Titre: Title:	Developing a diagnostic tool for children's accessibility, and independent mobility, and well-being in Montreal, Canada
Auteur: Author:	Zahra Tavakoli Dastjerdi
Date:	2024
Type:	Mémoire ou thèse / Dissertation or Thesis
Référence: Citation:	Tavakoli Dastjerdi, Z. (2024). Developing a diagnostic tool for children's accessibility, and independent mobility, and well-being in Montreal, Canada [Thèse de doctorat, Polytechnique Montréal]. PolyPublie. https://publications.polymtl.ca/59282/

URL de PolyPublie: PolyPublie URL:	https://publications.polymtl.ca/59282/
Directeurs de recherche: Advisors:	Owen Waygood, & Geneviève Boisjoly
Programme: Program:	Génie civil

POLYTECHNIQUE MONTRÉAL

affiliée à l'Université de Montréal

Developing a diagnostic tool for children's accessibility, and independent mobility, and well-being in Montreal, Canada

ZAHRA TAVAKOLI DASTJERDI

Département des génies civil, géologique et des mines

Thèse présentée en vue de l'obtention du diplôme de *Philosophiæ Doctor*

Génie civil

Août 2024

POLYTECHNIQUE MONTRÉAL

affiliée à l'Université de Montréal

Cette thèse intitulée :

Developing a diagnostic tool for children's accessibility, and independent mobility, and well-being in Montreal, Canada

présentée par **Zahra TAVAKOLI DASTJERDI**

en vue de l'obtention du diplôme de *Philosophiæ Doctor*

a été dûment acceptée par le jury d'examen constitué de :

Catherine MORENCY, présidente
Owen WAYGOOD, membre et directeur de recherche
Geneviève BOISJOLY, membre et codirectrice de recherche
Kevin MANAUGH, membre externe
Susan HANDY, membre externe

DEDICATION

Dedicated to all girls pursuing their dreams,

and

To all the children on this planet.

ACKNOWLEDGEMENTS

For me, a PhD wasn't just a degree but a path to grow, step out of my comfort zone, and learn about being autonomous. Starting my PhD during Covid-19 and being alone for months was perhaps one of the most challenging times of my life. However, despite all that challenges, I am deeply grateful to have always been surrounded by people who helped and supported me throughout.

First, I want to extend my heartfelt thanks to my incredible supervisor, Professor Owen Waygood for his constant support and encouragement over the past three years. His insights, feedback, and encouragement have been instrumental in shaping this research. Thank you, Owen, for your amazing mentorship and for always being there to support me. This project has been a turning point in my career, and I am deeply grateful for the opportunity to contribute to such a significant subject.

Also, I would like to express my gratitude to my wonderful co-supervisor, Professor Genevieve Boisjoly, for her unwavering support and guidance throughout my PhD journey. I am deeply grateful for the dedication you invested in helping me achieve my goals. It was a pleasure working with you.

This project also provided me with the wonderful opportunity to work with other amazing people in the field. I am deeply appreciative of everything I learned from Professor Antonio Paez. It was an absolute pleasure to work and learn from him. Additionally, I want to thank my amazing colleague, Shabnam Abdollahi, who was always there for me.

Living with a PhD student is not easy. It involves dealing with many ups and downs. I am incredibly grateful to have had my best friend, partner, and husband, Stelian, by my side, shoulder to shoulder. Every time I faced an obstacle or challenge, he was always there. This journey couldn't have been completed without his love and support.

Thousands of kilometers far from my country, my heart was always with my family. I want to express my deepest thanks to my wonderful parents, whose love, patience, and encouragement have supported me to this day. In addition, I would like to thank my brother, Hadi, for all the help he has provided me from the moment I applied for PhD position until today.

Lastly, but certainly not least, if Montreal feels like home to me today, it is because of the second family I have here among my friends. Ghazal, Ghazaleh, Lucy, and Nana, thank you for listening

to me, supporting me, always being there for me, and encouraging me to finish this journey. It is such a blessing to have you all in my life.

An incredible journey comes to an end with this acknowledgement. My sincere thanks go out to each and every one of you.

RÉSUMÉ

Le réseau de mobilité contribuent de manière significative aux déplacements des enfants vers leurs destinations quotidiennes. Pourtant, leur mobilité et leurs habitudes de déplacement sont souvent négligées, la planification des transports donnant la priorité aux besoins des adultes. Cette approche centrée sur les adultes a accru la dépendance des enfants à l'égard de la voiture, réduisant leur accessibilité et limitant leurs interactions avec leur environnement local. Par conséquent, les enfants sont privés de la possibilité de se déplacer de manière indépendante vers diverses destinations quotidiennes. En plus de nuire à la santé physique des enfants, le manque de possibilités de déplacements actifs peut avoir un impact négatif sur leur développement psychologique, cognitif et social. Il est donc essentiel de créer des environnements plus accessibles pour promouvoir la mobilité et le bien-être général des enfants.

Le comportement des adultes en matière de déplacements étant différent de celui des enfants, les mesures actuelles de l'accessibilité aux destinations quotidiennes peuvent ne pas être adaptées aux enfants. Les enfants se déplacent vers des destinations quotidiennes différentes, leurs capacités de marche sont limitées et ils peuvent être plus exposés aux dangers de la circulation, ce qui a un impact considérable sur leur mobilité. Bien qu'il existe diverses mesures d'accessibilité, elles ne sont pas spécifiquement adaptées aux besoins des enfants. Un exemple d'une telle mesure est le Walk Score, qui mesure l'accessibilité à pied d'un quartier, en fonction de sa connectivité et des commerces et services présents. Par conséquent, cette mesure générale des destinations locales peut ne pas refléter la manière dont un quartier est réellement lié aux besoins des enfants. D'autres mesures existantes de l'accessibilité à pied pour les enfants se concentrent souvent sur un seul type de destination, comme les écoles ou les parcs et terrains de jeux. Certaines études ont mesuré l'accessibilité des enfants en utilisant un éventail plus large de destinations ; cependant, ces études n'ont pas considéré les dangers de la circulation comme un obstacle à la mobilité des enfants. En outre, les études précédentes se sont concentrées presqu’exclusivement sur l'activité physique des enfants et n'ont pas fourni d'informations spécifiques sur la manière dont ces destinations sont associées à de multiples domaines de la santé et du bien-être des enfants. Il est donc essentiel de développer des mesures d'accessibilité spécifiques aux enfants, afin de minimiser les effets négatifs d'une planification des transports centrée sur les adultes.

L'objectif de ce projet de recherche est de développer un outil qui mesure l'accessibilité des enfants à leurs destinations quotidiennes en tenant compte de la manière dont ces destinations sont liées à leur santé et à leur bien-être. Les principales questions de recherche de cette étude sont les suivantes

1) Comment mesurer l'accessibilité des enfants ?

2) Quel est le lien entre les différentes destinations et la santé et le bien-être des enfants ?

Pour répondre à cette question, cette thèse propose de créer des outils permettant de mesurer l'accessibilité des enfants en fonction de leurs besoins et préférences spécifiques, en identifiant les destinations pertinentes pour les enfants dans leur quartier. Ensuite, elle évalue l'accessibilité des enfants à ces lieux en tenant compte des dangers de la circulation qui pourraient entraver leur mobilité. Enfin, elle estime l'accessibilité en fonction de la relation entre ces destinations et différents domaines du bien-être en utilisant les connaissances et perceptions des parents et des enfants.

