Metro Vancouver, BC: Grandview-Woodland (East Vancouver), Steveston (Richmond), and Lonsdale (North Vancouver).

Grandview-Woodland is the "urban" neighbourhood considered in this study. It is in the City of Vancouver, located east of downtown Vancouver. It is bounded by Burrard Inlet to the north, East 12th Avenue to the south (East Broadway used for this study), Clark Drive to the west and Nanaimo Street to the east (Figure 4). This neighbourhood is home to about 5% of the City of Vancouver population.[96] There are approximate 5375 people per square kilometre and the majority of households are either low- (46%) or high- (18.2%) rise apartments.[97] Only 11.4% of households are single-family homes.[97] Grandview-Woodland has a gridiron/fused grid street network and 14.5% of the land-use is a recreation or protected area.[98] The median after-tax household income is $48,041 and approximately 11% of the population is children (under 15).[97]

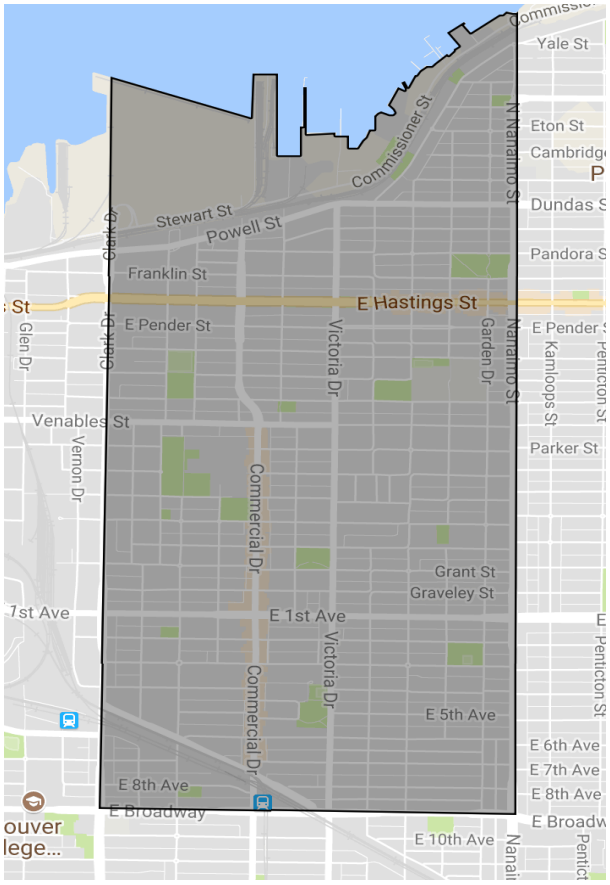

Figure 4: Grandview-Woodland study area in Vancouver.

Steveston is the "suburban" neighbourhood in this study. It is in the City of Richmond bounded on two sides by water and one side by agricultural land. The boundaries of Steveston were considered to be William Road to the north, the Fraser River to the south, the Strait of Georgia to the west and No. 2 Road to the east (Figure 5). There are 1162 people per kilometre and over half of household dwellings are single-family detached homes (30%) or row homes (26%).[99] Steveston's street network is primarily curvilinear and cul-de-sac set in a large grid and 13% of the land-use is designated as recreation and green space.[98] The median after-tax household income is $61,397 and approximately 14% of the population is under 15 years old. [99]

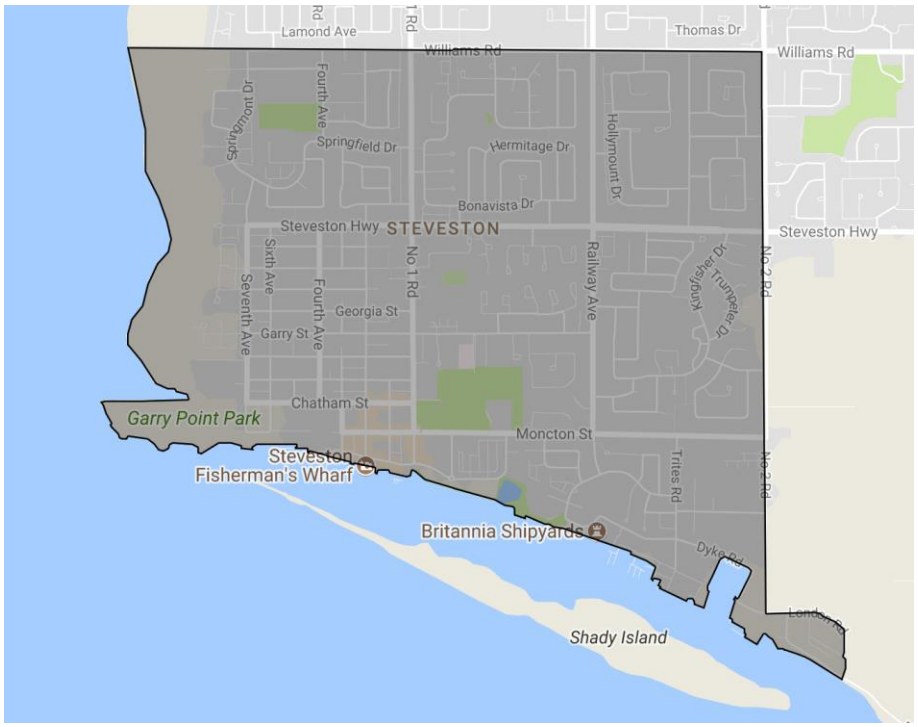

Figure 5: Steveston study area in Richmond.

Lonsdale is the "urban-suburban mix" neighbourhood considered in this study, but is geographically unique because of North Vancouver's proximity to the North Shore Mountains. For this study, the boundaries were considered to be the Trans-Canada Highway to the north, Burrard Inlet to the south, Bewicke Avenue/Westview Drive to the west and Grand Boulevard to the east (Figure 6). In the District of North Vancouver, 49% of the land area is designated as recreation and green space[98] with only 344 people per square kilometre.[100] Lonsdale is a primarily gridiron street network and mid-density residential; 31% of homes are single-family detached and 43% low- and high- rise apartments.[100] The median after-tax income is $69,610 and 15.5% of the population is under 15 years old.[100]

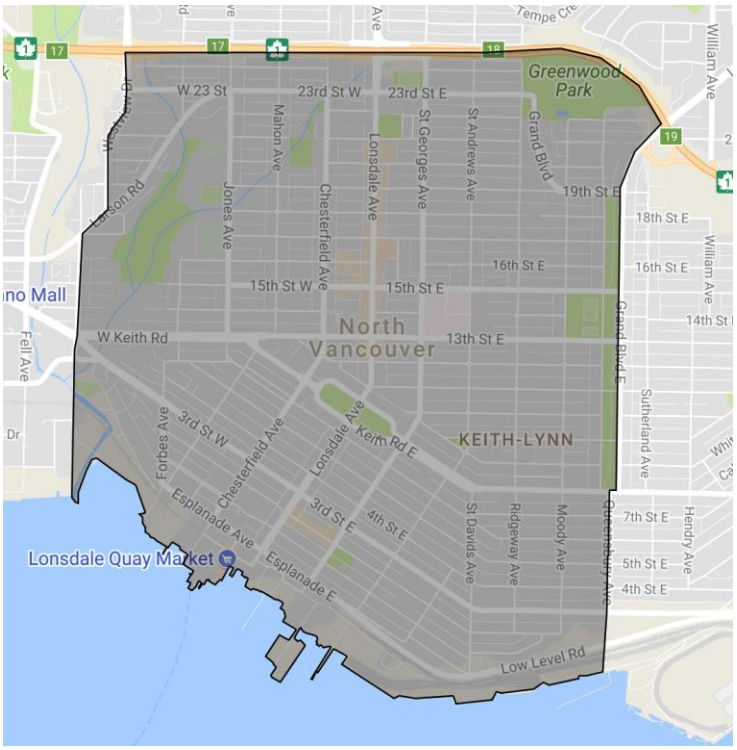

Figure 6: Lonsdale study area in North Vancouver.

3.4 Data Collection

Data were collected in 2016 and 2017 between April and June and September and October. This data collection period allowed the effects of school and weather to be controlled for by avoiding collecting data during the rainy season with less daylight hours or during the summer break when daily routines change.

Ethics approval was granted through the University of British Columbia/Children's and Women's Health Centre of British Columbia Research Ethics Board in October 2015. Each participating child received an honorarium of $100 total over two meetings. Participating parents received an honorarium of $50 after the second meeting.

Screening and initial meeting

Potential participants were provided with the purpose and general procedure of the study over the telephone during a screening interview and invited to ask questions. After eligible participants were identified, an initial meeting was arranged to go over study procedures. At the initial meeting, children and parents were again verbally briefed on the study purpose and procedures and gave written assent and consent, respectively. Participants were informed that they could withdraw from the study at any point without penalty.

As part of the main study, children and parents were each provided with a digital or paper demographic questionnaire (see Appendix A.1 and A.2). Children were given GPS watches (Garmin Forerunner 220) and accelerometers (Actical, Philips Respironics, Bend OR) and taught how to wear the devices. Children were instructed to wear the GPS watch on their wrist, making sure to save the data at the end of each day and restart the GPS as soon as they wake up each morning. Children were given daily activity diaries (see Appendix B.1) to complete, indicating start and end times of where they were, who they were with, what they were doing throughout the day, and when they removed the devices. Parents were also given daily surveys about their children's unsupervised activities (see Appendix B.2). Data were collected for seven days. At the end of the data collection period the devices, children's daily activity diaries, parent daily surveys, and both child and parent demographic questionnaires were picked up by research study personnel and processed to allow children to review their mobility data at a follow-up meeting.

Data processing

The GPS and accelerometer data were uploaded, merged, and coded using Personal Activity and Location Measurement System (PALMS) software (University of California San Francisco, Release 1.4.2). The end product of this merge was a file for each participant that contained 40,320 time-stamped rows of data (1 row for each 15-second epoch over 7 day measurement period), and several columns that include the time of the measure, the accelerometer count value, and the longitude and latitude coordinates recoded by the GPS watch. As explained below, additional columns of data were entered into this file, first in an automated manner by PALMS and then manually by the research team. PALMS is a web-based integrated measurement system that is capable of merging and processing time-stamped PA data collected with accelerometers and location data collected with GPS devices.[101] PALMS software contains validated algorithms that used the GPS data to identify rows of data that occurred during a trip and, in a separate column, the transportation mode (walking, bicycling, or vehicle) or each trip. [101]

The merged output was manually cleaned by one of five research assistants. Missing GPS coordinates were identified and, when possible, GPS coordinates were imputed using children's daily activity diaries and parents' daily surveys. Any coordinates that remained missing were noted. The activity diaries were then used to confirm the trip numbers and transportation modes that PALMS calculated and any discrepancies were noted. Columns of data that reflected indoor/outdoor location (inside, outside, both), accompaniment (alone, with friends or siblings, with adults), and activity type (verbatim of child written description) were inputted based on children's daily surveys. This resulted in the creation of a seven-day location and activity profile for each child. Any gaps in this information were noted. Based on discrepancies and missing

information related to children's location, indoor/outdoor, and accompaniment, questions were prepared for the follow-up meeting with the child.

GPS data were uploaded to Garmin Connect (Garmin, Version 4.6.3.0), a web-based platform that allows the visualization of data collected from any Garmin device.[102] This allowed maps of each day's activities to be produced for each child to guide a portion of the follow-up meeting.

Follow-up meeting

Approximately 10 to 14 days after the initial meeting, two research assistants visited the home of the participants for a follow-up meeting. Seven of the parents who completed the demographic questionnaire did not complete the parent interview, for a total of N=117 interviewed parents. Each family had at least one parent participate in the interview. One researcher interviewed the participating parent(s) while the second researcher conducted an interview with the child. As part of the parent interview, the parent(s) were either asked to verbally describe (N=14) or draw on a hard copy map (N=103) places where their child was allowed to go without supervision and/or their child's boundaries. The discrepancy in how parents were asked to describe their children's boundaries was due to a procedural change after the first 14 participants. Children's interviews were child-led go-along walking interviews of their neighbourhoods. At the end of the child interview, children participated in map-elicitation in which they were shown their daily maps from the study week and the interviewer reviewed all of the queries identified during data processing. All interviews were digitally recorded.

Final data processing

After the second meeting, one of two research assistants updated the seven-day location and activity profile for each participant, filling in any remaining fields with information collected during the map-elicitation portion of the interview.

3.5 Measures

The parent demographic questionnaire included a series of self-report measures to depict parent perceptual factors and IM parenting practices. IM parenting practices were further assessed using self-report measures from the parent interview. Children's territorial range was assessed using combined objective and self-report measures. The measures used are summarized in Table 1 and a more in-depth description of each measure follows.

Table 1: Summary of measures.

Construct	Measure			Completed by:
Intrapersonal factors	Child age and gender			Child
Interpersonal factors	License for independent mobility[1,26]			Parent
	Roaming allowance[27]			Parent
	Parental boundary	Area	Measure derived from hand drawn maps	Parent
		Distance		
Perceptual factors	Physical environment			
	Convenience	NEWS Scale A: Destinations[71] NEWS Scale B: Recreation facilities[71]		Parent
	Accessibility	NEWS Scale C: Residential density[71] NEWS Scale D: Land-use mix access[71] NEWS Scale E: Street connectivity[71] NEWS Scale F: Walking facilities[71]		Parent
	Attractiveness	NEWS Scale G: Aesthetics[71]		Parent
	Safety	NEWS Scale H: Traffic safety[71]		Parent
	Social environment			
	Safety	NEWS Scale I: Crime safety[71] Social Danger Perception Scale		Parent
	Comfort	Neighbourhood Relations Scale		Parent
Territorial range	Area	Measure derived from GPS location data, accelerometer, and daily activity diaries		Child
	Distance			

3.5.1 Intrapersonal Factors: Child Gender and Age

Gender and age were self-reported by the child in their demographic questionnaire.

3.5.2 Interpersonal Factors: Independent Mobility Parenting Practices

License for Independent Mobility

The demographic questionnaire that parents completed included the License for Independent Mobility Scale (LIMS).[1] The LIMS includes six yes/no questions that ask parents whether they

allow their child to do certain things: cross main roads alone, travel to places other than school within walking distance alone, travel home from school alone, go out alone after dark, cycle on main roads alone, and use local buses alone.[1] Licenses are conceptualized to be granted to children by their parents as recognition that they are competent enough to do certain things. The number of licenses a parent grants a child represents the degree of IM a parent allows their child to have.[26] An index for each child was calculated from the six mobility licenses. A recent Canadian study examined the psychometric properties of this measure of IM and found that test-retest reliability was adequate to good for the IM index, with intraclass correlation coefficients (ICC) ranging from 0.63 to 0.88.[103]

Roaming allowance

Children's roaming allowance was determined through parent-report on the parent demographic questionnaire. Based on a question used by Veitch et al., parents were asked: How far is your child allowed to roam on his/her own (or with friends) without adult accompaniment?[27] Response options were: "My child is not allowed out alone", "my child is allowed out within my yard and/or driveway", "my child is allowed out within my street", "my child is allowed out within 2-3 streets from my home", "my child is allowed out within a 15 minute walk from home", "my child is allowed out more than a 15 minute walk from home".[27] Responses were coded from 1 to 6, with high scores representing larger allowed IM range. Test-retest reliability was found to be moderate (ICC = 0.59) in a sample of Australian children.[27]

Parental Boundaries

Parental boundary area and distance were determined from parent-report during the parent interview in the follow-up meeting and digitized into ArcGIS (ESRI, Version 10.5). This section will describe the general procedure for data processing and then specify: 1) parental boundary enclosure, 2) area calculation, and 3) distance calculation.

Data Processing: Of the 124 parents who participated in the *State of Play* study, 117 parents participated in the mapping portion of the interview which asked parents to draw on a map (N=103) or describe (N=14) their children's boundaries. For children with more than one participating parent, the two parent maps were combined during digitization in ArcGIS (ESRI, Version 10.5). For parents who provided verbal indications of where their child was allowed to go and/or what their boundaries were, point features were created using each identifiable location (specific name, address, or intersection reference given). Parents who drew on a hard copy map fell into three categories: specific boundaries, marked locations, or general locations. If parents drew specific boundaries on the map provided to them, all vertices were digitized as point features. If parents marked locations where their child was allowed to go without supervision, those locations were digitized as point features. Often, parents allowed their child to go to locations outside of the printed map area and wrote the location in the margin (i.e.: different town). In these circumstances, a major landmark in the location was chosen and digitized as a point feature. For all point features, locations were determined using exact coordinates if the parent had labelled the location, or using intersections as reference.

Parental Boundary Enclosure: Each participant's point layer was then subjected to the Minimum Bounding Geometry - Convex Hull command in order to produce a polygon capturing everywhere the child was allowed to go without supervision. Convex hull geometry is a process in which all of the selected GPS coordinates are enclosed in the smallest possible polygon and is a common method of defining children's activity spaces.[64,104,105]

Area: Parental boundary area was calculated as the area enclosed within the polygon derived using the above procedure. For each participant, geometric attributes were added to the polygon and area was specified to be calculated in square kilometres. Output in the attribute table then contained the area for each polygon.

Distance: Parental boundary distance was calculated as the maximum distance (crow fly) from home the child was allowed to go, according to the parent map. Each participant's home coordinates were available in another point layer and used to create a near table with the convex hull polygon. The parental boundary distance was extracted from the near table as the furthest point on the polygon from the home location.

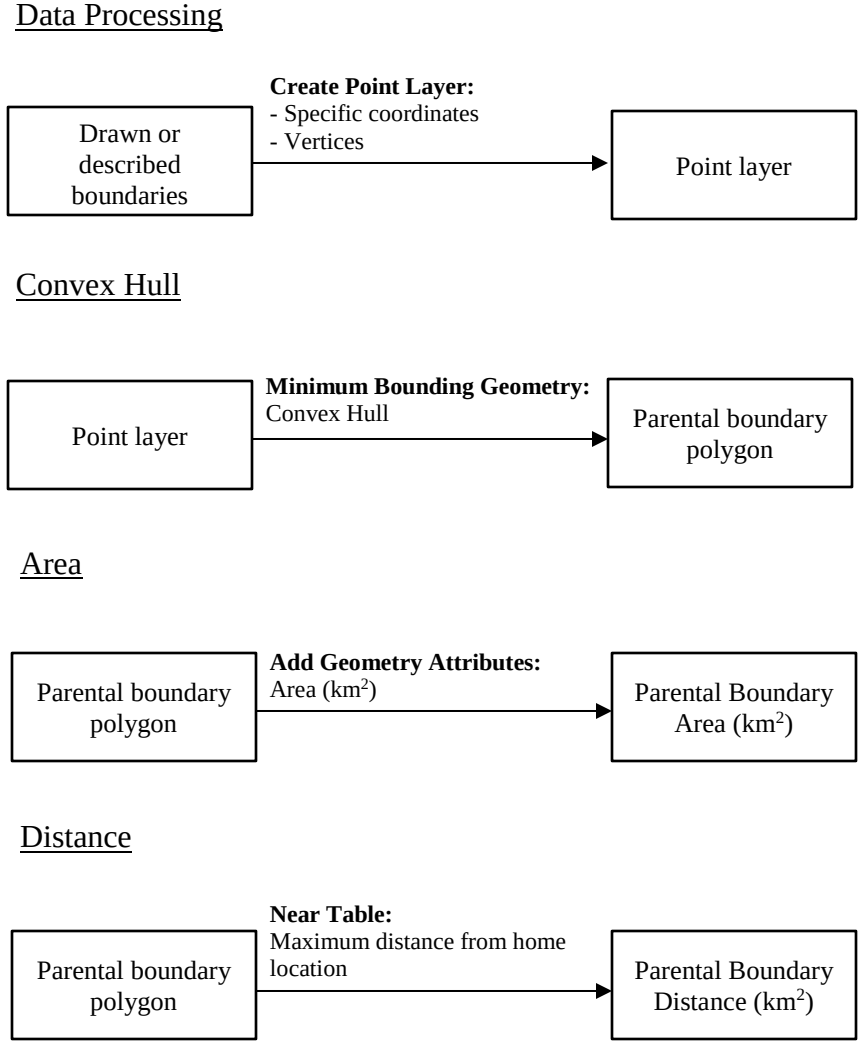

Figure 7: Workflow of parental boundary calculation.

3.5.3 Perceptual Factors: Neighbourhood Environment

3.5.3.1 Parental Perceptions of the Physical Environment

Parental perceptions of the neighbourhood physical environment were assessed using eight scales of the Neighbourhood Environment Walkability Scale (NEWS) (see Appendix C.1), completed as part of the parent demographic questionnaire.[71] The parent-report youth version of the scale was used. Reliability of the scales for this version was tested on a sample of children

(5- to 11-year-olds) and adolescents (12- to 15-year-olds) in Boston, Cincinnati, and San Diego, US[71] and is described below.

Convenience

Destinations: The availability and variety of destinations was assessed in terms of the perceived walking time to various shops, services, and other destinations (20 items: convenience store, supermarket, hardware store, produce market, laundromat, clothing store, post office, library, elementary school, high school, book store, fast food restaurant, coffee shop, bank, restaurant, video store, pharmacy, hairdresser, offices, transit stop). [71] Response options included "1-5 minutes", "6-10 minutes", "11-20 minutes", "21-30 minutes", "31 or more minutes", or "don't know".[71] Destinations were coded from 1 to 5 with "don't know" being coded as 5.[71] All items were reverse coded, summed, and averaged to determine a score, with higher scores denoting higher perceived destination accessibility and diversity.

The internal consistency of the destinations scale was found to be good for children ($\alpha = 0.87$) and excellent for adolescents ($\alpha = 0.93$).[71] Test-retest reliability was adequate for both children (ICC = 0.80) and adolescents (ICC = 0.77).[71]

Recreation Facilities: The availability and variety of recreation facilities was assessed with 14 items that measure perceived walking time to parks, gyms, and specific recreation centers (indoor gym, beach, hiking trail, basketball court, playing fields, YMCA, Boys and Girls Club, swimming pool, running track, school yard, small park, large park, playground equipment, and public open space).[71] Response options included "1-5 minutes", "6-10 minutes", "11-20

minutes", "21-30 minutes", "31 or more minutes", or "don't know".[71] Destinations were coded from 1 to 5 with "don't know" being coded as 5.[71] All items were reverse coded, summed, and averaged to determine a score, with higher scores denoting higher perceived recreation facility accessibility and diversity.

The internal consistency of the recreation facilities scale was found to be acceptable for children ($\alpha = 0.80$) and good for adolescents ($\alpha = 0.83$).[71] Test- retest reliability was adequate for children (ICC = 0.73) and moderate for adolescents (ICC = 0.67).[71]

Accessibility

Residential Density: Perceived residential density was assessed by rating whether specific types of homes were present in the neighbourhood. Parents were asked to assess the proportion of single family houses, townhouses/ row houses, duplex/semi-detached, and condo/apartment buildings. [71] Proportion of each home type was coded from 1 ("none") to 5 ("all").[71] Perceived residential density was calculated using the following formula: (1*single family houses score) + (12*townhouses/row houses score) + (2*duplex/semi-detached) + 25*(condo/apartment score).[71] Higher scores denoted higher perceived residential density.

The internal consistency of the residential density scale was found to be excellent for children ($\alpha = 0.83$) and acceptable for adolescents ($\alpha = 0.77$).[71] Test-retest reliability was adequate for children (ICC = 0.82) and adolescents (ICC = 0.71).[71]

Land-use Mix Access: Perceived land-use mix access was assessed in terms of the perceived accessibility of or barriers to various places (5 items: stores, parking, destinations, transit, hills, and physical barriers).[71] All items were coded from 1 ("strongly disagree") to 4 ("strongly agree"), with hills and physical barriers being reverse coded. Items were summed and averaged, with higher scores denoting higher accessibility of different land-uses.

For the land-use mix access scale the internal consistency was found to be acceptable for children ($\alpha = 0.78$) and adolescents ($\alpha = 0.72$) and test-retest reliability was adequate for children (ICC = 0.73) and moderate for adolescents (ICC = 0.64).[71]

Street Connectivity: Perceived street connectivity was assessed in terms of the perceived street network typology (3 items: few cul-de-sacs, short blocks, and various routes).[71] All items were coded from 1 ("strongly disagree") to 4 ("strongly agree"). Items were summed and averaged, with higher scores denoting better street connectivity.

For the street connectivity scale the internal consistency was found to be acceptable for children ($\alpha = 0.75$) and adolescents ($\alpha = 0.74$) and test- retest reliability was adequate for children (ICC = 0.73) and moderate for adolescents (ICC = 0.67).[71]

Walking Facilities: Perceived walking and cycling facilities were assessed in terms of the perceived pedestrian environment (3 items: sidewalks present, sidewalks separated from road by parked cars, and sidewalks separated from street by grass/garden).[71] All items were coded from

1 (“strongly disagree”) to 4 (“strongly agree”), summed, and averaged. Higher scores denoted better walking facilities.

For the walking and cycling facilities scale the internal consistency was found to be good for children ($\alpha = 0.81$) and acceptable for adolescents ($\alpha = 0.79$) and test- retest reliability was adequate for children (ICC = 0.78) and moderate for adolescents (ICC = 0.68).[71]

Attractiveness

Aesthetics: Perceived neighbourhood aesthetic was assessed in terms of parents’ perceptions of pleasant things to look at in the neighbourhood (4 items: street trees, interesting things, beautiful natural things, and nice homes/buildings).[71] Items were rated from 1 (“strongly disagree”) to 4 (“strongly agree”), summed, and averaged, with higher scores denoting better perceived aesthetics.[71]

The internal consistency of the neighbourhood aesthetic scale was found to be acceptable for children ($\alpha = 0.76$) and adolescents ($\alpha = 0.75$).[71] Test-retest reliability was adequate for children (ICC = 0.75) and moderate for adolescents (ICC = 0.61).[71]

Safety

Traffic Safety: Perceived pedestrian and automobile traffic safety was assessed through a subscale that asked parents to respond to questions related to traffic speeds and volume (7 items: busy traffic, slow traffic speed, above speed limit, lighting, eyes on the street, crosswalks and signals, and exhaust fumes).[71] All items were coded from 1 (“strongly disagree”) to 4 (“strongly

agree"); busy traffic, above speed limit, and exhaust fumes were reverse coded; then all items were summed and averaged, with higher scores denoting higher perceived traffic safety.[71]

The internal consistency of the traffic safety scale was found to be acceptable for children (α = 0.79) and good for adolescents (α = 0.81) and test-retest reliability was adequate for children (ICC = 0.74) and moderate for adolescents (ICC = 0.66).[71]

3.5.3.2 Perceived Social Environment

Parental perceptions of the neighbourhood social environment were assessed in terms of safety and comfort using the NEWS crime scale, the Social Danger Perception Scale (SDPS), and the Neighbourhood Relations Scale (NRS).

Safety

Crime Safety: Parental perception of social safety in terms of crime was assessed through the NEWS crime scale which asked parents to respond to questions about perceived crime rates and sense of "stranger danger" (6 items: high crime rate, unsafe for child at night, worried about child at home alone because of strangers, worried about child at home with friend because of strangers, worried about child in neighbourhood because of strangers, and worried about child at park because of strangers).[71] All items were coded from 1 ("strongly disagree") to 4 ("strongly agree"), reverse coded, then summed and averaged, with higher scores denoting higher perceived crime safety.

The internal consistency of the crime safety subscale was found to be good for children and adolescents ($\alpha = 0.87$) and test-retest reliability was adequate for children (ICC = 0.87) and adolescents (ICC = 0.78).[71]

Social Danger Perception: The SDPS was used to assess parent perceptions of social safety in terms of micro-crimes and social incivilities (7 items: drug use, ill-intentioned adults, syringes, frightening things, robberies, strange people, and neglected areas).[88] Social dangers were coded on a scale from 1 ("strongly agree") to 4 ("strongly disagree"), with high scores representing perceptions of low incivilities and low scores representing perceptions of high incivilities. The internal consistency of the scale was found to be good ($\alpha = 0.83$).[88]

Comfort

Neighbourhood Relations: Parental perception of social comfort in terms of social cohesion and social capital was assessed using the NRS (5 items: visit at neighbours' homes, have neighbours over, stop and talk to people, meet with neighbours to do things together, and exchange favours with neighbours).[22] Parents responded on a rating scale that included "never", "sometimes", "often", "very often", and "every day".[22] Responses were scored from 1 ("never") to 5 ("everyday"). High scores represent high social cohesion and low scores represent low social cohesion.[22] The scale used in this study was identical to that developed by Prezza et al.,[22] which included four items from Buckner's 1988 scale.[106] The internal consistency of Buckner's scale was found to be excellent ($\alpha = 0.86$ to $\alpha = 0.89$).[22]

3.5.4 Territorial Range

Children's territorial range area and distance were calculated in four stages, with the latter three being similar to the parental boundary calculations: 1) identifying IM from home for each participant, 2) bounding children's spatial range, 3) area calculation, and 4) distance calculation. This section will briefly describe each stage (Figure 8).

Identifying IM from Home: The seven-day location and activity profiles (see section 3.4) for each participant were imported into ArcGIS (ESRI, Version 10.5) for further processing. GPS coordinates were selected by attribute for times when the child was unsupervised (alone or with friends/siblings) and outside. This resulted in a seven-day IM profile for each child. The seven-day IM profile map was visually inspected for any trips that were not taken to or from the participant's home location. If there was a trip that did not connect to the participant's home location, it was manually removed as it was not representative of a place the child could access independently from home. This resulted in a clean seven-day IM from home profile for each child.

Bounding Children's Spatial Range: Each seven-day IM from home profile was then subjected to the Minimum Bounding Geometry - Convex Hull command in order to produce a polygon capturing everywhere the child had gone independently over the study week. Convex hull geometry is a process in which all of the selected GPS coordinates are enclosed in the smallest possible polygon and is a common method of defining children's activity spaces.[64,104,105]

Area: Territorial range area was calculated as the area enclosed within the polygon derived using the above procedure. For each participant, geometric attributes were added to the polygon and area was specified to be calculated in square kilometres. Output in the attribute table then contained the area for each polygon and was extracted as territorial range area.

Distance: Territorial range distance was calculated as the maximum distance (crow fly) from home the child went independently during the study week. Each participant's home coordinates were available in another point layer and used to create a near table with the convex hull polygon. The territorial range distance was extracted from the near table as the furthest point on the polygon from the home location.

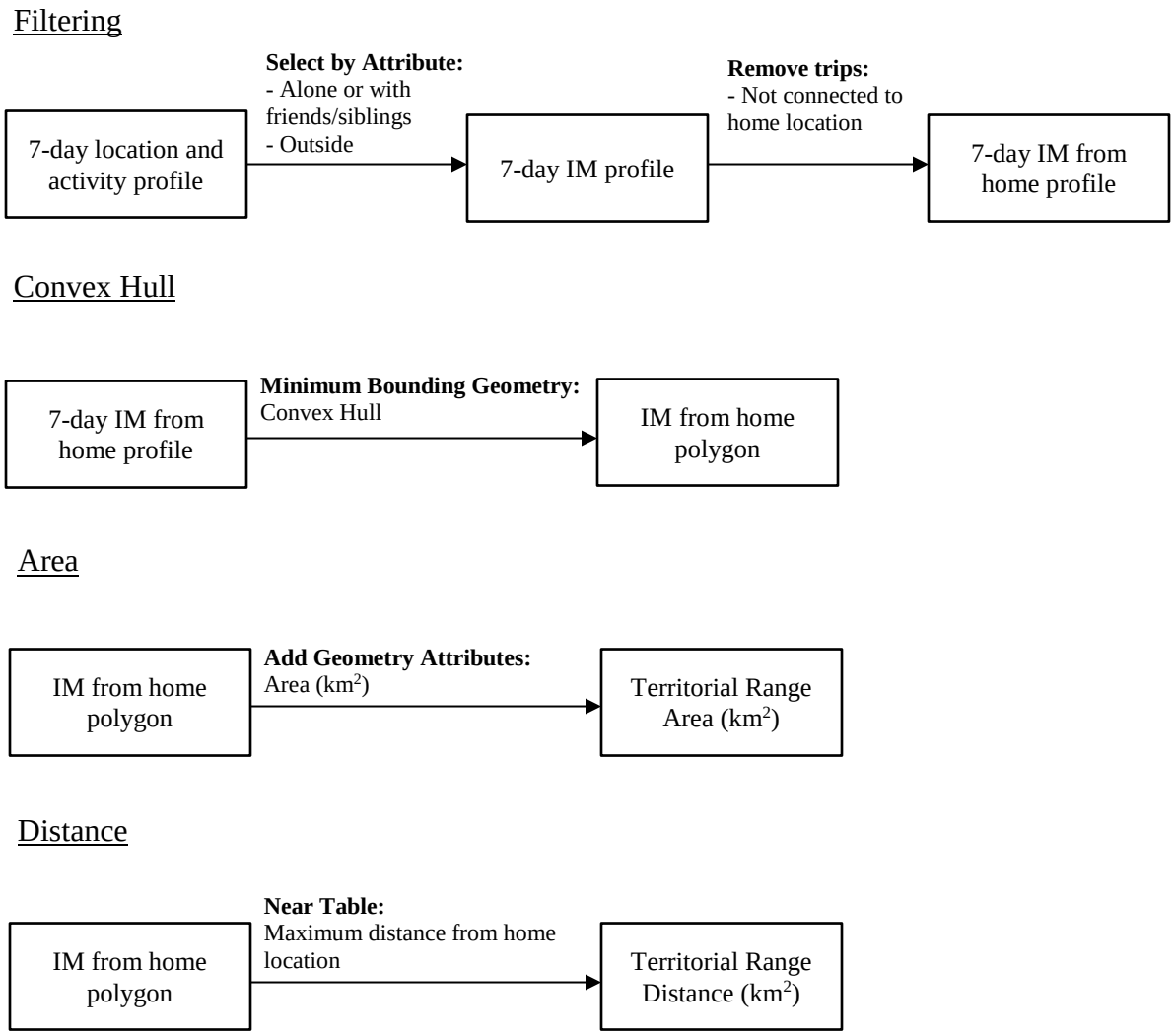

Figure 8: Workflow of territorial range calculation.