Les outils développés soulignent l'importance d'identifier les besoins des enfants en matière d'accessibilité à leurs destinations quotidiennes. L'intégration des contributions de multiples parties prenantes, y compris les enfants, les parents et les experts, garantit une compréhension globale des besoins des enfants. Elle permet également d'identifier les différents seuils de distance de marche des enfants et l'impact des dangers de la circulation sur l'accès à ces lieux. Basé sur les perceptions des parents et des enfants, l'outil développé illustre comment les différentes catégories de destinations soutiennent plusieurs domaines de bien-être. En d'autres termes, les résultats montrent que l'accessibilité à des destinations spécifiques aux enfants peut être considérablement affectée par des limitations dues au danger de la circulation lorsqu'il s'agit d'atteindre des lieux significatifs qui pourraient être liés à leur bien-être.

La nature systématique de cette analyse facilite son adaptation et son application à d'autres contextes. La méthode peut donc être utilisée pour améliorer la mesure de l'accessibilité à pied des enfants dans différents environnements. Les outils de diagnostic peuvent également guider les décideurs politiques dans la création d'espaces urbains inclusifs et favorables aux enfants, et ils peuvent contribuer à identifier des lieux d’interventions prioritaires visant à améliorer l'accessibilité à pied des enfants.

ABSTRACT

Mobility network plays a significant role in children's travel to their daily destinations, yet their mobility and travel patterns are often overlooked as transportation planning prioritizes adult needs. This adult-centric approach has increased car dependency among children, reducing their accessibility, and limiting their interaction with their local environments. As a result, children are being deprived of the chance to be independently travel to a variety of daily destinations. In addition to negatively affecting children's physical health, a lack of active travel opportunities can negatively impact their psychological, cognitive, and social development. Therefore, creating more accessible environments is essential to promoting children's mobility and overall well-being.

As adults' travel behavior differs from that of children, current measures of accessibility might not be appropriate for children. Children travel to different daily destinations, they have limited walking abilities, and they may be at greater risk from traffic danger which greatly impacts their mobility. In consequence, while there are various accessibility measures, they are not specifically tailored to children's needs. An example of such a measure is Walk Score, which measures a neighborhood's walking accessibility based on the general amenities and connectivity. Therefore, this general measure of local destinations might not capture how a neighborhood truly relates to children. Some other existing children's walking accessibility measures related to children's travel often focus on a single type of destination such as schools or parks and playgrounds. Some studies have measured children's accessibility using a wider range of destinations; however, these studies did not consider traffic danger as a barrier for children's mobility. Moreover, previous studies have focused almost exclusively on children's physical activity and did not provide specific insight into how these destinations are associated with multiple domains of children's health and well-being. It is therefore crucial to develop child-specific accessibility measures to minimize the negative effects of adult-centered transportation planning.

The objective of this research project is to develop a tool that measures children's accessibility to their daily destinations with consideration to how those destinations relate to their health and wellbeing. The main research questions for this study are:

1) **How can children's accessibility be measured?**
2) **How do various destinations relate to children's health and well-being?**

To address this question, this dissertation proposes to build tools for measuring children's accessibility based on their specific needs and demands by identifying child-relevant destinations in their neighborhood. Next, it evaluates children's accessibility to such places by considering traffic danger that could hinder their mobility, and then it will estimate accessibility based on the relationship between those destinations and different domains of well-being by using inputs from both parents and children.

The developed tools emphasize the importance of identifying children's needs regarding their accessibility to their daily destinations. Incorporating input from multiple stakeholders, including children, parents, and experts, ensures a comprehensive understanding of children's needs. It also captures children's different walking distance thresholds and the impact of traffic danger on accessing these places. Based on the perceptions of parents and children, the developed tool illustrates how different categories of destinations support multiple domains of well-being. In other words, the results illustrate how accessibility to child-specific destinations can be significantly impacted by limitations due to traffic danger when it comes to reaching meaningful places that could be related to their well-being.

The systematic nature of this analysis facilitates its adaptation and application to other contexts. The method can therefore be used to improve the measurement of children's walking accessibility in different environments. The diagnostic tools can also guide policymakers in creating inclusive and supportive urban spaces for children, and it can identify the place of interventions to improve children’s walking accessibility.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

CIM Children's Independent Mobility

GIS Geographic Information System

GPS Global Positioning System

DA Dissemination Area

GTFS General Transit Feed Specification

OSM Open Street Map

r5r Rapid Realistic Routing on Real-world and Reimagined Networks

LIST OF APPENDICES

CHAPTER 1 INTRODUCTION

Mobility network plays a significant role in children's travel to important destinations (Waygood, Friman, et al., 2017). However, children's mobility and their travel patterns are often overlooked as transportation planning prioritizes the needs of working adults by using various adult-centric metrics such as vehicular Level of Service (LOS). The adult-centered approach has likely resulted in increased car dependency among children, which has changed their travel behaviors, reduced children's accessibility, and decreased their interaction with their local environments. Following this, children's physical activity and independent travel have declined in recent years, with some research describing this trend as "inactivity" or "immobility" (Cervesato & Waygood, 2019; Cordovil et al., 2015). Through this trend, children are deprived of the chance to be independent in their daily trips and of the opportunity to experience a variety of daily destinations since walking rates among children have declined sharply in North American contexts (Cloutier, 2018). Not having the opportunity for active travel can adversely affect children's emotional, cognitive, and social development, as well as their physical health (Waygood, Friman, et al., 2017). According to the World Health Organization (WHO) Healthy Cities initiative, creating child-friendly cities is crucial for promoting integrated healthy city commitments, policies, and actions, supporting all residents' well-being (WHO, 2010). Considering children's specificities is important not only for inclusivity, but also for the community's health and development. As a result, creating more accessible environments is essential to promoting children's mobility and contributing to the overall well-being of children.

Defining accessibility as a concept is crucial for understanding children's accessibility to their destinations through independent travel. In the context of land use and transport planning, accessibility refers to the ease with which individuals are able to access multiple opportunities or valued destinations within a territory (Levinson, 2020). An earlier study defines accessibility as a method for illustrating how land use and transport systems can facilitate people's ability to reach destinations by one or a combination of modes of transportation (Geurs & van Wee, 2004). As adults' travel behavior differs from that of children, current measures of accessibility might not be appropriate for measuring children's accessibility. Children travel to different daily destinations (Desjardins et al., 2022), they have limited walking abilities (Freeman & Tranter, 2011; Morency

et al., 2020), and they may be at greater risk of traffic danger (Rothman, 2019), which greatly impact their mobility (Amiour et al., 2022a; Amiour et al., 2022b; Mitra & Manaugh, 2020). In consequence, while there are various accessibility measures, they are not specifically tailored to children's needs. For example, different measures such as Walk Score evaluate a neighborhood's walking accessibility by assessing amenities within walking distance and connectivity (Herrmann et al., 2017). Such measures do not take into account that not every age group has the same travel preferences and needs. Walk Score is also based on the proximity of adult-oriented services and amenities, such as restaurants, grocery stores, and retail stores. Although it is a measurement of local destinations, it might not capture how a neighborhood could facilitate children's travel.

Existing accessibility measures related to children's travel often focus on a single type of destination such as schools (Schlossberg et al., 2006) or parks and playgrounds (Robillard et al., 2023). Some studies analyzed a wider range of destinations for measuring children's accessibility (Badland et al., 2015; Loebach & Gilliland, 2014) that included education, health, public transport, recreation, social and cultural, food retail, and financial. This latter work provides a more holistic view, but children's accessibility to destinations may not be fully captured by accessibility as measured for adults. Children's ability to travel safely and independently may be significantly affected by factors such as traffic danger. Children's vulnerability to traffic danger requires safer and routes, which are rarely taken into consideration in accessibility assessments for adults.

A recent study developed a measurement instrument based on the basic rights of children in terms of the physical and social environments in which they live. Using this method, parents determined which features of neighborhoods enhance child friendliness (Gong et al., 2024). Another study was conducted to determine which relationships exist between context-specific physical and social environment measures and children's independent mobility to neighborhood destinations (Christensen et al., 2015). Previous studies have mostly focused on children's physical activity and lacked specific insights into understanding how access to these destinations contributes to multiple domains of children's health and well-being. Therefore, it is crucial to develop child-specific accessibility measures to address the negative impacts of adult-centered transportation planning on children's health. These research gaps highlight the need for a child-specific tool that reflects children's accessibility.