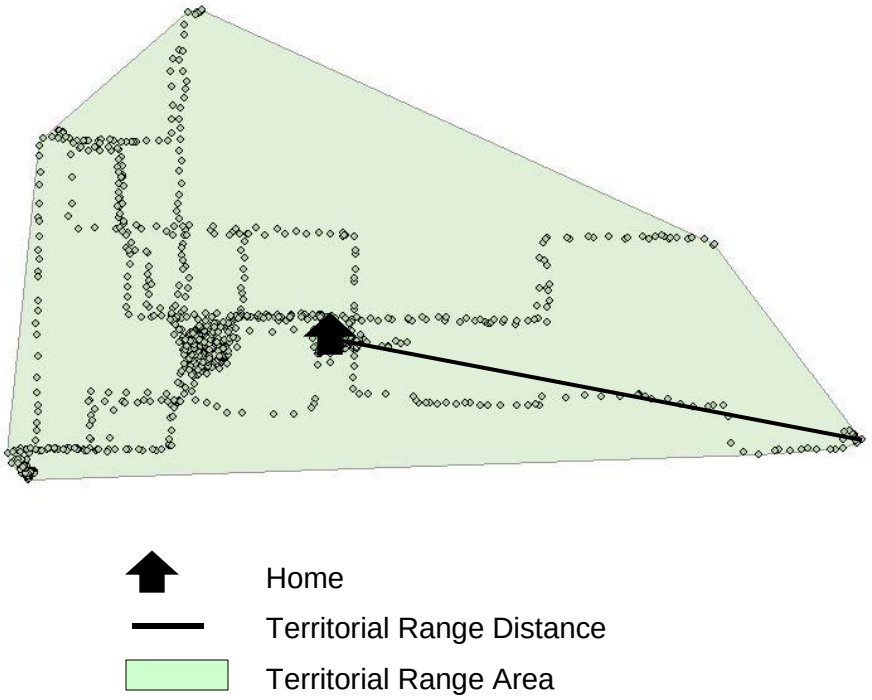

Figure 9: Territorial range area and distance.

3.6 Data Analysis

To assess the research aims, all analyses were completed using Stata 13 (StataCorp, College Station TX). Parental boundary area and distance and children's territorial range area and distance measures were log transformed prior to all analyses to account for non-normal distributions of these variables.

Descriptive statistics were run to examine the sample characteristics and variables. Percentage or mean, standard deviation (SD), and range were calculated for child and parent demographic characteristics. Means, medians, SDs, and ranges were calculated for parental perceptions of the neighbourhood environment, IM parenting practices, and territorial range variables. To examine how LIM, roaming allowance, and parental boundary area and distance were related, Pearson's product moment correlation coefficients were calculated. Univariate regressions adjusted for

child age, child gender, and neighbourhood were used to explore relationships among the variables. Bivariate scatter plots and residual plots were examined to ensure the assumptions of linear regression were not violated.

Path analysis was used to examine the direct and indirect effects of the parental perceived neighbourhood environment on territorial range and whether this relationship was mediated by IM parenting practices. Parental perceptions of the neighbourhood environment variables were entered as independent variables (IV), territorial range area and distance were entered as dependent variables (DV), and IM parenting practices were entered as mediating variables (MV). All variables were standardized prior to analysis in order to account for measurement on different scales. Each model adjusted for child age, child gender, and household income. Full information maximum likelihood method was used to account for missing data (household income). In total, six separate models were run: territorial range area mediated by LIM, territorial range distance mediated by LIM, territorial range area mediated by roaming allowance, territorial range distance mediated by roaming allowance, territorial range area mediated by parental boundary area, and territorial range distance mediated by parental boundary distance. In each model, the following direct effects were examined: IV on MV, MV on DV, and IV on DV. The indirect effect of the IV on the DV was also examined. Significance was assessed at $p<0.05$.

The results present the standardized coefficient (SC), but for any significant direct and indirect effects at $p<0.05$, the unstandardized coefficients were exponentiated[107] and interpreted as percent increase[108] in order to account for the log transformed dependent variables. Hayes'

methodology was used to interpret these effects,[109] specifically, that the effect of the independent variable on the dependent variable, was either direct or indirect through the mediator.

Chapter 4: Results

4.1 Demographic Characteristics

The demographic characteristics of the sample of children and their parent (N=95) are given in Table 2. The children were equally split by age and gender. The majority of participating parents were mothers (85.3%). Participating families were approximately equally distributed among the three neighbourhoods, but the sample was predominantly white, educated, high income, and living in single detached homes.

Table 2: Demographic characteristics.

Demographic Characteristics		**%**	**Mean ± SD [Range]**
Child Gender	Female	49.5	
N=95	Male	50.5	
Child Age	10	27.4	
N=95	11	26.3	
	12	24.3	
	13	21.0	
Child Grade N=95			6 ± 1 [4-9]
Child Race	White	67.0	
N=94	Asian	24.5	
	Other	8.5	
Parent Gender	Female	85.3	
N=95	Male	14.7	
Parent Age N=95			45 ± 4 [35-56]
Parent Race	White	72.3	
N=94	Asian	20.2	
	Other	7.5	

Parent Marital Status	Married/Common-law	90.5
N=95	Single/Separated/Divorced/Widowed	9.5
Parent Education	High school or less	9.5
N=95	College diploma/trade certificate	24.2
	Bachelor's degree	36.8
	Above Bachelor's degree	29.5
Parent Employment Status	Employed	77.9
N=95	Unemployed	22.1
Household Income	<$50,000	12.0
N=83	$50,000-$89,999	19.3
	$90,000-$129,999	28.9
	≥$130,000	39.8
Household Dwelling Type	Single detached	54.7
N=95	Semi-detached/Duplex	17.9
	Rowhouse/Townhouse	15.8
	Apartment	11.6
Children in Household	1	20.0
N=95	2	54.7
	3	20.0
	4	5.3
Neighbourhood	Grandview-Woodland	31.6
N=95	Lonsdale	34.7
	Steveston	34.7

Note: SD=Standard Deviation; %=Percentage

4.2 Descriptive Statistics for Parental Perceptions of the Neighbourhood Environment, Independent Mobility Parenting Practices, and Children's Territorial Range

The distributions of parental perceptions of the environment, IM parenting practices, and children's territorial range variables are given in Table 3. Average scores indicating parental perceptions of the neighbourhood physical and social environment generally fall toward the high end of the range, with the exception of residential density. Despite parents indicating an average

roaming allowance of 5 on a scale of 1 to 6, the average LIM score was much lower at 3 on a scale of 0 to 6. Overall, children's territorial range was low, but highly variable. Half of the participants went no further than 800 metres from home, but ranged from not going anywhere to a maximum distance of 32 kilometres away from home. The same was observed for area. Half of the participants stayed within 0.3 square kilometres of their home, but there was a range from some children not going anywhere to children travelling within 505 square kilometres around their home.

Table 3: Descriptive statistics for parental perceptions of the neighbourhood environment, independent mobility parenting practices, and children's territorial range.

	N	Mean ± SD	Median	Observed Range	Possible Range
Independent Variables					
Destinations	95	3.6 ± 0.8	3.7	1.7-5	1-5
Recreation Facilities	95	3.4 ± 0.6	3.4	1.3-4.7	1-5
Residential Density	95	114 ± 32	119	44-160	40-200
Land-use Mix	95	3.5 ± 0.4	3.5	2.5-4	1-4
Street Connectivity	95	3.3 ± 0.5	3.3	2-4	1-4
Walking Facilities	95	3.3 ± 0.6	3.3	1.3-4	1-4
Aesthetics	95	3.5 ± 0.5	3.8	1.8-4	1-4
Traffic Safety	95	2.9 ± 0.5	2.9	1.7-3.9	1-4
Crime Safety	95	3.5 ± 0.5	3.7	1.8-4	1-4
Social Danger Perception	95	2.9 ± 0.7	2.9	1-4	1-4
Neighbourhood Relations	95	3.3 ± 0.7	3.4	1-4.4	1-5
Mediating Variables					
License for Independent Mobility	95	3.3 ± 1.5	3	0-6	0-6
Roaming Allowance	95	5.1 ± 1.1	5	1-6	1-6
Parent Area (km^2)	94	4 ± 11	1.3	0-102	--
Parent Distance (km)	94	2.4 ± 2.9	1.6	0 -18	--
Dependent Variables					
Child Area (km^2)	94	7.0 ± 52	0.29	0 -505	--
Child Distance (km)	94	1.6 ± 3.5	0.78	0 -32	--

Note: N=Number; SD=Standard Deviation

4.3 Relationships among the Independent Mobility Parenting Practices Measures

As shown in Table 4, the various measures of IM parenting practices are significantly correlated. Parental boundary area and distance were highly correlated, followed by LIM with roaming allowance.

Table 4: Correlation among the independent mobility parenting practices measures

	License for IM	Roaming Allowance	PB Area	PB Distance
License for IM	**1.00**	--	--	--
Roaming Allowance	**0.72**	**1.00**	--	--
PB Area	**0.61**	**0.62**	**1.00**	--
PB Distance	**0.63**	**0.65**	**0.93**	**1.00**

Note: IM=Independent Mobility; PB=Parental Boundary
Bold=p<0.05

4.4 Associations between Parental Perceptions of the Neighbourhood Environment, Independent Mobility Parenting Practices, and Children's Territorial Range

Table 5 gives the univariate associations between the parental perceived neighbourhood environment, IM parenting practices, and children's territorial range. All values are standardized regression coefficients adjusted for child age, child gender, and household income and significance assessed at $p<0.05$.

Parental Perceptions of the Neighbourhood Environment and Independent Mobility Parenting Practices

Only three of the parental perceived neighbourhood environment variables (street connectivity (SC=0.23), walking facilities (SC=0.19), and neighbourhood relations (SC=0.24)) were found to

be significantly associated with any of the IM parenting practices variables, and all were associated with roaming allowance (see Table 5).

Independent Mobility Parenting Practices and Children's Territorial Range

Most of the IM parenting practices variables showed positive associations with children's territorial range (see Table 5). Roaming allowance was significantly associated with both territorial range measures (SC=0.37 for area and SC=0.34 for distance), parental boundary area with child territorial range area (SC=0.37), and parental boundary distance with child territorial range distance (SC=0.35). LIM was not significantly associated with either territorial range area or distance.

Parental Perceptions of the Neighbourhood Environment and Children's Territorial Range

No significant associations were found between the parental perceived environmental variables and child territorial range area or distance (see Table 5).

Covariates

Child age was found to be a significant covariate for all associations (see Table 5). Child age was consistently associated with IM parenting practices and children's territorial range. The strength of the association with IM parenting practices and children's territorial range increased with age. For IM parenting practices, strength of associations ranged from 0.27 to 0.32 for 11-year-olds, 0.28 to 0.48 for 12-year-olds, and 0.56 to 0.63 for 13-year-olds. All ages had significantly greater IM parenting practices allowances than 10-year-olds. For children's territorial range, 12- and 13-

year-olds had significantly greater territorial range area and distance than 10-year-olds. Larger associations were observed for 13-year-olds (0.52 for area, 0.50 for distance) than for 12-year-olds (0.34 for area, 0.30 for distance). Child gender was not significantly associated with IM parenting practices or children's territorial range. Generally, household income was not a significant covariate.

Table 5: Univariate analysis adjusted for child age, child gender, and household income (N=95).

	Mediators				Dependent Variables	
	Licenses for IM	Roaming Allowance	PB Area	PB Distance	TR Area	TR Distance
	SC p-value	SC p-value	SC p-value	SC p-value	SC p-value	SC p-value
Independent Variables						
Destinations	0.15 p=0.09	0.09 p=0.26	-0.06 p=0.53	-0.08 p=0.43	-0.06 p=0.59	-0.08 p=0.47
Recreation Facilities	0.04 p=0.63	0.00 p=0.97	-0.17 p=0.08	-0.17 p=0.10	-0.05 p=0.66	-0.08 p=0.49
Residential Density	-0.04 p=0.66	0.00 p=0.99	-0.04 p=0.66	-0.01 p=0.94	0.06 p=0.55	0.09 p=0.36
Land-use Mix Access	0.03 p=0.76	0.00 p=0.99	-0.05 p=0.58	-0.05 p=0.62	-0.09 p=0.38	-0.12 p=0.27
Street Connectivity	0.15 p=0.08	**0.23 p=0.00**	0.06 p=0.55	-0.01 p=0.90	0.02 p=0.82	0.00 p=0.99
Walking Facilities	0.11 p=0.15	**0.19 p=0.01**	0.05 p=0.54	0.09 p=0.29	0.07 p=0.46	0.06 p=0.50
Aesthetics	0.07 p=0.41	0.12 p=0.12	-0.09 p=0.33	-0.09 p=0.29	0.00 p=0.98	0.02 p=0.82
Traffic Safety	-0.01 p=0.90	0.06 p=0.46	-0.03 p=0.71	-0.03 p=0.76	0.10 p=0.29	0.10 p=0.29
Crime Safety	0.13 p=0.15	0.12 p=0.14	0.00 p=0.96	0.08 p=0.42	-0.07 p=0.48	-0.11 p=0.31
Social Danger Perception	-0.06 p=0.47	-0.09 p=0.21	-0.07 p=0.44	-0.02 p=0.83	-0.07 p=0.46	-0.06 p=0.57
Neighbourhood Relations	0.12 p=0.19	**0.24 p=0.00**	0.07 p=0.46	0.06 p=0.52	-0.01 p=0.94	-0.05 p=0.63
Mediators						
License for IM					0.19 p=0.17	0.14 p=0.33
Roaming Allowance					**0.37 p=0.01**	**0.34 p=0.03**
Parental Boundary Area					**0.37 p=0.00**	--
Parental Boundary Distance					--	**0.35 p=0.01**
Covariates						
Child age (ref: 10)						
11	**0.32 p=0.00**	**0.30 p=0.00**	**0.27 p=0.01**	**0.27 p=0.02**	0.21 p=0.08	0.18 p=0.15
12	**0.47 p=0.00**	**0.48 p=0.00**	**0.31 p=0.00**	**0.28 p=0.01**	**0.34 p=0.00**	**0.30 p=0.01**
13	**0.63 p=0.00**	**0.57 p=0.00**	**0.57 p=0.00**	**0.56 p=0.00**	**0.52 p=0.00**	**0.50 p=0.00**
Child gender (ref: Female)						
Male	0.15 p=0.07	0.14 p=0.08	0.14 p=0.10	0.12 p=0.19	0.12 p=0.20	0.11 p=0.26
Income (ref: <$50,000)						
$50,000-$89,999	-0.22 p=0.06	**-0.30 p=0.01**	-0.14 p=0.26	-0.12 p=0.34	-0.21 p=0.13	-0.19 p=0.19
$90,000-$129,999	0.07 p=0.60	-0.02 p=0.86	0.23 p=0.09	0.22 p=0.11	-0.21 p=0.16	-0.25 p=0.10
≥$130,000	0.04 p=0.78	0.05 p=0.71	0.13 p=0.36	0.15 p=0.29	-0.10 p=0.51	-0.11 p=0.51

Note: IM=Independent Mobility; PB=Parental Boundary; SC=Standardized Coefficient; TR=Territorial Range
Bold=p<0.05

4.5 Mediated Associations of Parental Perceptions of the Neighbourhood Environment with Children's Territorial Range

Tables 6, 7, 8, and 9 present the associations among the parental perceived neighbourhood environment and children's territorial range as mediated by IM parenting practices. The direct and indirect effects of each model are discussed in more detail below. All coefficients are standardized and adjusted for child age, child gender, and household income and significance is assessed at $p<0.05$.

4.5.1 Direct Effects

Parental Perceptions of the Neighbourhood Environment and Independent Mobility Parenting Practices

Certain aspects of parental perceptions of the neighbourhood environment had a significant direct effect on IM parenting practices (see Tables 6, 7, 9). In terms of the perceived physical environment, only perception of walking facilities was significantly associated with IM parenting practices. Specifically, more positive perceptions of sidewalk quality were associated with increased roaming allowance. For a one SD increase in perceived walking facilities, roaming allowance increased by 0.16 SD. Regarding the social environment, perceived crime safety and neighbourhood relations were found to be significantly associated with IM parenting practices. Increased perceptions of crime safety were associated with LIM and parent boundary distance. Specifically, when parents perceived a lower crime rate and were less fearful of stranger danger, LIM and parent boundary distance increased. For a one SD increase in perceived crime safety score, LIM score increased by 0.21 SD and parental boundary distance increased by 27% (SC=0.22) (see Tables 6 and 9, respectively). Neighbourhood relations were found to be associated with roaming allowance, meaning that when parents had more positive perceptions about social cohesion in their neighbourhood, roaming allowance increased. Specifically,

one SD increase in perceived neighbourhood relations score was associated with a 0.21 SD increase in roaming allowance score (see Table 7).