The objective of this research project is:

To develop tools that measure children's accessibility to their daily destinations with consideration to how those destinations relate to their health and wellbeing.

The main research questions for this project are:

1)How can children's accessibility be measured?

2)How do various destinations relate to children's health and well-being?

To address this question, it is important to measure children's accessibility based on children's specific needs and demands by identifying and evaluating the importance of child-relevant destinations within their local neighborhoods. Next, I will evaluate children's ability to reach such places by considering traffic danger which could hinder their mobility. I then identify the relation between those destinations and different aspects of well-being by using the input from both parents and children.

CHAPTER 2 CRITICAL OVERVIEW OF THE LITERATURE

To assess and improve mobility within urban environments, transportation planning relies on a variety of tools and indicators. However, the need to shift from traditional mobility-focused approaches to comprehensive accessibility-based measures has grown over the years (Banister, 2008). As a result of this paradigm shift, transportation is no longer simply about mobility, but also about the ease of access to opportunities and services. According to this approach, sustainable mobility requires a rethinking of the city based on proximity and accessibility rather than distance and speed (Banister, 2008; Deakin, 2006). As part of this sustainable mobility paradigm, new tools and indicators are developed and applied so that accessibility can be effectively measured and evaluated, such as those that assess the ease with which destinations can be reached, the quality of transport options, and the integration of land use and transportation systems (Banister, 2008).

Despite the significant progress made in transportation planning with these emerging tools and indicators, it is critical to remember that they are primarily intended for adults. There are, however, significant differences between the transportation needs and experiences of children and adults. The transportation planning process must take special consideration of the mobility patterns and safety requirements of children, as well as their accessibility to their daily services and amenities (Mitra, 2013). A significant benefit of sustainable mobility paradigm shift is the opportunity to explore how access to various destinations affects quality of life, particularly for children. The relationship between destination accessibility and children's well-being can help planners better understand and address the needs of children in urban environments, potentially resulting in more child-friendly and health-promoting cities (Waygood, Friman, et al., 2017). Therefore, the need for better tools and indicators for addressing the particular transportation needs of children is growing. It may be possible to use a range of indicators, including child-friendly transportation infrastructure and the distance that they are able to walk to their daily destinations. As such, children-specific tools would ensure that urban transportation planning becomes more inclusive and more responsive to all age groups.

This chapter synthesizes existing knowledge and highlights the gaps in understanding the relationship between children's walking accessibility to their desired destinations and the impact of those destinations on children's overall well-being. The chapter is not an exhaustive overview of the literature as each article of this dissertation presents the relevant research to each sub-objective.

Accessibility

Accessibility in transport and land use relates to the potential of reaching spatially dispersed opportunities (Páez et al., 2012). It also refers to the ease of getting to valued destinations by various modes in the context of land use and transportation planning (Geurs & van Wee, 2004; Levinson & Wu, 2020). In particular, time barriers, distance, travel time, cost, land use systems, and individual needs are all important factors (Geurs & van Wee, 2004). Accessibility reflects the availability of multiple opportunities (destinations), taking into account land use, transportation infrastructure, distance, and travel time (Bell, 2009; Boisjoly & El-Geneidy, 2017b).

An accessibility measure captures to what extent the built environment could facilitate or hinder children's travel. Several studies have demonstrated that high levels of accessibility reduces transport costs (Geurs & van Wee, 2004; Handy, 2020), reflects equity in accessibility and transport (Martens & Golub, 2012), and encourages active transportation modes (Handy et al., 2002; Levinson, 1998; Panter et al., 2019). Children's accessibility indicators and the methods of measuring accessibility are presented in detail in **Chapter 4**.

Reviewing the prior literature shows that there are significant gaps with respect to measuring children's walking accessibility. Children's environments must be assessed using an approach that uses child-specific accessibility measures. In other words, measuring children's walking accessibility without customising it based on children's needs and without considering environmental barriers for them may be a poor measure of children's accessibility. Previous studies have usually focused on certain destinations, such as schools (Curtis et al., 2015; Mitra, Buliung, & Roorda, 2010; Schlossberg et al., 2006) and parks (Robillard et al., 2023) without considering a wider variety of places that children can visit in their daily lives. One exception is an Australian study that measured accessibility to 33 destinations over nine categories (Badland et al., 2015), however, it did not consider traffic danger in its analysis. To our knowledge, previous studies have not measured accessibility for children while considering the limitations of traffic danger on their independent access. It could be plausible that children could not reach their daily destinations even in the neighborhoods with a high level of accessibility to multiple destinations due to the presence of dangerous roads. Therefore, not all the infrastructure or all the destinations are accessible to children. As such, the combinations of having suitable routes with low traffic danger along with

child-relevant destinations will provide us with a measure of accessibility that better reflects children's independent accessibility.

Children's destinations

Identifying children's destinations is essential to measuring their accessibility, since their needs and desires differ from adults. Unlike adults, children's primary destinations might include schools, playgrounds, and might put a lot of weight on simply meeting up with friends (Badland et al., 2015; Desjardins et al., 2022). In light of their limited spatial autonomy, it is essential for such destinations to be accessible locally. The majority of travel or national surveys are designed for adults, typically relying on second-hand information through parents which makes it difficult to identify children's destinations that they travel independently. Researchers have previously used Global Positioning System (GPS) (Babb et al., 2017; Loebach & Gilliland, 2016; Olsen et al., 2019), and travel diaries with children to investigate children's neighborhood destinations (Waygood, 2010). Among the most common destinations are schools, retail, sports facilities, recreational areas, parks, and public transportation (Badland et al., 2015; Fyhri et al., 2011; Villanueva, Giles-Corti, Bulsara, Timperio, et al., 2012; Waygood, 2010). Additional information is also available in **Appendix A**.

There are some gaps regarding children's destinations which would improve accessibility and enrich the background literature. First, a preliminary investigation is needed into the destinations of children, since it is necessary to understand the value of every place from both parents' and children's perspectives. Another study on accessibility used data from children's travel diaries to identify a wide range of destinations (Badland et al., 2015). In addition to the benefits of mapping and categorizing children's perspectives on places they visit, it's important to consider the unique context and small scale of this study that limit its applicability in other settings (Badland et al., 2015). Although that study captures where children went, it is possible that children would like to go to other places, but they are simply not available or accessible thus would not be captured in such an approach. Second, previous studies have overlooked informal destinations that are often not included in GIS data but play a significant role in children's daily lives. Although the number of formal destinations has been identified from multiple sources and studies, it is essential that children's input be heard to ensure these measures reflect their unique preferences and experiences accurately. School and parks may be considered formal destinations, but friends' homes, play areas

or playing in the street in front of the house may also be considered informal destinations. These kinds of destinations need further investigation to be recognized from various stakeholders. The process of identifying children's destinations is presented in detail in **Chapters 6**.

The Relation of Accessibility to Children's Well-Being:

The domains of health and well-being includes physical, psychological, and social dimensions (Dodge et al., 2012; Pollard & Lee, 2003). Accessibility to different destinations can support different aspects of the well-being domains for children. Recreational facilities, like parks and playgrounds, support physical well-being through active play (Badland et al., 2015; Villanueva, Giles-Corti, Bulsara, Timperio, et al., 2012). Community centres, libraries, and the homes of friends contribute to psychological and social well-being by facilitating social interaction, emotional support, and a sense of belonging (Fyhri et al., 2011; Kyttä et al., 2018). Schools, museums, and educational centers contribute to cognitive well-being by encouraging learning, curiosity, and intellectual development (Babb et al., 2017; Oliver et al., 2011). In reviewing children's accessibility to their daily destinations, it is necessary to consider the ways in which such destinations can impact various aspects of their well-being. A more in-depth discussion about the well-being domains and children's and parents' understanding of how different destinations relate to them is explored in **Chapter 7**.

There is a noticeable lack of knowledge regarding how access to these destinations relate to children's health and well-being. Prior research, including recent work, has mainly examined the relationship between children's travel and their physical and social well-being (Christian et al., 2015; Gong et al., 2024). Research has shown that independent travel provides children with more opportunities for physical activity and outdoor play (Waygood et al., 2020). Several studies have examined the relationship between children's transport behavior, their level of physical activity, and various indicators of physical health (Oliver et al., 2014; Waygood et al., 2020). However, the psychological and cognitive aspects of well-being have received less attention when it comes to children's travel and their accessibility.

It is essential to directly involve both children and parents to understand their perspectives about how those destinations might support children's well-being. In general, some studies asked about a wide range of destinations and only include a small sample of children in only one city (Badland

et al., 2015; Sharmin et al., 2021) or they only used the opinions of parents (Carver et al., 2013; Gong et al., 2024; Qiu & Zhu, 2021) for some specific destinations. Some studies asked about a list of locations and opportunities from both groups of parents and children (Brown et al., 2008; Chaudhury et al., 2017). In all these studies, the types of destinations mentioned were mostly based on interviews and mapping activities. Even though the background literature is helpful, applying those details or general methodology to the accessibility tool for other urban settings may not be accurate due to the small sample size and unique nature of these studies.

Also, the focus of prior research has been primarily on the frequency of visits to children's destinations. Only focusing on frequency of visits can reveal how frequently children visit certain destinations, without considering underlying reasons or barriers that can hinder their mobility. Children might like to visit these destinations more often if there were no barriers, such as distance or traffic danger. As a result, children's needs may not be understood for their true preferences due to this approach. Therefore, it is important to capture the desired frequency of visits, which indicates how often they would like to visit these destinations. This desired frequency is important to capture because it reveals their genuine interest and the potential benefits of improving accessibility. Considering this aspect is necessary to provide a clearer picture of children's ideal accessibility pattern, as it shows their actual preferences and needs. However, considering both the frequency and the desired frequency of going to different destinations as well as the relation of those destinations to different dimensions of well-being (not necessarily physical domain) from different groups of children and parents or experts have rarely been explored in prior research. It's important to understand that children and their parents have different priorities when it comes to frequency and the desired frequency of different destinations. It is possible that parents emphasize the importance of schools and recreational areas, while children place more value on other places from their own perspectives. It is therefore crucial to identify both the frequency and the desired frequency of children's activities from the perspective of both parents and children to help urban planners and policymakers prioritize enhancing their accessibility to the destinations that are most meaningful to them.

CHAPTER 3 OVERALL RESEARCH APPROACH AND METHODOLOGY

This thesis aims to enhance the understanding and measurement of children's accessibility to their daily destinations. This study is a part of the Children's Independent Mobility Environment project. SSHRC funded the research project led by my supervisor Professor Owen Waygood. The project focuses specifically on children aged 8-12 who might travel independently (i.e., without an adult) and it had different sections regarding children's active transportation, traffic danger and their accessibility. Although the age when children begin traveling independent varies across cultures, it generally begins around ten in Canada and North America (Cervesato & Waygood, 2019). As such, this thesis will be primarily focused on children of that age range.

Considering the gaps which were introduced in the previous chapter, the key research questions guiding this study are:

1) How can children's accessibility be measured?
2) *How do various destinations relate to children's health and well-being?*

To address this question, the study will develop tools that measure accessibility to daily destinations for children, taking into account the limitation of traffic danger and considering how those destinations relate to their health and wellbeing. By identifying and evaluating child-relevant destinations within their local neighborhoods as well as traffic danger, this tool will be tailored to the unique needs and demands to measure children's accessibility.

The following sub-objectives will help generate the tools:

- relevant destinations and walking distance thresholds with respect to children's needs

Understanding children's non-school destinations is key to understanding their full range of activities through their daily travels. The importance of recognizing these varied types of destinations is essential for evaluating accessibility to their daily desired destinations. As it was mentioned before, many studies of children's travel have focused on travel to school; however,

children have many other important destinations that need further investigation. The distance children are able and willing to travel to those destinations will be also reviewed.

- Generate children's walking accessibility indicators

The study will then evaluate children's ability to reach their daily destinations (as identified in the prior sub-objective), by taking traffic safety infrastructure into consideration. To determine the number of local child-relevant destinations within reach, appropriate distance thresholds will be used. This step aims to provide a comprehensive measure of walking accessibility by taking traffic danger penalty scores into account. As a result, this process gives a realistic view of how children's travel is likely impeded and how it impacts their accessibility to local destinations.

- Identify how destinations relate to children's well-being

The purpose of the focus groups was to determine whether children and adults could assign destinations to different domains of well-being, that is, which destinations support which well-being domains: physical, psychological, cognitive, and social. This step involves two key inputs: focus groups (with children, parents and experts) to determine whether this task is feasible; surveys to get the perspective of a larger sample population (since the small number of focus group participants are not representative).

- Measuring well-being accessibility and children's preferences: assessing the actual and desired frequency of children's destinations

The fourth objective is to measure well-being accessibility while considering the importance of destinations to children. Not all destinations hold the same value for children and adults, making it crucial to apply both parents' and children's perceptions to analyze how these destinations might support different well-being domains. This is achieved by gathering information not only on the frequency of visits but also on whether children would like to increase or decrease their visits if all barriers were removed. Through these insights, gaps in the literature can be filled, providing a more comprehensive understanding of destinations that significantly impact children's well-being. The research will then explore the relationship between accessibility to these destinations and various aspects of children's well-being across the main domains.

These sub-objectives are addressed in three distinct papers. A summary of how each article relates to each sub-objective is shown in Figure 3-1:

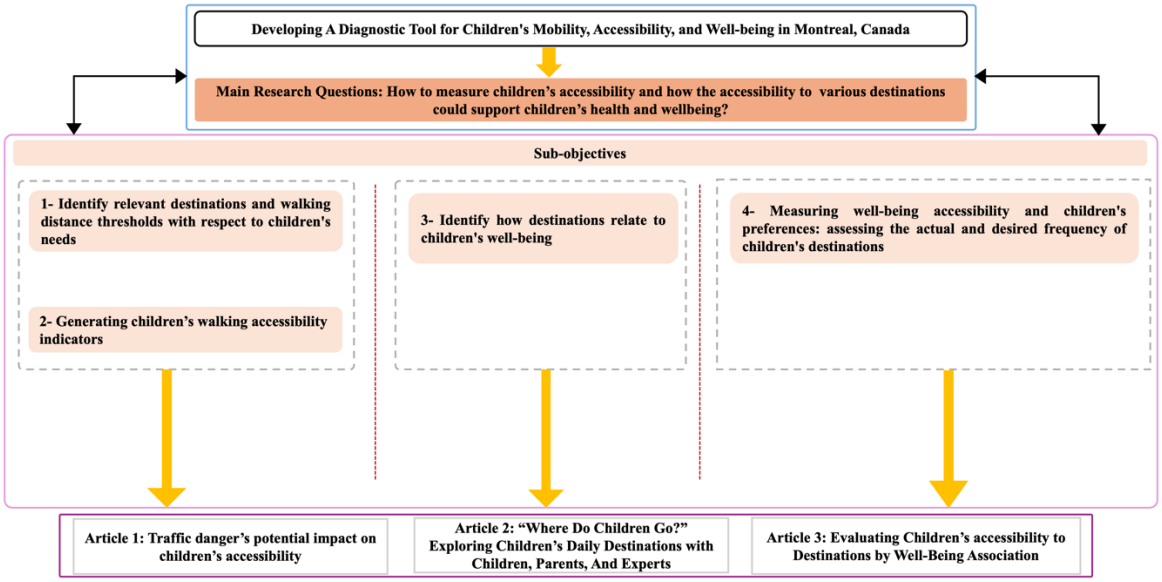


Figure 3-1 Research objectives and articles

3.1 Overall methodology

The overall methodology to address each sub-objective is regarded as follow:

3.1.1 Identify relevant destinations and walking distance thresholds with respect to children's needs

To achieve the first two sub-objectives, two preliminary steps were taken.