Independent Mobility Parenting Practices and Children's Territorial Range

Significant direct effects of IM parenting practices on children's territorial range were observed for all variables (see Tables 6-9). Increased LIM and increased roaming allowance were both associated with larger territorial range area and increased roaming allowance was associated with larger territorial range distance. For a one SD increase in LIM score, territorial range area increased by 161% (SC=0.27) and distance by 49% (SC=0.23) (Table 6), while for a one SD increase in roaming allowance score, territorial range area increased by 314% (SC=0.38) and distance by 93% (SC=0.35) (Table 7). Although these increases may seem extremely large, they can be better understood in the context of the sample. Looking at children in the 50th percentile (territorial range area=0.29km^2, territorial range distance=0.78 km), an increase of 161% in territorial range area would be approximately 0.47 square kilometres for a total roaming area of 0.76km^2 (approximately 0.87 kilometres from home). An increase of 49% in territorial range distance would be approximately 0.38 kilometres, for a maximum distance from home of 1.16 kilometres. Similarly, for these same children, an increase of 314% in territorial range area would be 0.91 square kilometres for a total roaming area of 1.20 km^2 (approximately 1.1 kilometres from home) and an increase of 93% in territorial range distance would be 0.73 kilometres for a maximum distance from home of 1.51 kilometres. Associations were also observed between parental boundary area and children's territorial range area, as well as between parental boundary distance and children's territorial range distance. For a 10% increase in each of parent boundary area and distance, territorial range area and distance each increased by 6% (SC=0.40 for both) (see Tables 8 and 9).

Parental Perceptions of the Neighbourhood Environment and Children's Territorial Range

Direct effects of parental perceptions of the neighbourhood environment on children's territorial range were only observed in models that included LIM or parental boundary distance (see Tables 6-9). Parental perceptions of increased residential density and better traffic safety were directly associated with increased territorial range distance when LIM was included in the model (Table 6). One SD increase in perceived residential density was associated with a 39% increase (SC=0.19) in territorial range distance so that maximum distance from home increases by 0.30 kilometres to become 1.08 kilometres for a child in the 50th percentile (0.78 km). One SD increase in perceived traffic safety was associated with a 46% increase (SC=0.23) in territorial range distance so that maximum distance from home increases by 0.36 kilometres to become 1.14 kilometres for a child in the 50th percentile (0.78 km). Parental perceptions of better traffic safety, as well as perceptions of lower land-use mix access and lower crime safety, were also directly associated with increased territorial range distance in the model including parental boundary distance (Table 9). One SD increase in each of perceived traffic safety, land-use mix access, and crime safety were associated with an increase of 46% (SC=0.23), decrease of 42% (SC=-0.21), and decrease of 51% (SC=-0.23) in territorial range distance, respectively. For a child in the 50th percentile (0.78 km), this corresponds to changes of a 0.36 kilometre increase, a 0.33 kilometre decrease, and a 0.40 kilometre decrease to result in maximum distances from home of 1.14, 0.45, and 0.38 kilometres, respectively.

4.5.2 Indirect Effects

Parental Perceived Neighbourhood Environment and Children's Territorial Range

The indirect effects for parental perceptions of the neighbourhood environment on children's territorial range were mostly non-significant, with one exception (see Tables 6-9). Parental perception of neighbourhood relations had a positive, indirect effect on children's territorial range area and distance when mediated by roaming allowance. This means that when parents had positive perceptions of neighbourhood relations (good sense of social cohesion and connectedness), children's territorial range area and distance increased indirectly through the effect of increased roaming allowance. Specifically, for one SD increase in perceived neighbourhood relations score, territorial range area increased by 32% (SC=0.08) and distance by 14% (SC=0.07). In the context of the sample, this would mean the territorial range area for a child in the 50^{th} percentile (0.29 km^2) would increase by approximately 0.09 square kilometres for a total territorial range area of 0.38 km^2 (approximately 0.62 kilometres from home), and distance (0.78 km) would increase by approximately 0.l1 kilometres for a total territorial range distance of 0.89 kilometres.

4.5.3 Covariates

Child age was found to be a significant covariate in the models examined. Child gender was a significant covariate in two of the models. Household income was a significant covariate in some models (see Tables 6-9).

Child Age

Regarding IM parenting practices, the results show that LIM, roaming allowance, and parental boundary area and distance all increased significantly for 11-, 12-, and 13-year-olds relative to 10-year-

olds. The increases were more pronounced for older children. The strongest association was observed for roaming allowance for 13-year-old children (SC=0.64) (Table 7), followed by LIM for 13-year-old children (SC=0.63) (Table 6).

In the relationship between parental perceptions of the neighbourhood environment and children's territorial range, age had a varying effect depending which IM parenting practice variable was included in the model. Age was a significant covariate for direct effects models when LIM, parental boundary area, or parental boundary distance was included in the model, but only for 12- and 13-year-olds (Tables 6, 8, 9). For the models including roaming allowance, only being 13 was significantly associated with increased territorial range area and distance (Table 7).

In terms of the indirect models, increasing age had the strongest association with territorial range when the path was mediated by roaming allowance (Table 7) or parental boundary area (Table 8). A significant effect of increasing age was seen for all of 11-, 12-, and 13-year olds. In the parental boundary distance model, only 13-year-olds had significantly greater territorial range (Table 9). For models mediated by LIM, age was a significant covariate in the indirect model of territorial range area (for 12- and 13-year-olds), but not territorial range distance (Table 6).

Child Gender

Generally, child gender was not a significant covariate, with the exception of the direct effect models for parental perceptions of the neighbourhood environment and parental boundary area and distance (SC=0.l9 and 0.16, respectively) and the indirect model for territorial range area through parental

boundary area (SC=0.08). In these models, being male was associated with increased parental boundary area (Table 8) and increased parental boundary distance (Table 9) compared to females.

Household Income

Household income was a significant covariate for some models, but no specific pattern was observed. All significant associations were negative, indicating that increased household income is associated with decreased territorial range area and distance (see Tables 6-9).

Table 6: Association between parental perceptions of the neighbourhood environment and children's territorial range, mediated by license for independent mobility (N=95).

	License for IM	**Territorial Range Area**		**Territorial Range Distance**	
	Direct Effect	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect
	SC p-value	SC p-value	SC p-value	SC p-value	SC p-value
Independent Variables					
Destinations	0.21 p=0.09	-0.23 p=0.10	0.06 p=0.17	-0.26 p=0.07	0.05 p=0.20
Recreation Facilities	-0.10 p=0.39	0.04 p=0.77	-0.03 p=0.42	0.01 p=0.91	-0.02 p=0.43
Residential Density	-0.05 p=0.51	0.15 p=0.10	-0.01 p=0.53	**0.19 p=0.03**	-0.01 p=0.53
Land-use Mix Access	0.05 p=0.65	-0.13 p=0.22	0.01 p=0.65	-0.17 p=0.12	0.01 p=0.65
Street Connectivity	0.05 p=0.63	0.04 p=0.74	0.01 p=0.64	0.03 p=0.75	0.01 p=0.64
Walking Facilities	0.00 p=1.00	0.07 p=0.47	0.00 p=1.00	0.08 p=0.41	0.00 p=1.00
Aesthetics	0.02 p=0.83	0.02 p=0.82	0.01 p=0.83	0.10 p=0.35	0.00 p=0.83
Traffic Safety	-0.11 p=0.29	0.21 p=0.06	-0.03 p=0.34	**0.23 p=0.04**	-0.02 p=0.35
Crime Safety	**0.21 p=0.04**	-0.15 p=0.21	0.06 p=0.13	-0.20 p=0.09	0.05 p=0.16
Social Danger Perception	-0.11 p=0.27	-0.08 p=0.48	-0.03 p=0.32	-0.05 p=0.63	-0.02 p=0.34
Neighbourhood Relations	0.04 p=0.67	-0.04 p=0.70	0.01 p=0.68	-0.06 p=0.56	0.01 p=0.68
Mediator					
License for IM		**0.27 p=0.02**		**0.23 p=0.05**	
Covariates					
Child age (ref: 10)					
11	**0.32 p=0.00**	0.12 p=0.30	0.09 p=0.06	0.10 p=0.39	0.07 p=0.09
12	**0.41 p=0.00**	**0.24 p=0.04**	**0.11 p=0.04**	**0.24 p=0.04**	0.09 p=0.08
13	**0.63 p=0.00**	**0.40 p=0.00**	**0.17 p=0.03**	**0.42 p=0.00**	0.14 p=0.06
Child gender (ref: Female)					
Male	0.13 p=0.09	0.08 p=0.36	0.04 p=0.17	0.06 p=0.46	0.03 p=0.21
Income (ref: <$50,000)					
$50,000-$89,999	-0.19 p=0.14	**-0.29 p=0.04**	-0.05 p=0.20	**-0.29 p=0.04**	-0.04 p=0.23
$90,000-$129,999	0.09 p=0.51	**-0.36 p=0.01**	0.02 p=0.53	**-0.41 p=0.01**	0.02 p=0.53
≥$130,000	0.06 p=0.70	-0.21 p=0.17	0.02 p=0.70	-0.20 p=0.19	0.01 p=0.70

Note: IM= Independent Mobility; SC=Standardized Coefficient
Bold= p<0.05

Table 7: Association between parental perceptions of the neighbourhood environment and children's territorial range, mediated by roaming allowance (N=95).

	Roaming Allowance	**Territorial Range Area**		**Territorial Range Distance**	
	Direct Effect	Direct Effect	Indirect Effect	Direct Effect	Indirect Effect
	SC p-value	SC p-value	SC p-value	SC p-value	SC p-value
Independent Variables					
Destinations	-0.04 p=0.74	-0.16 p=0.25	-0.01 p=0.74	-0.19 p=0.15	-0.01 p=0.74
Recreation Facilities	-0.08 p=0.38	0.06 p=0.62	-0.03 p=0.40	0.04 p=0.76	-0.03 p=0.41
Residential Density	0.09 p=0.21	0.10 p=0.26	0.03 p=0.25	0.15 p=0.09	0.03 p=0.26
Land-use Mix Access	-0.12 p=0.15	-0.08 p=0.46	-0.05 p=0.20	-0.12 p=0.26	-0.04 p=0.20
Street Connectivity	0.13 p=0.11	-0.02 p=0.88	0.05 p=0.16	-0.01 p=0.90	0.05 p=0.17
Walking Facilities	**0.16 p=0.04**	0.02 p=0.87	0.06 p=0.09	0.03 p=0.76	0.06 p=0.10
Aesthetics	0.07 p=0.38	0.01 p=0.94	0.03 p=0.40	0.08 p=0.43	0.03 p=0.40
Traffic Safety	0.05 p=0.56	0.16 p=0.16	0.02 p=0.56	0.19 p=0.09	0.02 p=0.57
Crime Safety	0.14 p=0.11	-0.14 p=0.23	0.05 p=0.17	-0.19 p=0.09	0.05 p=0.18
Social Danger Perception	-0.07 p=0.42	-0.09 p=0.39	-0.03 p=0.44	-0.06 p=0.56	-0.02 p=0.44
Neighbourhood Relations	**0.21 p=0.00**	-0.10 p=0.29	**0.08 p=0.04**	-0.12 p=0.23	**0.07 p=0.05**
Mediator					
Roaming Allowance		**0.38 p=0.00**		**0.35 p=0.01**	
Covariates					
Child age (ref: 10)					
11	**0.30 p=0.00**	0.09 p=0.41	**0.12 p=0.02**	0.07 p=0.55	**0.11 p=0.03**
12	**0.49 p=0.00**	0.17 p=0.17	**0.19 p=0.01**	0.17 p=0.17	**0.17 p=0.02**
13	**0.64 p=0.00**	**0.34 p=0.01**	**0.25 p=0.01**	**0.34 p=0.01**	**0.23 p=0.01**
Child gender (ref: Female)					
Male	0.08 p=0.23	0.08 p=0.36	0.03 p=0.27	0.06 p=0.48	0.03 p=0.28
Income (ref: <$50,000)					
$50,000-$89,999	**-0.36 p=0.00**	-0.18 p=0.22	**-0.14 p=0.03**	-0.18 p=0.22	**-0.13 p=0.04**
$90,000-$129,999	-0.10 p=0.36	**-0.31 p=0.03**	-0.04 p=0.38	**-0.35 p=0.01**	-0.04 p=0.39
≥$130,000	-0.08 p=0.53	-0.17 p=0.26	-0.03 p=0.54	-0.16 p=0.28	-0.03 p=0.54

Note: SC=Standardized Coefficient
Bold= p<0.05

Table 8: Association between parental perceptions of the neighbourhood environment and children's territorial range area, mediated by parental boundary area (N=95).

	Parental Boundary Area	**Territorial Range Area**	
	Direct Effect	Direct Effect	Indirect Effect
	SC p-value	SC p-value	SC p-value
Independent Variables			
Destinations	0.00 p=1.00	-0.17 p=0.19	0.00 p=1.00
Recreation Facilities	-0.18 p=0.14	0.09 p=0.47	-0.07 p=0.16
Residential Density	0.04 p=0.69	0.12 p=0.17	0.01 p=0.69
Land-use Mix Access	0.07 p=0.48	-0.15 p=0.15	0.03 p=0.49
Street Connectivity	0.04 p=0.71	0.03 p=0.79	0.02 p=0.71
Walking Facilities	0.05 p=0.56	0.05 p=0.59	0.02 p=0.56
Aesthetics	-0.07 p=0.47	0.06 p=0.55	-0.03 p=0.48
Traffic Safety	-0.01 p=0.94	0.18 p=0.09	0.00 p=0.94
Crime Safety	0.10 p=0.39	-0.13 p=0.26	0.04 p=0.40
Social Danger Perception	-0.08 p=0.41	-0.08 p=0.45	-0.03 p=0.42
Neighbourhood Relations	0.07 p=0.44	-0.05 p=0.57	0.03 p=0.45
Mediator			
Parental Boundary Area		**0.40 p=0.00**	
Covariates			
Child age (ref:10)			
11	**0.24 p=0.02**	0.11 p=0.30	**0.10 p=0.04**
12	**0.27 p=0.01**	**0.25 p=0.02**	**0.11 p=0.03**
13	**0.60 p=0.00**	**0.34 p=0.00**	**0.24 p=0.00**
Child gender (ref: Female)			
Male	**0.19 p=0.02**	0.04 p=0.68	**0.08 p=0.05**
Income (ref: <$50,000)			
$50,000-$89,999	-0.25 p=0.06	-0.24 p=0.08	-0.1 p=0.09
$90,000-$129,999	0.18 p=0.20	**-0.40 p=0.00**	0.07 p=0.23
≥$130,000	0.06 p=0.71	-0.22 p=0.14	0.02 p=0.71

Note: SC=Standardized Coefficient
Bold= p<0.05

Table 9: Association between parental perceptions of the neighbourhood environment and children's territorial range distance, mediated by parental boundary distance (N=95).

	Parental Boundary Distance	**Territorial Range Distance**	
	Direct Effect	Direct Effect	Indirect Effect
	SC p-value	SC p-value	SC p-value
Independent Variables			
Destinations	0.00 p=1.00	-0.21 p=0.11	0.00 p=1.00
Recreation Facilities	-0.18 p=0.14	0.07 p=0.57	-0.07 p=0.17
Residential Density	0.08 p=0.33	0.15 p=0.09	0.03 p=0.34
Land-use Mix Access	0.12 p=0.25	**-0.21 p=0.05**	0.05 p=0.27
Street Connectivity	-0.07 p=0.52	0.07 p=0.51	-0.03 p=0.52
Walking Facilities	0.15 p=0.12	0.02 p=0.82	0.06 p=0.15
Aesthetics	-0.12 p=0.25	0.16 p=0.13	-0.05 p=0.27
Traffic Safety	-0.06 p=0.55	**0.23 p=0.03**	-0.03 p=0.56
Crime Safety	**0.22 p=0.05**	**-0.23 p=0.03**	0.09 p=0.08
Social Danger Perception	-0.07 p=0.47	-0.05 p=0.62	-0.03 p=0.47
Neighbourhood Relations	0.08 p=0.40	-0.08 p=0.40	0.03 p=0.41
Mediator			
Parental Boundary Distance		**0.40 p=0.00**	
Covariates			
Child age (ref: 10)			
11	**0.22 p=0.03**	0.08 p=0.44	0.09 p=0.06
12	**0.21 p=0.04**	**0.25 p=0.01**	0.08 p=0.07
13	**0.55 p=0.00**	**0.34 p=0.00**	**0.22 p=0.00**
Child gender (ref: Female)			
Male	**0.16 p=0.05**	0.03 p=0.75	0.07 p=0.08
Income (ref: <$50,000)			
$50,000-$89,999	-0.21 p=0.12	-0.24 p=0.07	-0.08 p=0.15
$90,000-$129,999	0.15 p=0.29	**-0.44 p=0.00**	0.06 p=0.31
≥$130,000	0.05 p=0.71	-0.21 p=0.15	0.02 p=0.71

Note: SC=Standardized Coefficient
Bold= p<0.05

4.6 Summary of Results

A summary of direct and indirect effects is presented in Figure 9. Highlights include: a) limited evidence for the direct effect of the parental perceived neighbourhood environment on IM parenting practices (hypothesis 1), b) moderate evidence for the direct effect of IM parenting practices on children's territorial range (hypothesis 2), c) some evidence for the direct effect of the parental perceived neighbourhood environment on children's territorial range (hypothesis 3a), and d) limited evidence that IM parenting practices mediate the relationship between the parental perceived neighbourhood environment and children's territorial range (hypothesis 3b).