As the first preliminary step, the first sub-objective of this PhD thesis is to identify relevant destinations and walking distance thresholds for children. As assessing accessibility to children's daily desired destinations involves understanding their full range of activities not just travelling to school. Therefore, it is crucial to understand the diverse types of destinations they travel to on a daily basis.

In the first step, I contributed to a scoping review to identify non-school destinations for children (Desjardins et al., 2022). As the review points out, research on children's diverse non-school destinations is relatively limited compared to school trips, despite the fact that they can travel to many other places in their lives. In the study, peer-reviewed articles were analyzed for children aged 6-13 corresponding to elementary school years. According to the findings, children travel independently or actively to locations such as parks, recreational facilities, and retail locations. The

research indicates that safety concerns or environmental barriers may restrict children's access to certain places. This study informed my PhD research on measuring children's accessibility to multiple destinations.

3.1.2 Generate children's walking accessibility indicators

The second sub-objective is to identify indicators of children's walking accessibility. It involves evaluating children's ability to reach their daily destinations by considering traffic safety infrastructure and using appropriate distance thresholds. A comprehensive measure of walking accessibility is provided by incorporating traffic danger penalty scores that provide an accurate reflection of how children's travel is impeded in real life.

Therefore, the second preliminary step was to participate in a critical "proof-of-concept" study to estimate traffic danger and integrate it into accessibility measures. With respect to that, I contributed to the analysis of how dangerous intersections affect children's walking accessibility (Abdollahi, Tavakoli, et al., 2023). This study was crucial as a preliminary assessment of how traffic danger or environmental barriers might affect children's travel. The project helped in the development of my PhD research on accessibility that applied traffic danger.

The first two sub-objectives along with the preliminary steps, enabled me to define accessibility indicators, by applying the traffic danger penalty score to the segments and calculate walking accessibility to all possible child-related destinations identified in section 3.1.3. The results of these two sub-objectives are explained in **Article 1 (Chapter 4).**

3.1.3 Identify how destinations relate to children's well-being

The next sub-objective of this PhD thesis is to identify the relation between destinations and children's well-being. The development of a child-friendly environment requires an inclusive approach that incorporates all relevant stakeholders' voices. Instead of solely relying on survey results, focus groups could provide a more interactive method of testing children and adults' ability to assign destinations to different well-being domains which was needed for future steps. Therefore, this approach allowed me to design more targeted surveys in the final phase of the project which will be explained in the following chapters.

Further, children's daily destinations and how they affect their well-being can be better understood through focus groups with multiple stakeholders such as children, parents and experts. The scoping

review about identifying non-school destinations (Desjardins et al., 2022) provided a general understanding of formal destinations for children, but focus groups allowed a more detailed exploration of informal and overlooked places related to children's destinations.

Focus groups on child-related research are an essential, authentic method of capturing children's voices. Different destinations play a significant role in children's daily lives as a result of their experiences as the main users of the space. In such a context, focus groups are especially useful because they create an environment where participants feel comfortable and free to express themselves. Focus groups with children provide insight into common understandings, norms, and subcultures that are beyond the reach of other methods (Adler et al., 2019; Vogl, 2023). Children can discuss sensitive topics more freely without parental supervision (Heary & Hennessy, 2002). Through the focus groups, children become experts on their own lives (Gibson, 2012). Participating in focus groups gives them a voice and recognizes their unique perspective, which is important when discussing topics that directly affect them (Vogl, 2023). Rather than including children in adult focus groups, separate focus groups with children are crucial to capturing child perspectives. When compared to adults, children have different cognitive abilities, language skills, and life experiences (Gibson, 2012). In comparison to adult-led one-to-one interviews, children may feel more comfortable expressing their ideas among peers (Adler et al., 2019).

Prior research that conducted focus groups with children provided valuable insight into their perspectives (Butschi, 2021; Furneaux & Manaugh, 2019). Some studies did focus groups with experts or parents to understand their perspectives on child-related topics (Adler et al., 2019; Vogl, 2023). However, no comprehensive comparison of perspectives from children, parents, and experts has been conducted previously. As a result of this multifaceted approach, focus groups added to the background knowledge and filled in gaps left by the scoping review, ensuring a better understanding of children's destinations and their role in their overall health. The result of this part will be explained in Article 2 in Chapter 6.

3.1.4 Measuring well-being accessibility and children's preferences: assessing the actual and desired frequency of children's destinations

For following the last sub-objective, the findings were further strengthened when a broader survey of the general public was combined with the focused discussions, capturing diverse viewpoints and experiences from a wider audience.

The focus groups provided valuable insights but were limited in scope. To further explore children's destinations and the relation of those destinations to well-being domains, we developed four Canada-wide surveys in total (two different surveys; for each there was one with children and one with parents). Further details on the surveys are included in the Chapter 7, but relevant information to this thesis work that was not possible to include in that article are provided here.

The first survey examined the frequency and desired frequency to several categories of destinations as a result of a review of non-school destinations (Desjardins et al., 2022). The objective was to understand how important these places are in children's daily travel. The second survey examined the relationship between the same destinations as the first survey and the four aspects of well-being dimensions.

3.1.4.1 Survey design

In the survey design, specific measures were taken to ensure the quality and reliability of the responses.

For the survey with children, the main challenge about having an online survey was to make sure that the respondents are actually children. Therefore, we added two parts in the first sections of both surveys:

3.1.5 Using a high-pitched sound

As individuals age, especially as they get older, their sensitivity to higher frequencies diminishes. This is why most adults cannot hear very high-pitched sounds that children can perceive. In order to test whether the respondents were likely children we developed a technique based on that. We uploaded 3 different sounds and asked the respondents if they can hear anything, and if so, how would they feel (are they annoyed, relaxed, happy, excited, sad, bored, stressed, or not hear anything). The first sound was of children playing to test that the respondents could hear a noise. If respondents could not, they were eliminated. The expected response was happy or excited. The second sound was the sound of water running in a stream. The expected response was relaxed. The third sound used a 15000HZ signal that only children can generally hear (for example, if you are an adult reading this you probably cannot hear this, but a child can: 15 000 Hz test tone). If the respondents had heard the two previous noises, but responded that they could not hear this one, they were eliminated. In our tests we also discovered that the ability to play sounds was limited to

people completing the online survey using Google Chrome. Therefore, we could only apply this to some participants, and we thus needed to develop another test of whether the respondents were actually children.

3.1.6 Asking about certain Canadian playground games

As mentioned, we needed another test to determine if the respondents were likely children. It was difficult to think of such a question that children would know, but not adults. My supervisor, Owen Waygood, discovered through discussions with his own children some playground games that they knew that he did not play as a child in Canada. They realized this game was also known by the children of friends and relatives in Saskatchewan.

Two questions were developed related to each game that were consistent across the two geographic locations (Montreal and rural Saskatchewan). The name of the game was not given, but there was a picture of children playing the game along with a description of the game. Using the social network of my supervisor, Owen Waygood, we tested with children across Canada. The results were that these games were known by children in other cities in Saskatchewan, British Columbia, Alberta, Manitoba, and Ontario in both urban and rural areas suggesting that they were likely well known across the majority of the Canadian population. None of those children had any difficulty, but their parents did not know the games.

Respondents could start the survey if they could respond correctly to the first two questions correctly or at least one of the two questions on the second game.