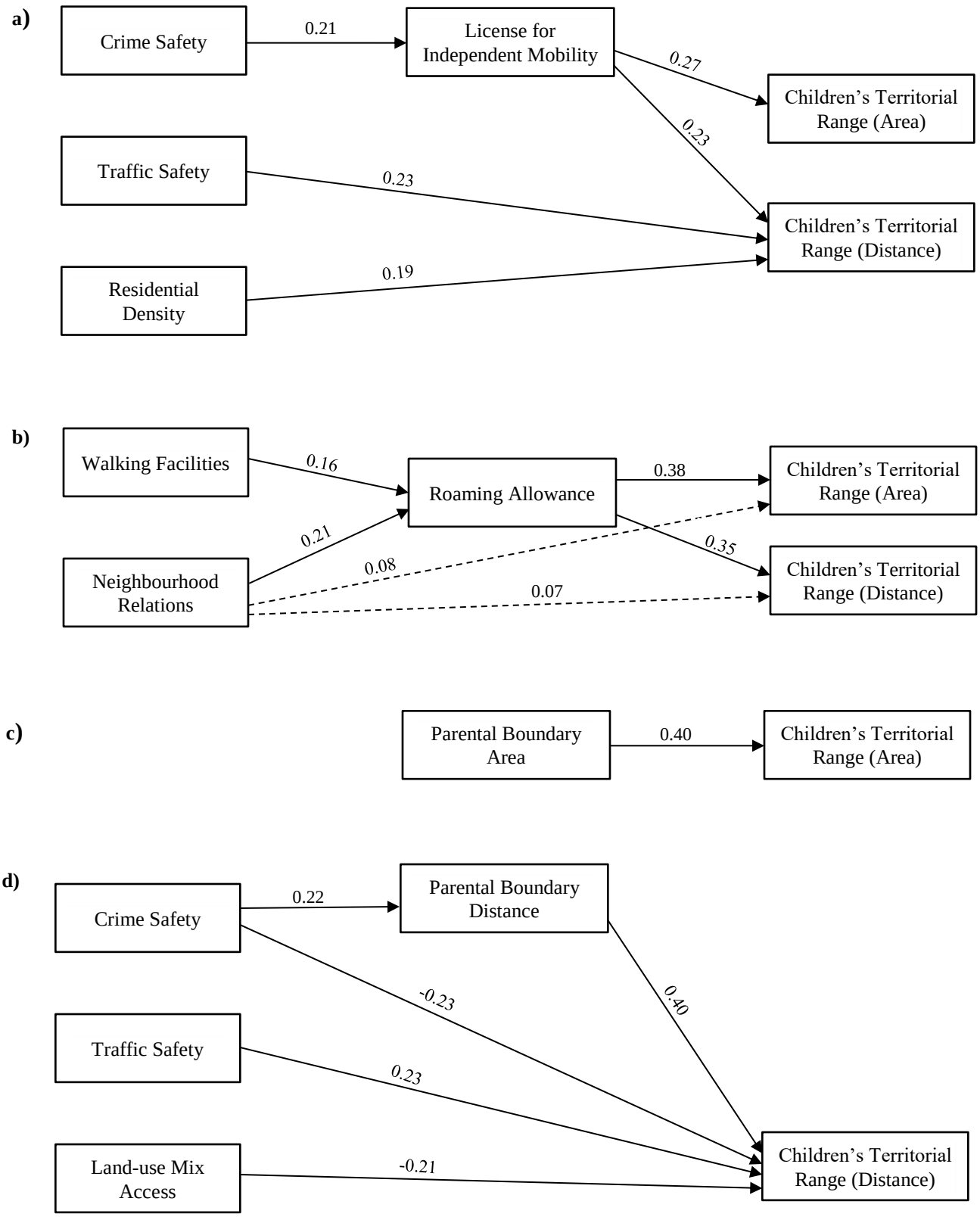

Figure 10: Summary of direct (solid line) and indirect effects (dashed line). All paths adjusted for child age, child gender, and household income. Eleven environmental variables were assessed for each of the four mediators. Only significant effects ($p<0.05$) are shown. Models included a) license for independent mobility, b) roaming allowance, c) parental boundary area, and d) parental boundary distance.

Chapter 5: Discussion

The purpose of this study was to examine the association between parental perceptions of the neighbourhood environment and children's territorial range, specifically how this association is mediated by parenting practices related to IM. This study is unique in that it considered IM parenting practices as mediators in the relationship between parental perceptions of the neighbourhood environment and children's territorial range. Results from this study provide a new perspective on the relationships between different measures of IM and territorial range and how parental perceptions of the neighbourhood environment differentially influence children's territorial range.

Consistent with other studies, this study showed some relationships between parental perceptions of the neighbourhood environment and children's territorial range.[21,65–67] Some direct and indirect effects of parental perceptions of the neighbourhood environment and children's territorial range were observed, thus only partially supporting hypotheses 3a and 3b. Direct effects of certain aspects of parental perceptions of the neighbourhood environment on children's territorial range were observed - namely land-use mix access, residential density, traffic safety, and crime safety. Indirect effects of parental perceptions of the neighbourhood environment (specifically neighbourhood relations) on children's territorial range were observed only when the model was mediated by roaming allowance. Furthermore, this study showed that although the four measures of IM parenting practices are significantly correlated, they are not similarly influenced by the same environmental factors, failing to fully support hypothesis 1. Finally, all measures of IM parenting practices were shown to significantly and directly affect children's territorial range, albeit to differing degrees, providing support for hypothesis 2.

5.1 Relationships between the Parental Perceived Neighbourhood Environment and Independent Mobility Parenting Practices

The first hypothesis of this study assumed that parental perceptions of the social and physical neighbourhood environment would be associated with IM parenting practices. However, results did not fully support this hypothesis. Findings from this study highlight that few aspects of parental perceptions of the neighbourhood environment were associated with IM parenting practices. This is in contrast with previous research which has generally found associations between the perceived environment and various measures of IM.[19–23,26,62,65–67,74–76,83–86]

With the exception of parental perceptions of walking facilities, none of the physical environmental variables related to convenience, accessibility, attractiveness, or safety were associated with IM parenting practices. Although this exact relationship has not been examined in the past, it would make sense that parents who perceive places to go, easy access, interesting things to look at, and good traffic safety would allow their children more IM. It may be that this association was not observed in this study because of neighbourhood characteristics specific to the observed communities. Despite being selected for varying levels of urban/suburban characteristics, street networks, densities, and geographies, all of the neighbourhoods included in this study are unique compared to other urban and suburban neighbourhoods in major North American cities. Specifically, all of the neighbourhoods in this study reflect principles of "Vancouverism": dynamic and active urban areas, public spaces, many parks and green spaces, mixed residential and commercial density, and walkable streets.[110] These environmental characteristics of the neighbourhoods under study may be unique from neighbourhoods included

in previous research in five main ways: 1) mixed land-use is present in all neighbourhood types; 2) the size and location of school and park grounds; 3) similar residential density in the three neighbourhoods; 4) pedestrian connectivity even in a curvilinear street network; and 5) limited presence of high-volume, high-speed roads.

First, planning practices in the neighbourhoods in this study have resulted in the presence of mixed land-use in all of the neighbourhoods, making access to retail and services convenient. This may be different from other study areas that have more traditional suburbs that have separated land-use and may make destinations more accessible for children.[111]

Second, unlike many other urban areas, the neighbourhoods in this study have many parks and green spaces due to purposeful urban design.[110] Additionally, neighbourhood schools have been maintained in the study neighbourhoods – more, smaller elementary schools dispersed throughout neighborhoods rather than one large, central school.[112] These characteristics results in easy access to parks, open spaces, and play areas that may not have been observed in previous research.

Third, urban areas are often considered to have high density housing including a high proportion of high rise apartment buildings and suburban areas to include single family homes with some townhomes. The neighbourhoods in this study did not follow this trend, with single family homes predominating in all of the neighbourhoods[113]; similar presence of semi-detached, row houses, and low-rise apartment buildings in all three neighbourhoods; and few high-rise apartment buildings.

Fourth, curvilinear street networks are typically thought of as disconnected, making it difficult to travel to places further from home, which would reduce territorial range area. One reason that no association with street connectivity was found in this study may be that in the neighbourhood with a curvilinear street network (Steveston), pedestrian and cyclist connections were maintained through pathways at ends of cul-de-sacs resulting in less variance in this sample. Alternatively, children may be cutting through the ample parks and school grounds, making the actual connectivity of streets less relevant to their territorial range.

Fifth, unlike other neighbourhoods in cities of similar size, the neighbourhoods in this study have few if any highways transecting them (Lonsdale has a highway at the north side of the study area, but has pedestrian over- and underpasses). These neighbourhoods all boast walkable, active streets with low speed limits and traffic calming measures.[110]

While lack of sidewalks was not predominantly observed in the neighbourhoods studied, availability and quality of sidewalks may deter parents to allow their child to be independently mobile. While the other aspects of parental perceptions of the physical environment broadly examined the neighbourhood, the presence of sidewalks can be specific to participants' homes. This provides a rationale for why that may be the only physical environmental variable that is significantly associated with IM parenting practices.

In regard to parental perceptions of the social environment, significant associations of perceptions of crime safety and neighbourhood relations with IM parenting practices were

observed. Results are consistent with existing literature which highlights that perceptions of crime have significant influences on parenting practices related to IM.[1,26,86] The measure of perceived crime used in this study captures perceived "stranger danger" which has been highlighted throughout the literature as influencing more restrictive IM parenting practices.[1,26,86] The lack of association between social danger perception and IM parenting practices is also consistent with previous literature that has found no association between social incivilities (drugs, strange people, neglected areas, etc.) and allowed IM.[76] A possible reason for no association in this study is that while one of the neighbourhoods included (Grandview-Woodland) is known for the presence of these social incivilities, it may be that parents are interested in raising their children in a multi-cultural and socioeconomically diverse environment and do not necessarily restrict their IM because of it. Findings that more positive perceptions of neighbourhood relations were significantly associated with IM parenting practices are consistent with previous research that indicates that parents who perceive higher social cohesion are more likely to allow children to roam further.[114]

In sum, there are many unique aspects of the neighbourhoods included in this study that may explain the difference between findings in the current study and previous research. This highlights the need to replicate this research in similar neighbourhoods to see if these associations or lack of associations remain.

5.2 Relationships between Independent Mobility Parenting Practices and Children's Territorial Range

The second hypothesis of this study assumed that IM parenting practices would be directly associated with children's territorial range. Results supported this hypothesis. IM parenting practices were associated with children's territorial range and the key finding is that IM parenting practices did not have a consistent magnitude of effect on children's territorial range, despite being highly correlated with each other. In addition, parental boundaries were included in this study to explore their possibility as a more accurate measure of children's IM than LIM or roaming allowance. However, while they showed significant associations with their related measure of children's territorial range, the strength of these associations was similar to those for roaming allowance and was a lot more work on behalf of the participant and the researcher to process.

Roaming allowance also showed relatively large associations with children's territorial range, which was somewhat surprising given that it is a single question. This suggests that asking parents how far they allow their children to go on a scale is representative of how far children actually go. Roaming allowance may show a strong association with children's territorial range because it is a more general version of the parental boundaries measure (approximately how far the child is allowed to go) which allows for a higher degree of flexibility, but still measures a spatial aspect of IM.

Parental boundaries and roaming allowance had stronger associations with children's territorial range than LIM. While LIM was highly correlated with roaming allowance (r=0.72), roaming

allowance had a larger magnitude of association with territorial range than LIM did. One possible explanation for this is that LIM is measuring something different than the other three variables. While parental boundaries and roaming allowance are both spatial measures, LIM is more of a behavioural measure. It asks about *what* children are allowed to do, not *where* they are allowed to go. These results provide evidence for previous suggestions that LIM may not accurately reflect children's spatial mobility.[12] While these results are similar to findings from Bhosale et al. in that there is a significant relationship between LIM and spatial measures of children's IM (territorial range in this study),[12] it adds to them by suggesting that there are other alternative IM measures that capture the spatial element of children's actual IM more accurately.[12]

5.3 Relationships between the Parental Perceived Neighbourhood Environment and Children's Territorial Range

The third and final hypothesis of this study was that parental perceptions of the neighbourhood environment would be directly associated with children's territorial range, and that this relationship would be mediated by IM parenting practices. Results from the study only partially support this hypothesis. While some direct and indirect effects were observed, there were some key findings: 1) direct effects of parental perceptions of the neighbourhood environment on children's territorial range differed depending on which IM parenting practice variable was included in the model, and 2) indirect effects were only observed for models including roaming allowance as the mediator, and mediation changed the direction of association.

Direct Effects

Regarding the effect of land-use mix and residential density on children's territorial range, a recent meta-analysis by Sharmin et al. concluded that land-use mix in the neighbourhood environment is significantly associated with children's IM and that residential density is not significantly associated (though is related in the negative direction) with children's IM.[115] Results from this study indicate opposite effects, showing a significant negative association with land-use mix and a significant positive association with residential density. At first glance, the land-use mix result may seem counterintuitive, but the difference in findings may be explained by neighbourhood characteristics specific to this study and a difference in outcome measures. For example, one of the items in the land-use accessibility scale suggests that hilly streets make it difficult for children to walk in. While a parent may rate this as strongly agree, in a community like Lonsdale where all north-south streets are on a hill, hilliness is unavoidable and may not stop children from actually going places in their neighbourhood. Other questions ask about how easy it is for their child to walk to stores, interesting places, and transit stops. Parents who strongly agree with these items would have a higher score, and it would be expected that children would then have greater territorial range since past research has indicated that this is positively associated with IM. However, this study looks at distance from home, rather than comparing children who have some IM with those who do not. Since this study's outcome measures are spatial and because mixed land-use is so accessible in the neighbourhoods examined, findings suggest that children do not have to travel very far to get to all the places they need and want to go, resulting in a smaller territorial range and explaining the negative association.

In terms of the association of parental perceptions of traffic safety with children's territorial range, this study corroborates results reported in previous research, showing this association with children's IM, AT, and PA in previous research.[20–23,26,62,67,74,75,84,85] Interestingly, parental perception of traffic safety was only significantly directly associated with territorial range, not with IM parenting practices (discussed above). This suggests a different mechanism than what was anticipated (that parental fear of traffic leads to IM restrictions which subsequently leads to decreased territorial range). In this study it was observed that children's territorial range distance was less when parents perceive traffic as more dangerous, despite not having significant IM restrictions. It may be that parents who perceive traffic to be an issue in their neighbourhood may have instilled this knowledge in their children when they were young. As a result, when the child is allowed to have a larger territorial range, they have internalized those perceptions and choose not to roam as far as a result.

The lack of association between parental perceptions of crime safety and children's territorial range observed in this study is contradictory to previous findings[21,22,69]: when parents perceive their neighbourhood to be less safe in terms of crime, children's territorial range is greater. Although this association is only significant with child distance when parental boundary distance was included in the model, all models follow a similar trend. A possible explanation is that children are not sharing this fear with their parent(s) because it is less visible than traffic danger and therefore do not let it influence their territorial range, or that parents whose children roam further from home experience a greater fear of crime because their child is further away (reverse direction of effect).

Indirect Effects

Significant indirect effects between parental perceptions of neighbourhood relations and children's territorial range were observed in this study. Previous research by Lin et al. has shown that more positive perceptions of neighbourhood cohesion (willingness to help, neighbours watch out for kids, trust, reciprocity, etc.), and neighbourhood connection (adults know the local children, parents know each other, etc.) on behalf of the parents were associated with increased number of independently mobile trips among children.[103] Findings from this study partially agree with those results. The direct effect of parental perception of neighbourhood relations was actually negatively associated with children's territorial range (see section 5.1); however, when roaming allowance was included as a mediator, the direction of association changed, resulting in a small, positive association with territorial range. This inconsistent mediation means that when parents perceive good relationships with neighbours, children's territorial range is smaller. This could be because if children have friends on their street and parents perceive this as strong neighbourhood relations, the children don't travel as far to play or hang out with their peers. When increased allowance to roam further from home is included in the model, it interacts with positive parental perceptions of neighbourhood comfort, and territorial range increases.

5.4 Covariates

Child Age

Findings from this study highlight the importance of increasing age as a predictor of increasing IM and strengthen findings from many previous studies.[1,26,55,116] The findings from this study add to existing research though, by demonstrating that age is not just associated with IM parenting practices, but with actual territorial range as well. As others suggested, the association between

age and IM parenting practices and territorial range may be related to increasing sense of maturity, increasing sense of responsibility, and an increasing desire to go further afield and access different types of destinations.[55,116]

While being 11 or 12 years old is a significant covariate for some associations, being 13 is significant for all associations except one. Parents seem to allow their children more freedoms and children seem to roam further as children grow up, but each increasing year of age is not equal. This trend may exemplify the shift from elementary school to high school and may be viewed by parents as the natural time to allow their children more independence, reflected in consistently larger magnitude of associations for 13-year-olds than 11- or 12-year-olds.