The combination of sounds and games were used later for data validation and cleaning which is explained in section 3.1.4.2.

3.1.6.1 Children's destinations' survey with children

We used the tests to have confidence that the responses were by children. It could be possible that not all children knew both games and due to technical issues, not all children could do the sound test. As such we developed different levels of confidence in whether the respondents were children that are described here:

Priority 1: The respondent was annoyed by the high-pitched noise and they responded correctly to game 1 (both parts) or they responded correctly to game 2 (both parts).

Priority 2: The respondent did report not being annoyed by the high-pitched noise but they had some reaction and they responded correctly to game 1 (both parts) or they responded correctly to game 2 (both parts).

Priority 3: The respondent did not use Google Chrome, but they responded correctly to game 1 (both parts) or they responded correctly to game 2 (both parts).

As with the parents' survey, two trap questions were used to test that the respondent was paying attention, and it will be explained in Article 3.

3.1.6.2 Data collection

Children's destinations survey with parents

The survey was structured into four sections: socio-demographic information, frequency of children's visits to various destinations, desired frequency of visits (i.e., if the destination were close and safe, how often would your child go there), and questions regarding children's walking distances. The details of first three sections will be explained in more detail in Chapter 7. I will describe the fourth section here as it was not used for reasons that will be explained here.

The fourth section asked parents about the furthest distance that their child could walk alone from their house location in each of the four directions (north, east, south, west). We first asked them about their postal code, and then asked them to pin the furthest point that their child could travel without an accompanying adult for each direction. Figure 3.2 shows the guide of the question for the distance section.

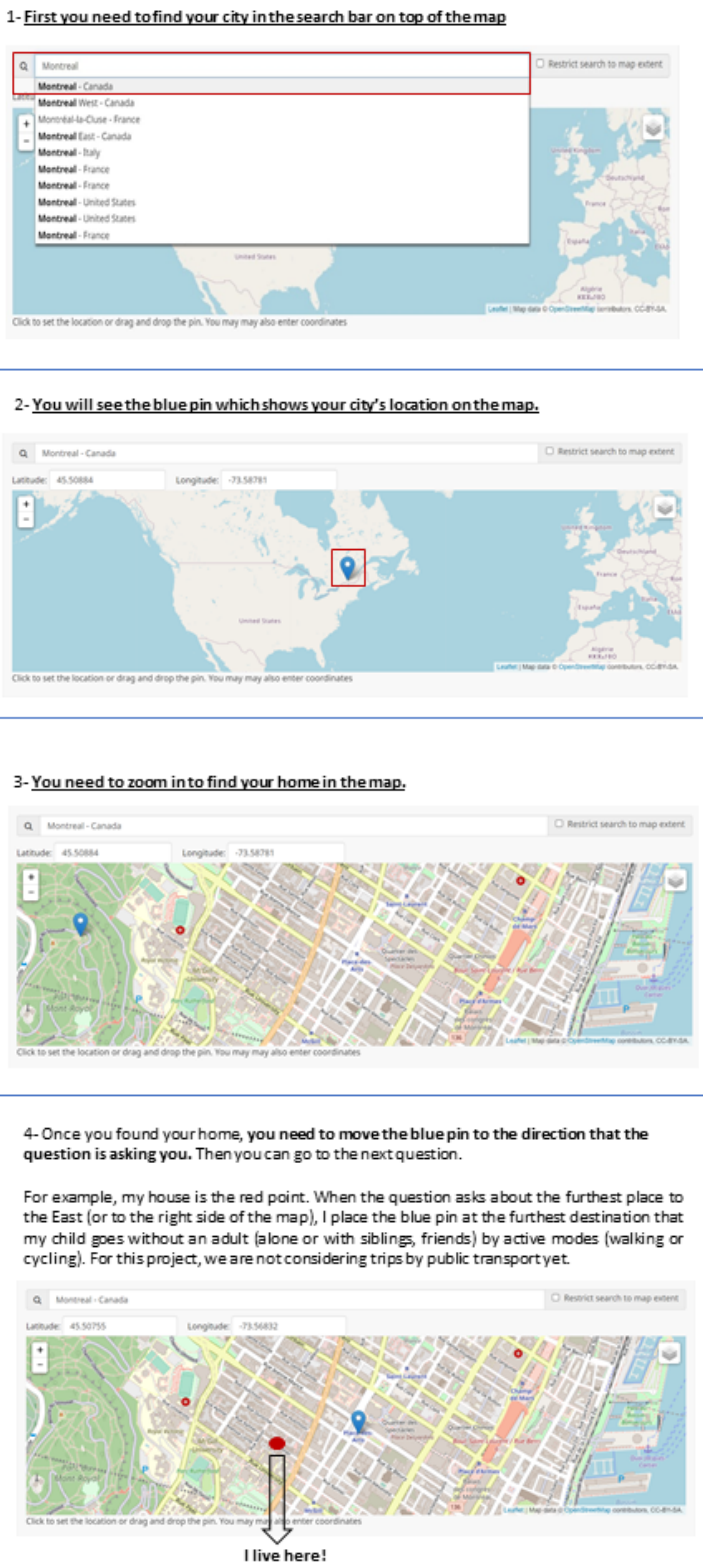


Figure 3-2 The instructions given to adults to complete this section

3.1.6.3 Data cleaning for distance Section

Because the question of the distance was designed in a separate part, the data regarding the reported distance had to be cleaned separate from the destinations. To do so, we first geocoded the postal codes, and calculated the Euclidean distance from each postal code to each direction (North, South, East, and West). In the first step of data cleaning, we noticed some unreasonable reported distances (more than 1000 km). Additionally, we dropped responses with identical distances for all four main directions, which often occurred due to copy/paste responses (e.g., all directions showed the same number of 4.60883087). Because unreasonable distances also exhibited the same pattern of identical numbers for all directions, we removed these entries to ensure the higher accuracy.

After these steps, 243 responses were retained for the distance section.

We used maximum distance and proximity to amenities as an indicator of accessibility in Canada. Basically, proximity measures quantify whether an amenity or service is accessible or available within a defined distance from a given location, taking into account both the distance and the size of the amenity (StatisticsCanada, 2022). We performed a simple regression analysis (provided in **Appendix B**) between proximity and distance. This model aimed to use the maximum distance (as the dependent variable) and the child's age, gender, and proximity to various amenities like employment opportunities, pharmacies, childcare facilities, health facilities, grocery stores, education institutions, libraries, parks, and public transit as the independent variables. Our goal was to examine whether there was a relationship between the amount of distance a child is able to travel, and the distances to amenities controlling for the age of the child. In addition, we were interested in investigating whether age alone explains how far children can travel or if there are other factors such as how close amenities are located.

The model results showed that only for children aged 12 and 14 years old was there a significantly higher maximum distances than their reference age group (7 years old; 1.6 km). The proximity measures for amenities did not show a statistically significant relationship with the maximum distance children could travel. The results of this survey question and the results of the analysis did not give us confidence in the quality of the responses here.

The regression analysis suggested that there might be a step change at around 12 years old in terms of distance, whereas the proximity to various amenities did not show a statistically significant

relationship. We do not suggest that this is the best method for determining the relationship between proximity and distance, since the limited number of responses may have influenced the results.

3.2 Dissertation organization

The following chapters of the dissertation are organized as follows:

I discussed the preliminary steps for identifying children's non-school destinations and evaluating children's walking accessibility based on dangerous intersections. That work was conducted in collaboration with others and is only summarized here (published articles are available).

Chapter 4 presents the first lead-author article as a proposed methodology for developing a tool that measures children's walking accessibility. The challenges and further discussion for developing this tool are then discussed in Chapter 5.

Chapter 6 consists of the second article on the focus group study exploring where children go in their daily lives.

Chapter 7 presents the third article which describes the methodology used to evaluate children's well-being accessibility as well as the results for the City of Montreal.