Child Gender

Child gender was also considered as a covariate in this study, but was found to have only some significant effects for models including parental boundaries. That child gender was not a significant covariate for the majority of effects is in contrast to a bulk of previous studies,[8,11,15–17,20,53,54] but provides additional evidence for recent arguments that the effect of gender on IM may be diminishing.[50] The hypothesized importance of child gender in IM parenting practices and territorial range is based in evidence that male children are often allowed to and encouraged to be more physically active, be more independent, and be more adventurous than female children.[117–120] As this would suggest, being a male child was found to be significantly positively associated with increasing parental boundaries in terms of both area and distance, indicating that parents may be more restrictive in terms of specific boundaries with female children than with male children. Despite this; however, being male was not significantly associated with increased

territorial range, offering evidence that boys and girls are travelling approximately the same distances from home. A possible reason for the overall lack of association between child gender and territorial range is that the difference between how far from home males are going compared to females is small because neither boys nor girls are roaming very far.

Household Income

Finally, household income was considered as a covariate to indicate SES. Findings were mixed in terms of the significance of household income to IM parenting practices, but the general trend (though mostly non-significant) for the association of household income and children's territorial range was that higher household incomes were associated with lower territorial range. This latter finding confirms previous evidence that SES is negatively related to children's IM.[49,51] As Lareau explains, in lower SES families, daily life for children consisted of play outside the house and the lack of organized activities meant that children were not being directed by adults and thus have more independence from them.[121] For children in higher SES families, daily life was filled with structured activities directed by adults, thus the children have less time for independent outdoor activities.[121] This association may not have been significant in the current study because of sampling bias (discussed below) in which most families participating viewed unstructured time and free play positively and conscientiously incorporated it into their children's lives even if they had the resources for their child to consistently be in organized activities.

5.5 Inconsistency of Results

This study used two dependent variables: children's territorial range area and children's territorial range distance. Despite these variables being derived from the same measure (GPS coordinates and daily activity diaries), they did not show the same associations with the independent or mediating variables. For example, in the LIM models, parental perceptions of some aspects of the environment were significantly associated with children's territorial range distance, but not their territorial range area. This was a surprising finding, but exemplifies the importance of understanding how the two measures are different. One possible explanation is that area is actually an inflated measure. For example, consider two children who both travel two kilometres north from home. Then consider that one of the children travels two kilometres east, and the other travels one kilometre east. Both children go a maximum of two kilometres from home, but the first child has an area of two square kilometres, while the second child has an area of only one square kilometre. Both children are allowed to go quite far from home, so area works unfavourably for the child who only goes in one direction.

5.6 Limitations

The limitations of this study need to be considered in order to appropriately assess the findings. First, the study used data collected from families who volunteered to participate in a mixed methods research study focused on neighbourhood playability. Due to the aims of the study as a whole and the involved nature of the data collection, there is a sampling bias towards families who: a) are interested in the content of the study, namely outdoor play, active transportation, and their neighbourhood, and b) have time and resources to participate in multiple meetings and fill in daily surveys. Furthermore, one of the main recruitment methods was through snowball

sampling, which may have resulted in a relatively homogenous sample with similar attitudes and values. Taken together, this makes it difficult to generalize findings to families who may not share those interests, attitudes, and values and may have caused skewed findings. Specifically, because this sample may have had less restrictive IM parenting practices and greater territorial range than the population, the results may indicate a better picture of IM and territorial range than is actually the case.

Second, territorial range was derived from cross-sectional data collected over a seven day period. Therefore, results only capture a small snapshot of children's potential territorial range. For example, a child with a very small territorial range may not have gone places he or she went the week before or will go the week after, making their area seem smaller than it would be had data been collected for a longer period of time. In a similar study by Bhosale et al. in which an online application was used by children to map their IM destinations, children's seven-day IM destination area (median=0.002 km^2) was much smaller than their six-month IM destination area (median=0.160 km^2), indicating that in the present study, longer term territorial range may have been significantly underestimated.[12]

Third, the data used in this study is subject to social desirability, recall, and measurement biases. Scales taken from parent questionnaires may be prone to social desirability bias as participants were aware that the purpose of the study was to investigate neighbourhood playability and may have responded with more pro-IM attitudes than they actually practice. Activity diaries used to code the PALMS output was subject to recall bias if the child did not take the surveys with them and fill them out as their day progressed, potentially causing location to be misrepresented and

resulting in an over- or under-estimation of territorial range. Additionally, the GPS watches used are not perfectly accurate, leading to potential measurement biases that may have resulted in territorial range measurements being slightly smaller or larger than actual. However, these last two limitations were likely less of an issue in this study because both measures were collected and could be cross-referenced.

Finally, most research on environments and IM privileges adult opinions, and children see the world in a fundamentally different way.[122,123] This study could have benefited from also considering child perceptions of the neighbourhood environment to see whether their own perceptions, as well as those of their parents, have direct effects on their territorial range.

5.7 Strengths

This study has a number of strengths. First, IM (territorial range in this study) was a more objective measure derived from a combination of GPS and daily diary data, as opposed to more subjective measures, such as self-report or proxy-report, which have been used more commonly in previous research. The issues with subjective measures are twofold: 1) if self-reported by children, the measures are at risk of recall bias; and 2) if reported by a parent, it assumes that parents know exactly where and what their child is doing, rather than recognizing children as social agents who make their own decisions about where they go and what they do there.[49,95,124] Although this study did use self-reported daily activity diaries, all entries were cross-referenced with the GPS data and when discrepancies arose, were clarified in a follow-up interview. This method of determining territorial range allows the collection of objective location data while still privileging children's reports, decreasing subjectivity and increasing completeness.

This study also included the typically used subjective measures - LIM, roaming allowance, and parental boundaries- creating a more complete picture of how these measures are related and what children's IM is influenced by. Previous research has typically considered LIM, roaming allowance, and parental boundaries as measures of children's IM. In this study, they were considered as measures of IM parenting practices and the objective territorial range measurement as actual IM. This offers a unique perspective on the role of these different measurements and what they actually represent, rather than what they are typically used to represent. It also allowed examination of how well different IM measures predict children's territorial range to give a sense of which measure is most closely associated with children's actual spatial mobility.

Finally, this is also the first study to look at parenting practices related to IM as a mediator between parental perceptions of the neighbourhood environment and children's territorial range. Given that previous research has shown relationships between parental perceptions of the neighbourhood environment and children's IM, AT, and PA[15,19,21–23,74,76,83,86,91,92,115] as well as the role of parents in allowing or restricting their children's IM,[24,30,62] it seems important to understand if parenting practices are in the pathway between how they perceive the environment and how far from home their child goes.

5.8 Implications for Future Research

Future studies should consider the following to improve understanding of the findings of this study. First, this study was conducted on a relatively small sample size for quantitative analysis. Future studies would benefit from conducting similar analyses on larger samples to give more

statistical power. They would also benefit from using different sampling methods to help reduce sampling bias. Including more families from different socio-demographic backgrounds would help extend the generalizability of the findings.

Second, this study used four measures of IM parenting practices and found that although they are highly correlated, they do not show the same relationships with the perceived environment or children's territorial range. This implies that studies using different measures of IM parenting practices may have different outcomes and should be considered when selecting measures in future studies or when comparing results with previous studies.

Finally, this study found that parental perceptions of the neighbourhood environment have limited associations with IM parenting practices and children's territorial range, directly and indirectly. Results suggest that in terms of the physical environment, easy accessibility is already in place, but improving traffic safety may positively influence children's territorial range. Findings also suggest that interventions should target social environmental factors in order to positively influence parenting practices related to IM. As previously suggested by Christian et al., community-based approaches to help increase sense of neighbourhood cohesion and social capital can foster a culture of support, trust, and reciprocity where people look out for children, helping change social norms and support children's IM.[76] Most significantly, results from this study highlight the importance of IM parenting practices on children's territorial range. Malone and Rudner suggest that negotiations between children and adults are key to influencing children's mobility in their neighbourhood,[49] and this study supports that suggestion. Recognizing the importance of parent-child IM negotiations shifts the focus of interventions

from environmental to behavioural. Parent interventions, such as programs targeted to shift attitudes towards IM, are necessary in order to reverse social norms of restrictive IM parenting practices.

Chapter 6: Conclusion

Research on children's IM has grown in recent years as concern over decreasing IM among children has become prevalent. However, consensus on how IM should be measured and how different measures are related is lacking.[12,124,125] Additionally, the neighbourhood environment has been identified as a potentially important factor influencing children's IM, but findings have been inconsistent. The purpose of this study was to examine how parental perceptions of the neighbourhood environment were associated with children's territorial range (measured using GPS, accelerometer, and activity diary data) and assess how this relationship was mediated by IM parenting practices (LIM, roaming allowance, parental boundaries).

Parental perceptions of some aspects of the neighbourhood environment were found to be associated with some IM parenting practices and children's territorial range. Parenting practices relating to children's IM allowances were all significantly associated with increasing territorial range, with spatial IM measures showing greater effects than a behavioural IM measure (LIM). This study provides evidence that parental perceptions of the neighbourhood environment may have some effect of children's territorial range, but strongly supports the role of parents as "gatekeepers" to their children's activities[24] and that the allowances or restrictions they place on their children influence their children's territorial range.[18]

Given the small, relatively homogenous sample examined in this study, it is important for future research to corroborate these findings with a larger and more diverse sample. However, in the sample considered in this study, findings suggest that future interventions to increase children's

IM should focus primarily on behavior change among parents since they are setting restrictions or allowances for children's IM.

References

1. Shaw, B. *et al. Children's independent mobility: A comparative study in England and Germany (1971-2010)*. (2013).
2. Badland, H. *et al.* Assessing neighbourhood destination access for children: Development of the NDAI-C audit tool. *Environ. Plan. B Urban Anal. City Sci.* **42,** 1148–1160 (2015).
3. Janssen, I. & Leblanc, A. G. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int. J. Behav. Nutr. Phys. Act.* **7,** 1–16 (2010).
4. Voss, M. W., Carr, L. J., Clark, R. & Weng, T. Revenge of the ' sit ' II : Does lifestyle impact neuronal and cognitive health through distinct mechanisms associated with sedentary behavior and physical activity ? *Ment. Health Phys. Act.* **7,** 9–24 (2014).
5. Burdette, H. L. & Whitaker, R. C. Resurrecting free play in young children. *Arch. Pediatr. Adolesc. Med.* **159,** 46–50 (2005).
6. Herrington, S. & Brussoni, M. Beyond physical activity: The importance of play and nature-based play spaces for children's health and development. *Curr. Obes. Rep.* **4,** 477–483 (2015).
7. Schoeppe, S., Duncan, M. J., Badland, H., Oliver, M. & Curtis, C. Associations of children's independent mobility and active travel with physical activity, sedentary behaviour and weight status: A systematic review. *J. Sci. Med. Sport* **16,** 312–319 (2013).
8. Page, A. S., Cooper, A. R., Griew, P., Davis, L. & Hillsdon, M. Independent mobility in relation to weekday and weekend physical activity in children aged 10 – 11 years : The PEACH Project. *Int. J. Behav. Nutr. Phys. Act.* **6,** 1–9 (2009).
9. Rosenberg, D. E., Cain, K. L., Conway, T. L., McKenzie, T. L. & Sallis, J. F. Active transportation to school over 2 years in relation to weight status and physical activity. *Obesity* **14,** 1771–1776 (2006).
10. Gray, C., Gibbons, R., Larouche, R., Beate, E. & Sandseter, H. What is the relationship between outdoor time and physical activity, sedentary behaviour, and physical fitness in children? A systematic review. *Int. J. Environ. Res. Public Health* **12,** 6455–6474 (2015).
11. ParticipACTION. *The ParticipACTION Report Card on Physical Activity for Children and Youth*. (2016).
12. Bhosale, J., Duncan, S., Stewart, T., Chaix, B. & Kestens, Y. Measuring children's independent mobility: Comparing interactive mapping with destination access and licence to roam. *Child. Geogr.* **3285,** 1–12 (2017).
13. Sallis, J. F. *et al.* An ecological approach to creating active living communities. *Annu. Rev. Public Health* **27,** 297–322 (2006).
14. McLeroy, K. R., Bibeau, D., Steckler, A. & Glanz, K. An ecological perspective on health promotion programs. *Health Educ. Q.* **15,** 351–377 (1988).
15. Fyhri, A. & Hjorthol, R. Children's independent mobility to school, friends and leisure activities. *J. Transp. Geogr.* **17,** 377–384 (2009).
16. Tranter, P. & Pawson, E. Children's access to local environments: A case-study of Christchurch, New Zealand. *Local Environ. Int. J. Justice Sustain.* **6,** 27–48 (2001).
17. Brown, B. *et al.* Gender differences in children's pathways to independent mobility. *Child. Geogr.* **6,** 385–401 (2008).
18. Pacilli, M. G., Giovannelli, I., Prezza, M. & Augimeri, M. L. Children and the public

realm: Antecedents and consequences of independent mobility in a group of 11-13-year-old Italian children. *Child. Geogr.* **11,** 377–393 (2013).
19. Kerr, J. *et al.* Active commuting to school: associations with environment and parental concerns. *Med. Sci. Sport. Exerc.* **38,** 787–794 (2006).
20. Timperio, A., Crawford, D., Telford, A. & Salmon, J. Perceptions about the local neighborhood and walking and cycling among children. *Prev. Med. (Baltim).* **38,** 39–47 (2004).
21. Carver, A., Timperio, A. & Crawford, D. Playing it safe: The influence of neighbourhood safety on children's physical activity — A review. *Health Place* **14,** 217–227 (2008).
22. Prezza, M. *et al.* The influence of psychosocial and environmental factors on children's independent mobility and relationship to peer frequentation. *J. Community Appl. Soc. Psychol.* **11,** 435–450 (2001).
23. Valentine, G., Mckendrickt, J., Valentine, G. & Mckendrick, J. Children's outdoor play: Exploring parental concerns about children's safety and the changing nature of childhood. *Geoforum* **28,** 219–235 (1997).
24. Witten, K., Kearns, R., Carroll, P., Asiasiga, L. & Tava'e, N. New Zealand parents' understandings of the intergenerational decline in children's independent outdoor play and active travel. *Child. Geogr.* **11,** 215–229 (2013).
25. Loebach, J. E. & Gilliland, J. A. Free range kids? Using GPS-derived activity spaces to examine children's neighbourhood activity and mobility. *Environ. Behav.* 1–33 (2014). doi:10.1177/0013916514543177
26. Hillman, M., Adams, J. & Whitelegg, J. *One False Move ... A Study of Children's Independent Mobility*. (Policy Studies Institute, 1990).
27. Veitch, J. *et al.* Are independent mobility and territorial range associated with park visitation among youth? *Int. J. Behav. Nutr. Phys. Act.* **11,** 1–6 (2014).
28. Rissotto, A. & Tonucci, F. Freedom of movement and environmental knowledge in elementary school children. *J. Environ. Psychol.* **22,** 65–77 (2002).
29. Hüttenmoser, M. Children and Their Living Surroundings: Empirical Investigations into the Significance of Living Surroundings for the Everyday Life and Development of Children. *Child. Environ.* **12,** 403–413 (2017).
30. O'Brien, M., Jones, D., Sloan, D. & Rustin, M. Children's independent spatial mobility in the urban public realm. *Childhood* **7,** 257–277 (2000).
31. ParticipACTION. *The Brain + Body Equation: Canadian kids need active bodies to build their best brains. The 2018 ParticipACTION Report Card on Physical Activity for Children and Youth.* (2018).
32. Statistics Canada. *Directly measured physical activity of children and youth, 2012 and 2013*. (2015).
33. Steinbach, R., Green, J. & Edwards, P. Look who's walking: Social and environmental correlates of children's walking in London. *Health Place* **18,** 917–927 (2012).
34. CANPLAY. *2014-2016 Kids CANPLAY: Active transportation among children and youth.* (2018).
35. Faulkner, G., Stone, M., Buliung, R., Wong, B. & Mitra, R. School travel and children's physical activity: A cross-sectional study examining the influence of distance. *BMC Public Health* **13,** 1–9 (2013).
36. Buliung, R. N., Mitra, R. & Faulkner, G. Active school transportation in the Greater

Toronto Area, Canada: An exploration of trends in space and time (1986-2006). *Prev. Med. (Baltim).* **48,** 507–512 (2009).
37. Katzmarzyk, P. T., Lee, I.-M., Martin, C. K. & Blair, S. N. Epidemiology of physical activity and exercise training in the United States. *Prog. Cardiovasc. Dis.* **60,** 3–10 (2017).
38. Pavelka, J. *et al.* Trends in active commuting to school among Czech schoolchildren from 2006 to 2014. *Cent. Eur. J. Public Health* **25,** S21–S25 (2017).
39. Chillon, P. *et al.* Six-year trend in active commuting to school in Spanish adolescents. *Int. J. Behav. Med.* **20,** 529–537 (2013).
40. van der Ploeg, H. P., Merom, D., Corpuz, G. & Bauman, A. E. Trends in Australian children traveling to school 1971 – 2003 : Burning petrol or carbohydrates ? *Prev. Med. (Baltim).* **46,** 60–62 (2008).
41. Fyhri, A., Hjorthol, R., Mackett, R. L., Fotel, T. N. & Kyttä, M. Children's active travel and independent mobility in four countries: Development, social contributing trends and measures. *Transp. Policy* **18,** 703–710 (2011).
42. Williams, G. C., Borghese, M. M. & Janssen, I. Objectively measured active transportation to school and other destinations among 10-13 year olds. *Int. J. Behav. Nutr. Phys. Act.* **15,** (2018).
43. CANPLAY. *2015 Kids CANPLAY: Active pursuits after school*. (2016).
44. Statistics Canada. *Canadian Health Measures Survey, 2007-2009*.
45. Gray, P. The decline of play and the rise of psychopathology in children and adolescents. *Am. J. Play* **3,** 443–463 (2011).
46. Clements, R. An investigation of the status of outdoor play. *Contemp. Issues Early Child.* **5,** 68–80 (2004).
47. Canadian Fitness and Lifestyle Research Institute. *Physical Activity Monitor, 2010*. (2012).
48. Hofferth, S. L. & Sandberg, J. F. in *Advances in Life Course Research- Children at the Millennium: Where Have We Come From, Where Are We Going?* (eds. Hofferth, S. L. & Owens, T. J.) **6,** 193–229 (Elsevier Science, 2001).
49. Malone, K. & Rudner, J. Global perspectives on children's independent mobility: A socio-cultural comparison and theoretical discussion of children's lives in four countries in Asia and Africa. *Glob. Stud. Child.* **1,** 243–259 (2011).
50. Shaw, B. *et al. Children's independent mobility: An international comparison and recommendations for action*. (2015).
51. Davison, K. K., Werder, J. L. & Lawson, C. T. Children's active commuting to school: Current knowledge and future directions. *Prev. Chronic Dis.* **5,** 1–11 (2008).
52. Carver, A., Timperio, A. F. & Crawford, D. A. Young and free? A study of independent mobility among urban and rural dwelling Australian children. *J. Sci. Med. Sport* **15,** 505–510 (2012).
53. Evenson, K. R., Huston, S. L., McMillen, B. J., Bors, P. & Ward, D. S. Statewide prevalence and correlates of walking and bicycling to school. *Arch. Pediatr. Adolesc. Med.* **157,** 887–892 (2003).
54. De Meester, F., Van Dyck, D., De Bourdeaudhuij, I. & Cardon, G. Parental perceived neighborhood attributes: Associations with active transport and physical activity among 10-12 year old children and the mediating role of independent mobility. *BMC Public*

Health **14,** 1–14 (2014).
55. Janssen, I., Ferrao, T. & King, N. Individual, family, and neighborhood correlates of independent mobility among 7 to 11-year-olds. *Prev. Med. Reports* **3,** 98–102 (2016).
56. Oliver, M. *et al.* Environmental and socio-demographic associates of children's active transport to school: A cross-sectional investigation from the URBAN Study. *Int. J. Behav. Nutr. Phys. Act.* **11,** (2014).
57. Mikkelsen, M. R. & Christensen, P. Is children's independent mobility really independent? A study of children's mobility combining ethnography and GPS/mobile phone technologies. *Mobilities* **4,** 37–58 (2009).
58. Pimentel, D. Criminal child neglect and the 'free range kid': Is overprotective parenting the new standard of care? *Utah Law Rev.* **52,** 947–999 (2012).
59. Ungar, M. *Overprotective parenting: Helping parents provide children the right amount of risk and responsibility*.
60. Bernstein, G. & Triger, Z. Over-Parenting. *UC Davis Law Rev.* **44,** 1221–1279 (2010).
61. Janssen, I. Hyper-parenting is negatively associated with physical activity among 7-12 year olds. *Prev. Med. (Baltim).* **73,** 55–59 (2015).
62. Carver, A., Timperio, A., Hesketh, K. & Crawford, D. Are children and adolescents less active if parents restrict their physical activity and active transport due to perceived risk? *Soc. Sci. Med.* **70,** 1799–1805 (2010).
63. Bhosale, J., Duncan, S. & Schofield, G. Intergenerational change in children's independent mobility and active transport in New Zealand children and parents. *J. Transp. Heal.* **7,** 247–255 (2017).
64. Bhosale, J., Duncan, S., Schofield, G., Page, A. & Cooper, A. A pilot study exploring the measurement of intergenerational differences in independent mobility. *J. Transp. Heal.* **2,** 522–528 (2015).
65. Kerr, J., Frank, L., Sallis, J. F. & Chapman, J. Urban form correlates of pedestrian travel in youth: Differences by gender, race-ethnicity and household attributes. *Transp. Res. Part D Transp. Environ.* **12,** 177–182 (2007).
66. Timperio, A. *et al.* Personal, family, social, and environmental correlates of active commuting to school. *Am. J. Prev. Med.* **30,** 45–51 (2006).
67. Veitch, J., Bagley, S., Ball, K. & Salmon, J. Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play. *Health Place* **12,** 383–393 (2006).
68. Orlowski, M. in *Introduction to Health Behaviors* 88 (Cengage Learning, 2015).
69. Ma, L., Dill, J. & Mohr, C. The objective versus the perceived environment: what matters for bicycling? *Transportation (Amst).* **41,** 1135–1152 (2014).
70. Janssen, I. Crime and perceptions of safety in the home neighborhood are independently associated with physical activity among 11-15year olds. *Prev. Med. (Baltim).* **66,** 113–117 (2014).
71. Rosenberg, D. *et al.* Neighborhood environment walkability scale for youth (NEWS-Y): Reliability and relationship with physical activity. *Prev. Med. (Baltim).* **49,** 213–218 (2009).
72. Carlson, J. A. *et al.* Built environment characteristics and parent active transportation are associated with active travel to school in youth age 12-15. *Br. J. Sports Med.* **48,** 1634–1639 (2014).

73. Broberg, A. & Sarjala, S. School travel mode choice and the characteristics of the urban built environment: The case of Helsinki, Finland. *Transp. Policy* **37,** 1–10 (2015).
74. Villanueva, K. *et al.* Where do children travel to and what local opportunities are available? The relationship between neighborhood destinations and children's independent mobility. *Environ. Behav.* **45,** 679–705 (2012).
75. Carver, A. *et al.* How do perceptions of local neighborhood relate to adolescents' walking and cycling? *Sci. Heal. Promot.* **20,** 139–147 (2005).
76. Christian, H. E. *et al.* The effect of the social and physical environment on children's independent mobility to neighborhood destinations. *J. Phys. Act. Heal.* **12,** 84–93 (2015).
77. Pont, K., Ziviani, J., Wadley, D., Bennett, S. & Abbott, R. Environmental correlates of children's active transportation: A systematic literature review. *Heal. Place* **15,** 827–840 (2009).
78. Rothman, L., To, T., Buliung, R., Macarthur, C. & Howard, A. Influence of social and built environment features on children walking to school: An observational study. *Prev. Med. (Baltim).* **60,** 10–15 (2014).
79. Saelens, B. E., Sallis, J. F. & Frank, L. D. Environmental correlates of walking and cycling: Findings From the transportation, urban design, and planning literatures. *Ann. Behav. Med.* **25,** 80–91 (2003).
80. Broberg, A., Salminen, S. & Kyttä, M. Physical environmental characteristics promoting independent and active transport to children's meaningful places. *Appl. Geogr.* **38,** 43–52 (2013).
81. Clifton, K. J., Livi Smith, A. D. & Rodriguez, D. The development and testing of an audit for the pedestrian environment. *Landsc. Urban Plan.* **80,** 95–110 (2007).
82. Mota, J. *et al.* Active versus passive transportation to school-differences in screen time, socio-economic position and perceived environmental characteristics in adolescent girls. *Ann. Hum. Biol.* **34,** 273–282 (2007).
83. Ghekiere, A. *et al.* Critical environmental factors for transportation cycling in children: A qualitative study using bike-along interviews. *PLoS One* **9,** 1–10 (2014).
84. Jago, R. *et al.* Licence to be active: Parental concerns and 10 – 11-year-old children's ability to be independently physically active. *J. Public Health (Bangkok).* **31,** 472–477 (2009).
85. Morrison, D. S., Thomson, H. & Petticrew, M. Evaluation of the health effects of a neighbourhood traffic calming scheme. *J. Epidemiol. Community Heal.* **58,** 837–841 (2004).
86. Foster, S., Villanueva, K., Wood, L., Christian, H. & Giles-Corti, B. The impact of parents' fear of strangers and perceptions of informal social control on children's independent mobility. *Health Place* **26,** 60–68 (2014).
87. Page, A. S., Cooper, A. R., Griew, P. & Jago, R. Independent mobility, perceptions of the built environment and children's participation in play, active travel and structured exercise and sport: the PEACH Project. *Int. J. Behav. Nutr. Phys. Act.* **7,** 1–10 (2010).
88. Prezza, M., Alparone, F. R., Cristallo, C. & Luigi, S. Parental perception of social risk and of positive potentiality of outdoor autonomy for children: The development of two instruments. *J. Environ. Psychol.* **25,** 437–453 (2005).
89. Kawachi, I. & Berkman, L. in *Social Epidemiology* (eds. Berkman, L. & Kawachi, I.) (Oxford University Press, 2000).

90. Kawachi, I., Subramanian, S. V & Almeida-Filho, N. A glossary for health inequalities. *J. Epidemiol. Community Heal.* **56,** 647–652 (2002).
91. Lu, W. *et al.* Children's active commuting to school: An interplay of self-efficacy, social economic disadvantage, and environmental characteristics. *Int. J. Behav. Nutr. Phys. Act.* **12,** 1–14 (2015).
92. Mitra, R., Faulkner, G. E., Buliung, R. N. & Stone, M. R. Do parental perceptions of the neighbourhood environment influence children's independent mobility? Evidence from Toronto, Canada. *Urban Stud.* **51,** 3401–3419 (2014).
93. Bursik, R. & Grasmick, H. *Neighborhoods and crime: the dimensions of effective community control*. (Lexington Books, 1993).
94. McNeill, L. H., Kreuter, M. W. & Subramanian, S. V. Social environment and physical activity: A review of concepts and evidence. *Soc. Sci. Med.* **63,** 1011–1022 (2006).
95. Kyttä, M. The extent of children's independent mobility and the number of actualized affordances as criteria for child-friendly environments. *J. Environ. Psychol.* **24,** 179–198 (2004).
96. City of Vancouver. *Grandview-Woodland Community Plan*. (2013).
97. Statistics Canada. Vancouver East (Federal Electoral District). *Census Profile, 2016 Census* (2017). Available at: http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=FED&Code1=59035&Geo2=PR&Code2=59&Data=Count&SearchText=vancouver&SearchType=Begins&SearchPR=01&B1=All&TABID=1.
98. Metro Vancouver. *Metro Vancouver's 2011 Generalized Land Use by Municipality*. (2016).
99. Statistics Canada. Steveston-Richmond East (Federal Electoral District). *Census Profile, 2016 Census* (2017). Available at: http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=FED&Code1=59031&Geo2=PR&Code2=59&Data=Count&SearchText=steveston&SearchType=Begins&SearchPR=01&B1=All&TABID=1.
100. Statistics Canada. North Vancouver, Federal Electoral District. *Census Profile, 2016 Census* (2017). Available at: http://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/page.cfm?Lang=E&Geo1=FED&Code1=59021&Geo2=PR&Code2=59&Data=Count&SearchText=north vancouver&SearchType=Begins&SearchPR=01&B1=All&TABID=1.
101. University of California San Diego & Center for Wireless & Population Health Systems. Personal Activity Location Measurement System: User guide. (2011).
102. Garmin Connect. Available at: https://connect.garmin.com/en-US/features/.
103. Larouche, R. *et al.* Test-retest reliability and convergent validity of measures of children's travel behaviours and independent mobility. *J. Transp. Heal.* **6,** 105–118 (2017).
104. Shareck, M., Kestens, Y. & Gauvin, L. Examining the spatial congruence between data obtained with a novel activity location questionnaire, continuous GPS tracking, and prompted recall surveys. *Int. J. Health Geogr.* **12,** 40 (2013).
105. Stewart, T. *et al.* A novel assessment of adolescent mobility: A pilot study. *Int. J. Behav. Nutr. Phys. Act.* **12,** 18 (2015).
106. Buckner, J. C. The development of an instrument to measure neighborhood cohesion. *Am.*

J. Community Psychol. **16,** 771–791 (1988).
107. Woolridge, J. M. *Introductory Econometrics*. (Cengage Learning, 2009).
108. Angeles, U. of C. L. How do I interpret a regression model when some variables are log transformed? *Institute for Digital Research and Education*
109. Hayes, A. F. Beyond Baron and Kenny: Statistical mediation analysis in the new millenium. *Commun. Monogr.* **76,** 408–420 (2009).
110. City of Vancouver. Urban planning, sustainable zoning, and development. *Home, property, and development* (2018). Available at: http://vancouver.ca/home-property-development/planning-zoning-development.aspx. (Accessed: 19th June 2018)
111. Saunders, D. Doug Saunders: The world wants Vancouververism. Shouldn't Canada? *The Globe and Mail* (2013).
112. Bercic, C. Carrie Bercic: Neighbourhood schools matter. *The Georgia Straight* (2017).
113. Lafleur, S. & Filipowicz, J. Opinion: Vancouver housing can't be both low-density and affordable. *The Province* (2017).
114. Schoeppe, S. *et al.* Socio-demographic factors and neighbourhood social cohesion influence adults' willingness to grant children greater independent mobility: A cross-sectional study. *BMC Public Health* **15,** 1–8 (2015).
115. Sharmin, S. & Kamruzzaman, M. Association between the built environment and children's independent mobility: A meta-analytic review. *J. Transp. Geogr.* **61,** 104–117 (2017).
116. Veitch, J., Salmon, J. & Ball, K. Children's active free play in local neighborhoods: A behavioral mapping study. *Health Educ. Res.* **23,** 870–879 (2008).
117. Little, H. & Eager, D. Risk, challenge and safety: Implications for play quality and playground design. *Eur. Early Child. Educ. Res. J.* **18,** 497–513 (2010).
118. Witt, S. D. The influence of peers on children's socialization to gender roles. *Early Child Dev. Care* **162,** 1–7 (2000).
119. Brustad, R. J. Attraction to physical activity in urban schoolchildren : Parental socializat ... *Res. Q. Exerc. Sport* **67,** 316–323 (1996).
120. Kollmayer, M., Schober, B. & Spiel, C. Gender stereotypes in education: Development, consequences, and interventions. *Eur. J. Dev. Psychol.* **15,** 361–377 (2016).
121. Lareau, A. *Unequal Childhoods: Class, Race, and Family Life*. (University of California Press, 2003).
122. Noonan, R. J., Boddy, L. M., Fairclough, S. J. & Knowles, Z. R. Write, draw, show, and tell: A child-centred dual methodology to explore perceptions of out-of-school physical activity. *BMC Public Health* **16,** 1–19 (2016).
123. Punch, S. Research with children: The same or different from research with adults? *Childhood* **9,** 321–341 (2002).
124. Bates, B. & Stone, M. R. Measures of outdoor play and independent mobility in children and youth: A methodological review. *J. Sci. Med. Sport* **18,** 545–552 (2015).
125. Oliver, M. *et al.* Associations between the neighbourhood built environment and out of school physical activity and active travel: An examination from the Kids in the City study. *Heal. Place* **36,** 57–64 (2015).

Appendices

Appendix A

A.1 Child Demographic Questionnaire

Child Participant Demographic Questionnaire and Scales
Playability study

Please know that providing this information is voluntary and you do not have to answer any questions that you do not want to answer.

A. General background information

Age: _____ **Gender:** _____
Grade:_____

What is your race/ethnicity: (Please check the most appropriate answer)

○ 1- Aboriginal/First Nation
○ 2- Asian
○ 3- Black
○ 4- Hispanic
○ 5- White
○ 6- Other
_____
○ 7- Prefer not to answer

Do you have any pets?: (Please check all that apply)

○ 1- I don't have any pets
○ 2- Dog(s)
○ 3- Cat(s)
○ 4- Other, please specify… _____

What time do you usually wake up in the morning? _____

What time do you usually go to bed at night? _____

How do you usually commute to school? _____

Regular school hours: _____ to _____

B. Physical activity

1. **How many hours a day (in your free time) do you usually spend playing outdoors OUTSIDE SCHOOL HOURS? Do not include time spent on organized physical activities such as sports and classes. (Please mark one box for weekdays and one box for weekend)**

Weekdays

1 ☐ None at all	2 ☐ About half an hour	3 ☐ About 1 hour
4 ☐ About 2 hours	5 ☐ About 3 hours	6 ☐ About 4 hours
7 ☐ About 5 hours	8 ☐ About 6 hours	9 ☐ About 7 or more hours

Weekend

1 ☐ None at all	2 ☐ About half an hour	3 ☐ About 1 hour
4 ☐ About 2 hours	5 ☐ About 3 hours	6 ☐ About 4 hours
7 ☐ About 5 hours	8 ☐ About 6 hours	9 ☐ About 7 or more

2. **Please add up all the time you spend in physical activity each day OUTSIDE OF SCHOOL HOURS:**

Physical activity is any activity that increases your heart rate and makes you get out of breath some of the time. Physical activity can be done in sports, school activities, playing with friends, or walking to school. Some examples of physical activity are running, brisk walking, inline skating, biking, dancing, skateboarding, swimming, playing soccer, basketball and football.