The general discussion of the research is presented in Chapter 8, and the conclusion and recommendations for future studies are explained in Chapter 9.

CHAPTER 4 ARTICLE 1: TRAFFIC DANGER'S POTENTIAL IMPACT ON CHILDREN'S ACCESSIBILITY

Zahra Tavakoli, Owen Waygood, Shabnam Abdollahi, Antonio Paez, Geneviève Boisjoly

Published on August 18, 2024, in the:

Transportation Research Part D

Abstract

Children are often overlooked in transportation decision-making processes, which typically prioritize adult needs and capacities. Adult-exclusive modes (motor vehicles) limit children's independent accessibility as they create traffic danger. The objective of this study is to estimate children's (aged 8-12) walking accessibility to child-relevant destinations when traffic danger is accounted for. Accessibility to child-relevant destinations is estimated without taking into account traffic danger and when traffic danger is considered. The results find that due to traffic danger, children's walking accessibility is estimated to be reduced by at least 75 %. When traffic danger is accounted for, the median value for access to public transport is 0 and social destinations is 1. Children's accessibility is likely considerably reduced by the danger imposed on them by adult-exclusive modes, motor vehicles, highlighting an environmental injustice. The tool can be used to target interventions to limit traffic danger to facilitate children's independent mobility.

Keywords: Children's independent mobility; Accessibility; Traffic danger; Children's destinations

4.1 Introduction

As active or independent travel (traveling without an adult's supervision) among children has declined (Rothman et al., 2018) and such travel is linked to various health and well-being benefits (Waygood et al., 2020), there is interest in improving conditions for such travel. However, there are still significant gaps regarding how to measure children's walking accessibility to reach their desired destinations. Children are generally neglected in the transportation decision-making process which is primarily based on the needs and capacities of adults and could thus be considered a marginalized group (Freeman & Tranter, 2011; Smeds et al., 2023). This focus on primarily motor vehicle transport has created dangerous traffic conditions. As a result of that parents often mention

as a limiting factor to children's independent mobility (CIM) (children's independent mobility is a trip without adults' supervisions) (Buliung et al., 2014; Westman et al., 2017). Further, children's walking speeds and abilities often limit the distances they can travel (Freeman & Tranter, 2011). Finally, children have different destinations for their daily travel than adults (Desjardins et al., 2022). As such, the objective of this research is to examine children's walking accessibility considering those three primary aspects: traffic danger, reasonable distances, and child-relevant destinations. This presents a novel approach to child-relevant destinations, as previous research has mostly focused on children's accessibility to schools or parks and not accessibility to diverse destination types. In addition, our research investigates the limiting factor of traffic danger for children's accessibility.

In reviewing how accessibility for children has been measured, it is important to consider the interplay between child-friendly infrastructure, children's mobility, and child-relevant destinations. In the context of transport and land use, accessibility refers to the possibility of reaching spatially dispersed opportunities (Páez et al., 2012) and mobility relates to movement from one location to another. Spatial accessibility methods are especially relevant when conducting equity studies targeting children, since the distribution and availability of services (Tsou et al., 2005) and the ease and safe access to them along the networks (Abdollahi, Tavakoli, et al., 2023) are significant factors supporting or inhibiting children's independent travel.

The presence of different infrastructure could influence children's walking distance and their accessibility to their desired destinations. The destinations that children will be able to reach depends on the distances that they can travel. If one considers walking, the distance threshold will depend on infrastructure features such as the network connectivity, transport network, etc. Prior studies found that the presence of sidewalks and crosswalks (Ewing et al., 2004), as well as controlled crossings and better street connectivity (Boarnet et al., 2005; Davison & Lawson, 2006; Timperio et al., 2004) have a strong influence on children's walking. Another study examined the relationship between the built environment and children's physical activity, reflecting that active travel was influenced by traffic density, speed, and the built environment features (Davison & Lawson, 2006). Several studies suggested different ranges of walking distance (Harten & Olds, 2004; Timperio et al., 2006). In reality, however, these thresholds may not reflect the actual distance children travel (Oliver et al., 2007; Villanueva, Giles-Corti, Bulsara, McCormack, et al., 2012).

Unlike adults, children face many obstacles for independent mobility. Therefore, general accessibility measures that are based on adults' capacities and interests may not always be sufficient to assess children's accessibility due to various differences when compared to adults. The fear of traffic danger can limit CIM as some streets are judged by parents to be too dangerous for children to cross (Buliung et al., 2014; Mitra, 2013; Westman et al., 2017). Also, social fears and parental concerns related to traffic danger could limit children's walking distance (Buliung et al., 2014; Westman et al., 2017). Therefore, simply measuring accessibility to multiple destinations by the existing network does not necessarily mean that children can travel to those places. Children might have good access to multiple destinations, but due to safety concerns or environmental barriers (the presence of major roads for example), they cannot reach their destinations. Various infrastructure can be put in place to make it possible for children to travel safely such as sidewalks and traffic controls (Amiour et al., 2022a). However, traffic danger on streets limits children's ability to cross the street, to fetch a ball that bounces out there, or simply being too dangerous even with traffic control devices (e.g., traffic light, stop signs) at intersections.

To measure children's accessibility, one should consider child-relevant destinations, mobility, and the availability of safe infrastructure to reach those locations. Mobility here considers the capacity to move from one location to another. In this research, we focus on walking as a fundamental means of travel by children. Child-relevant destinations might be considered a subset of all available destinations. Infrastructure that is safe enough for children to travel without an adult will not be the same as what is considered safe enough for a fully capable adult. Figure 1 illustrates the relationship between infrastructure, children's mobility (the ability to move over distances), and destinations, to measure accessibility for children.

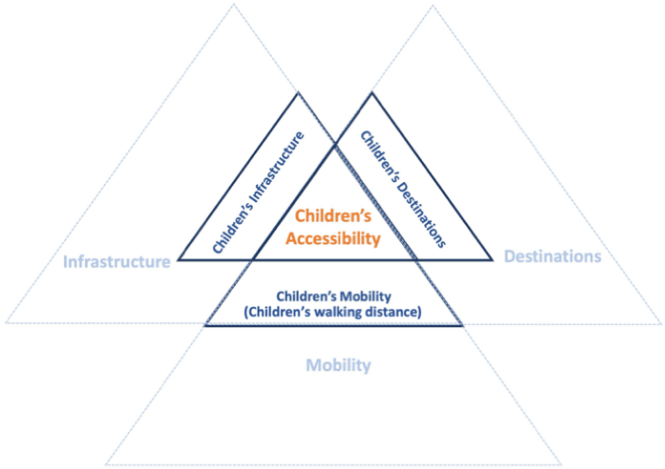


Figure 4-1 The relationship between infrastructure, destinations, and mobility to measure children's accessibility

Prior studies introduced various tools to measure children's accessibility (Badland et al., 2015; Witten et al., 2011); however, there are two important limitations. First, the majority of them assess accessibility for children to one type of facility (Chin & Foong, 2006; Comber et al., 2008; Robillard et al., 2023). Traveling to school has been the subject of numerous studies (Braza et al., 2004; Giles-Corti et al., 2011; Zhao et al., 2022), but increasingly, there is interest in non-school destinations such as playgrounds (Smoyer-Tomic et al., 2004) or green spaces (El Murr et al., 2022; Robillard et al., 2023). However, children's accessibility is associated with safety requirements (Zhao et al., 2022) that have not been considered in the latter studies. Second, some prior studies have examined equity with respect to accessibility measures (Chang & Liao, 2011; Tsou et al., 2005); however, those measures did not consider traffic danger, which is found to limit children's independent mobility. Children's accessibility indicators are not only about where they go, but it should also consider how safe it is for them to walk. Research by Reyes et al. (2014) used estimates of walking trip length to create circular buffers useful to estimate accessibility to parks. Another recent approach that aimed to consider traffic danger only considered streets with sidewalks and roads at 50 km/h or less (Robillard et al., 2023). Using 50 km/h as a safe level is of course questionable as such speeds are associated with a roughly 50/50 change of death given a collision (Rothman, 2019; Waygood et al., 2015). However, in both cases a detailed consideration of traffic danger was not developed nor were a variety of destinations considered. But with innovations in open software and data (Arribas-Bel et al., 2021; Lovelace, 2021; Soukhov & Paez, 2023), it is

now possible to conveniently incorporate those aspects in the analysis of accessibility for the case of children.