Weekdays

1 ☐ None at all	2 ☐ About half an hour	3 ☐ About 1 hour
4 ☐ About 2 hours	5 ☐ About 3 hours	6 ☐ About 4 hours
7 ☐ About 5 hours	8 ☐ About 6 hours	9 ☐ About 7 or more hours

Weekend

1 ☐ None at all
2 ☐ About half an hour
3 ☐ About 1 hour
4 ☐ About 2 hours
5 ☐ About 3 hours
6 ☐ About 4 hours
7 ☐ About 5 hours
8 ☐ About 6 hours
9 ☐ About 7 or more

3. Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?

1 ☐ 0 days
2 ☐ 1 day
3 ☐ 2 days
4 ☐ 3 days
5 ☐ 4 days
6 ☐ 5 days
7 ☐ 6 days
8 ☐ 7 days

4. **How would you rate your overall level of physical health?** *Please circle the number that most accurately describes your level of health at this time. On a scale of 1–5, where 1 is extremely poor and 5 is excellent.*

Extremely poor				**Excellent**
1	2	3	4	5

5. How would you rate your overall level of mental health? *Please circle the number that most accurately describes your level of health at this time. On a scale of 1–5, where 1 is extremely poor and 5 is excellent.*

Extremely poor				**Excellent**
1	2	3	4	5

4. Please say how you feel about these statements about the area where you live. (Please mark one box for each line)

	Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
• People say 'hello' and often stop to talk to each other in the street.	☐	☐	☐	☐	☐
• It is safe for younger children to play outside during the day.	☐	☐	☐	☐	☐

- You can trust people around here. ☐ ☐ ☐ ☐ ☐
- There are good places to spend your free time (e.g., recreation centres, parks, shopping centres). ☐ ☐ ☐ ☐ ☐
- I could ask for help or a favour from neighbours. ☐ ☐ ☐ ☐ ☐
- Most people around here would try to take advantage of you if they got the chance. ☐ ☐ ☐ ☐ ☐

	Strongly agree	**Agree**	**Disagree**	**Strongly disagree**
• Playing outside helps me think more clearly.	☐	☐	☐	☐
• Playing outside makes me healthier.	☐	☐	☐	☐
• When I'm angry, playing outside calms me down.	☐	☐	☐	☐
• I learn new things when playing outside.	☐	☐	☐	☐
• I feel like I have freedom when I play outside.	☐	☐	☐	☐
• I like to explore new places outside.	☐	☐	☐	☐
• I am afraid of getting lost outside.	☐	☐	☐	☐
• I don't like playing outside because there are strangers.	☐	☐	☐	☐
• I am afraid of wild animals or insects outside.	☐	☐	☐	☐
• I am afraid of getting hurt if I play outside.	☐	☐	☐	☐

- I don't like playing outside because there are people with drugs. ☐ ☐ ☐ ☐

In the area where you live…	**Strongly agree**	**Agree**	**Disagree**	**Strongly disagree**
• there are children to play with.	☐	☐	☐	☐
• there are children on streets.	☐	☐	☐	☐
• there are people walking and cycling around.	☐	☐	☐	☐
• there is a high crime rate.	☐	☐	☐	☐
• it's very noisy.	☐	☐	☐	☐
• there is a lot of bullying.	☐	☐	☐	☐

How often are you allowed to go to the following places on your own or with friends (without an adult)?	**Never**	**Some-times**	**Very often**	**Always**
• Friend's house	☐	☐	☐	☐
• School	☐	☐	☐	☐
• Local shops	☐	☐	☐	☐
• Park or playground	☐	☐	☐	☐
• Swimming pool	☐	☐	☐	☐
• Library	☐	☐	☐	☐

- Cinema ☐ ☐ ☐ ☐
- Arcade ☐ ☐ ☐ ☐
- Bus stops ☐ ☐ ☐ ☐
- Sport and shopping centre ☐ ☐ ☐ ☐

Thank You!

A.2 Parent Demographic Questionnaire

Parents Participant Demographic Questionnaire

Playability study

Please know that providing this information is voluntary and you do not have to answer any questions that you do not want to answer.

A. General background information

Age: _____

Gender:

- ○ 1- Male
- ○ 2- Female
- ○ 3- Other, please specify… _____
- ○ 4- Prefer not to answer

Race/ethnicity: (Please check the most appropriate answer)

- ○ 1- Aboriginal/First Nation
- ○ 2- Asian
- ○ 3- Black
- ○ 4- Hispanic
- ○ 5- White
- ○ 6- Other _____
- ○ 7- Prefer not to answer

Household income in net

- ○ 1- Less than $29,999
- ○ 2- $30,000-$49,999
- ○ 3- $50,000-$69,999
- ○ 4- $70,000-$89,999
- ○ 5- $90,000-$109,999
- ○ 6- $110,000-$129,999
- ○ 7- $130,000 or more
- ○ 8- Prefer not to answer

Marital Status: (Please check the most appropriate answer)

○ 1- Single / never-married	○ 4- Separated	○ 7- Prefer not to answer
○ 2- Married	○ 5- Divorced	
○ 3- Common-law	○ 6- Widowed	

Education completed: (Please check the most appropriate answer)

○ 1- Some high school
○ 2- High school graduate or GED
○ 3- Some university
○ 4- Some college
○ 5- College graduate
○ 6- University graduate
○ 7- Post graduate degree
○ 8- Other: _____
○ 9- Prefer not to answer

Employment status: (Please check the most appropriate answer)

○ 1- Employed for wages
○ 2- Self-employed
○ 3- Out of work and looking for work
○ 4- Out of work but not currently looking for work
○ 5- A homemaker
○ 6- A student
○ 7- Retired
○ 8- Unable to work
○ 9- Other: _____
○ 10- Prefer not to answer

How many children live in your household who are:

Less than 5 years old	
5 through 12 years old	
13 through 17 years old	

What is the structural type of dwelling of your home?

○ 1- Single-detached house
○ 2- Semi-detached house
○ 3- Row house
○ 4- Low-rise apartment
○ 5- High-rise apartment/condo
○ 6- Mobile home
○ 7- Other, please specify… _____

How far is your child allowed to roam on his/her own (or with friends) without adult accompaniment?: (Please check the most appropriate answer)

- ○ 1- My child is not allowed out alone
- ○ 2- My child is allowed out within my yard and/or driveway
- ○ 3- My child is allowed out within my street
- ○ 4- My child is allowed out within 2-3 streets from my home
- ○ 5- My child is allowed out within a 15 minute walk from home
- ○ 6- My child is allowed out more than a 15 minute walk from home

What time do you usually go to bed? _____

What time does your child usually go to bed? _____

B. Parental perceptions scales

Social Danger Perception Scale (Prezza et al., 2005)

Scale: 4=very true, 3= true, 2=false, 1=very false

1	In the streets around my home there are areas frequented by drug pushers and/or drug addicts	
2	A child who goes out alone can encounter ill-intentioned adults	
3	In my neighbourhood, you can find syringes on the ground	
4	A child who goes out alone can see things that may frighten him/her	
5	In my neighbourhood, there are robberies and bag-snatchings	
6	In my neighbourhood, there are people who dress/behave strangely	
7	In the streets around my home, there are neglected areas (dirty, with large abandoned objects, etc.):	

Perception of Positive Potentiality of Outdoor Autonomy for Children Scale (Prezza et al., 2005)

Scale: 4=very true, 3= true, 2=false, 1=very false

1	A child who goes out alone can meet and/or play with other children	
2	A child who goes out alone can become more responsible	
3	A child who goes out alone can make new friends	
4	A child who goes out alone can learn to be independent	
5	A child who goes out alone can learn her/his way around	

Neighbourhood Relations Scale (Prezza et al., 2001)

Scale: 5=everyday, 4=often, 3= sometimes, 2=rarely, 1=never

1	I visit with my neighbours in their homes	
2	I have neighbours over to my house to visit	
3	I stop and talk to people in my neighbourhood	
4	I meet with my neighbours to spend some time doing things together	
5	I exchange favours with my neighbours	

Licenses for Independent Mobility (Shaw et al., 2003)

Scale: Yes/No

1	Does your child travel home from school alone?	
2	When going to places other than school that are within walking distance, is your child allowed to go alone?	
3	Is your child allowed to cross main roads alone?	
4	Is your child usually allowed to go out alone after dark?	
5	Is your child allowed to cycle on main roads alone?	
6	Is your child usually allowed to travel on local buses alone (other than a school bus)?	

How far does your child roam on his/her own (or with friends) without adult accompaniment?: (Please check the most appropriate answer)

- ○ 1- Less than 5 minutes walk from home
- ○ 2- 5 to 10 minutes walk from home
- ○ 3- 10 to 15 minutes walk from home
- ○ 4- more than 15 minutes walk from home

The Tolerance of Risk in Play Scale (please see attached)

Neighborhood Environment Walkability Scale (please see attached)

Thank you!

Appendix B

B.1 Child Daily Activity Diary

DAY 1 – DATE:

1. What time did you wake up today?		2. What time are you going to bed tonight?	
3. What was the temperature like today?	o Hot o Comfortable o Cold	4. What was the weather like today? **Please select ALL that apply**	o Sunny o Rainy o Overcast o Snowy

5. What did you do today? Please write down what you did today from the time you wake up till you go to bed (excluding school hours 9AM-3PM)								
Start time	**End time**	**What were you doing?** (e.g., playing; practicing sports; staying at home; in transit/travelling; getting ready for school, etc.)	**Where were you?** (e.g., home; friend's house; shopping mall; at the park; in the car, etc.)	**If you were in transit/travelling, how did you get to your destination?** (e.g., walk, bike, bus, car etc.)	**Did this activity take place inside or outside?** (Select all that apply)	**Were you physically active** (e.g., walking, running, biking, playing, practicing sports etc.)?	**Were you with adult(s)?**	**Were you with friend(s) or sibling(s)?**
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no

See back page for more space and questions.

DAY 1 (cont'd)

Start time	End time	What were you doing? (e.g., playing; practicing sports; staying at home; in transit/travelling; getting ready for school, etc.)	Where were you? (e.g., home; friend's house; shopping mall; at the park; in the car, etc.)	If you were in transit/travelling, how did you get to your destination? (e.g., walk, bike, bus, car etc.)	Did this activity take place inside or outside? (Select all that apply)	Were you physically active (e.g., walking, running, biking, playing, practicing sports etc.)?	Were you with adult(s)?	Were you with friend(s) or sibling(s)?
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no
					o inside o outside	o yes o no	o yes o no	o yes o no

6. Did you take any of the monitors off during the day? If yes, please write down all the details below for each time you've taken your monito(s) off during the day.

Which monitor?	From what time to what time?	Why did you take it off?

Thank you!
Please don't forget to save your Location data and charge your Location monitor for tomorrow.

B.2 Parent Daily Survey

PARENT PARTICIPANT DAILY SURVEY [Participant ID:]

DAY 1 – DATE:

1. Was your child alone or without an adult anytime today? (For example: playing in the backyard, at the park, going to a friend's house)

- **Yes – If yes, please write down all the details below for each time your child was alone or without an adult anytime today.**
- **No**

Start time	End time	What was your child doing?	Who was your child with?	Did the activity take place inside or outside?

Thank you!

Please don't forget to save your child's Location data and charge the Location monitor for tomorrow.

Appendix C

C.1 Neighbourhood Environment Walkability Scale- Youth Version

Neighborhood Environment Walkability Scale – Youth (NEWS-Y)

Parent Version

From Active Where? study

Information on scoring can be found at:
http://www.drjamessallis.sdsu.edu/Documents/NEWS-Yscoring.pdf

Suggested reference:

Rosenberg, D. Ding, D., Sallis, J.F., Kerr, J., Norman, G.J., Durant, N., Harris, S.K., & Saelens, B.E. (2009). Neighborhood environment walkability scale for youth (NEWS-Y): Reliability and relationship with physical activity. *Preventive Medicine, 49*, 213-218.

A. Stores and other public places in the neighborhood where you and your child live

About how long would it take you to walk (on your own, without your children) from your home to the nearest stores or places listed below? Please circle the time it would take you to walk to each place, even if you don't normally go there.

e.g.	gas station	1-5 min	6-10 min	(11-20 min)	21-30 min	31+ min	don't know
1	convenience/corner store/ small grocery store/bodega	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
2	supermarket	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
3	hardware store	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
4	fruit/vegetable market	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
5	laundry or dry cleaners	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
6	clothing store	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
7	post office	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
8	library	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
9	elementary school	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
10	middle or high school	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
11	book store	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
12	fast food restaurant	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
13	coffee place	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
14	bank/credit union	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
15	non-fast food restaurant	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
16	video store	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
17	pharmacy/drug store	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
18	hairdressers/barber shop	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
19	any offices/worksites	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
20	bus, subway or train stop	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know

B. Recreation places in the neighborhood where you and your child live

About how long would it take you to walk (on your own, without your children) from your home to the nearest recreation place listed below? Please circle the time it would take you to walk to each place, even if you don't normally go there.

1	Indoor recreation or exercise facility (public or private)	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
2	beach, lake, river, or creek	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
3	bike/hiking/walking trails, paths	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
4	basketball court	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
5	other playing fields/courts (e.g., soccer, football, softball, tennis, skate park etc.)	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
6	YMCA	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
7	boys and girls club	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
8	swimming pool	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
9	walking / running track	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
10	school with recreation facilities open to the public	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
11	small public park	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
12	large public park	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
13	public playground with equipment	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
14	public open space (grass or sand/dirt) that is not a park	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know

C. Types of homes in your neighborhood

While thinking about the places where people live in your neighborhood, please circle an answer for each of the following questions. Your neighborhood is the local area around your home, within a 10-15 minute walk in any direction.

1. How common are <u>separate or stand alone one family homes</u> in your neighborhood?
   There are:

1	2	3	4	5
None	A few	Some	A lot	All the residences are separate one family homes

2. How common are <u>connected townhouses or rows of houses</u> in your neighborhood?
   There are:

1	2	3	4	5
None	A few	Some	A lot	All the residences are townhouses or row houses

3. How common are <u>multiple family or duplex homes</u> in your neighborhood?
   There are:

1	2	3	4	5
None	A few	Some	A lot	All the residences are multiple family/duplex homes

4. How common are <u>apartment or condo buildings</u> in your neighborhood?
   There are:

1	2	3	4	5
None	A few	Some	A lot	All the residences are in apartment or condo buildings

D. Access to services

Please circle the answer that best applies to the neighborhood where you and your child live. Both local and within walking distance mean within a 10-15 minute walk from your home.

1. Stores are within easy walking distance of our home.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. Parking is difficult in local shopping areas.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. There are many places for my child to go (alone or with someone) within easy walking distance of our home.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. From our home, it is easy for my child to walk (alone or with someone) to a transit stop (bus, subway, train).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. The streets in my neighborhood are hilly, making our neighborhood difficult for my child to walk in.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. There are major barriers to walking in our local area that make it hard for my child to get from place to place (for example, freeways, railway lines, rivers).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

E. Streets in my neighborhood

Please circle the answer that best applies to the neighborhood where you and your child live.

1. The streets in our neighborhood <u>do not</u> have many cul-de-sacs (dead-end streets).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. The distance between intersections (where streets cross) in our neighborhood is usually short. (100 yards or less; the length of a football field or less).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. There are many different routes for getting from place to place in our neighborhood. (My child doesn't have to go the same way every time.)

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

F. Places for walking

Please circle the answer that best applies to the neighborhood where you and your child live.

1. There are sidewalks on most of the streets in our neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. Sidewalks are separated from the road/traffic in our neighborhood by parked cars.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. There is grass/dirt between the streets and the sidewalks in our neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

G. Neighborhood surroundings

Please circle the answer that best applies to the neighborhood where you and your child live.

1. There are trees along the streets in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. There are many interesting things for my child to look at while walking in my neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. There are many beautiful natural things for my child to look at in my neighborhood (e.g., gardens, views).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. There are many buildings/homes in my neighborhood that are nice to look at for my child

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

H. Neighborhood safety

Please circle the answer that best applies to the neighborhood where you and your child live.

1. There is so much traffic along nearby streets that it makes it difficult or unpleasant for my child to walk (alone or with someone) in our neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. The speed of traffic on most nearby streets is usually slow (30 mph or less).

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. Most drivers go faster than the posted speed limits in our neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. Our neighborhood streets have good lighting at night.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. Walkers and bikers on the streets in our neighborhood can be easily seen by people in their homes.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. There are crosswalks and signals to help walkers cross busy streets in our neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

7. When walking in our neighborhood there are a lot of exhaust fumes.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

I. Crime safety

Please circle the answer that best applies to the neighborhood where you and your child live.

1. There is a high crime rate in our neighborhood.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

2. The crime rate in our neighborhood makes it unsafe for my child to go on walks (alone or with someone) at night.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

3. I am worried about letting my child play outside alone around my home (e.g., yard, driveway, apartment common area) because I am afraid of them being taken or hurt by a stranger.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

4. I am worried about letting my child be outside with a friend around my home because I am afraid my child will be taken or hurt by a stranger.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

5. I am worried about letting my child play or walk alone or with friends in my neighborhood and local streets because I am afraid my child will be taken or hurt by a stranger.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree

6. I am worried about letting my child be alone or with friends in a local or nearby park because I am afraid my child will be taken or hurt by a stranger.

1	2	3	4
strongly disagree	somewhat disagree	somewhat agree	strongly agree