This research focuses on children (aged 8 to 12) who might travel independently (i.e., without an adult). Although the age at which children begin to travel independent varies across cultures it generally begins around the age of ten in Canada and North America, though some might begin earlier (Cervesato & Waygood, 2019). As such, our framework will be primarily based on the literature for children of that age range.

The objective of this study is to assess the impact of traffic danger on the accessibility to child-relevant destinations. It will first measure accessibility by considering child-relevant destinations within a reasonable distance without considering the potential of traffic danger to limit children's travel and then compare this with accessibility when traffic danger is considered. This approach will provide an assessment of accessibility that demonstrates to what extent traffic danger impacts children's ability to independently reach local child-relevant destinations.

4.2 Literature review

In this section, the key considerations for measuring children's accessibility regarded as the definition of accessibility, child-relevant destinations, reasonable walking distance, and traffic danger are discussed.

4.2.1 Accessibility

This section reviews accessibility and its multiple components to understand how this measure can capture children's independent travel.

Defining accessibility as a concept is crucial for understanding children's walking accessibility to their destinations. In the context of land use and transport planning, accessibility refers to the ease with which individuals are able to access multiple opportunities or valued destinations within a territory (Levinson & Wu, 2020). An earlier study defined accessibility as a method for illustrating how land use and transport systems can facilitate people's ability to reach destinations by one or a combination of modes of transportation (Geurs & van Wee, 2004).

In reviewing accessibility, it is essential to cover the key components of this concept for a better understanding of its impact on CIM. The following components have been introduced in previous studies. First, in measuring accessibility, people should be able to cover the distance between a point of origin and destination using a specific mode of transport, taking cost, time, and effort into consideration (Geurs & van Wee, 2004). Being sensitive to the changes in land use systems is a second key factor. The quality, number, and distribution of opportunities and destinations influence accessibility (Geurs & van Wee, 2004). The land use system also has significant direct and indirect impacts on accessibility to the transport system. Considering the time barriers as well as people's abilities, needs, and opportunities could be another key component (Geurs & van Wee, 2004). This is an important point as children's schedules differ from adults. In the context of CIM, measuring walking accessibility reflects the availability of multiple opportunities (destinations) for children in their walking distance. Also, measuring accessibility by considering the land use, transportation infrastructure, distance and travel time to activities will reflect the availability of local destinations for children (Bell, 2009; Boisjoly & El-Geneidy, 2017b).

To develop a measure that reflects the influence of the built environment on children's walking accessibility, it is necessary to review how accessibility is measured, and determine which measures are most appropriate for this project as well as the remaining gaps. There are two ways to measure accessibility that focus on the ease of reaching destinations: Person-based measures and location-based measures. Person-based accessibility measures are generated at the individual level. They take into consideration, focus on an individual's spatial and temporal limitations along with land use characteristics and the transportation system (Geurs & van Wee, 2004; Owen & Levinson, 2015). Person-based measures of accessibility are useful to have a better understanding of accessibility from the standpoint of an individual's experience (Boisjoly & El-Geneidy, 2017b). In contrast, location-based metrics are often used to measure a region's accessibility (Boisjoly & El-Geneidy, 2017a). Location-based metrics measure the ease of access to destinations from origin locations. They may consider the ability to move from one place to another and consider the spatial distribution of opportunities (Geurs & van Wee, 2004). A common location-based metric is based on cumulative opportunities. This measure counts the opportunities that can be reached within time or travel cost thresholds (Boisjoly & El-Geneidy, 2017b). Another metric is the gravity-based measures that discounts opportunities according to the function of their travel distance or time.

This means that opportunities located farther away will be given less weight than those located closer (Boisjoly & El-Geneidy, 2017b).

To address children's walking accessibility, knowing about the number of destinations children could have access to (in the real world) is a straightforward method to interpret than when the value of the destinations is discounted based on the distance. Such measures have been shown to be much more applicable in practice (Boisjoly & El-Geneidy, 2017a). Considering this aspect, measuring accessibility with the cumulative measure based on children's ability could provide an adequate picture of children's independent travel behavior.

4.2.2 Child-relevant destinations

Destinations that children travel to vary from those that adults visit due to their different interests and life stage (Desjardins et al., 2022). Many studies of children's independent travel have focused on travel to school. However, children have many other important destinations. On top of schools, studies have found a wide variety of destinations such as multi-use parks, supermarkets, fast food restaurants, convenience stores, public transportation access points, cycle lanes, cultural activities, and sports as common destinations for children (Babb et al., 2017; Egli et al., 2020; Fyhri et al., 2011). These destinations could be classified into different categories such as education, consumer (financial), food retail, public transport, recreation, and social and cultural places (Badland et al., 2015). Such destinations must be found at a local level because of children's limited autonomy (Badland et al., 2015; Kyttä, 2004) and tendency to travel independently on foot (Berg et al., 2021).

4.2.3 Reasonable distances

Regarding the reasonable distance that children can walk, many studies have found that distance to major destinations for children influences their likelihood of walking or biking there (Ewing et al., 2004; Schlossberg et al., 2006). Studies in Australia have found that children aged 10 to 12 travel around 800 m for school (Timperio et al., 2006) and 1000 meters for their activity spaces (Babb et al., 2017). A study in Canada measured Euclidian distances and found that distances of 0.64 Km for weekday and 0.83 Km for weekends for 9-11 year-old children (Cervesato & Waygood, 2019). A study in Montreal, Canada using the 80 % threshold of walking trip distances as a measure of "reasonable distance" found that for children aged 7-8, it was over 800 m, for

children 9-10 years old it was 854 (boys) and 925 m (girls), and for children 11-12 years old it was just over 1000 meters (Morency et al., 2020).

4.2.4 Traffic danger

In reviewing traffic danger as it relates to children's travel, there are two important concepts to consider: the objective traffic safety and the perceived traffic safety. Objective traffic safety, also called "real traffic safety" (Nevelsteen et al., 2012), refers to the collisions and injuries caused by road traffic, such as fatalities and injuries caused by crashes. In other words, objective safety is a measure of the actual number of collisions or injuries on the road (Sørensen & Mosslemi, 2009). Perceived traffic safety, on the other hand, is the perception of safety or risk posed by road traffic (Li et al., 2013; Nevelsteen et al., 2012; Sørensen & Mosslemi, 2009). Another aspect of safety is how individuals evaluate safety, or how they perceive traffic safety (Sørensen & Mosslemi, 2009). When it comes to children, perceived traffic safety typically refers to parents' and children's perceptions of safety (Amiour et al., 2022a).

Several studies have examined children's ability to perceive traffic danger (Meir & Oron-Gilad, 2020; Meir et al., 2015; Meir et al., 2013; Schwebel & McClure, 2010) or their behavior regarding traffic safety (Alonso et al., 2018; Amiour et al., 2022a). Such research aimed at examining children's ability to understand traffic danger and their resulting behavior, such as when to cross the street (Rothman et al., 2015). Also, parents' perceptions of safety (both traffic and personal) play an important role in their children's active and independent travel behaviour (Mitra & Manaugh, 2020). An earlier study demonstrated that perceptions of traffic and neighborhood safety influence parental decisions regarding children's active, independent travel (McMillan, 2005). Parental decision making could be indirectly influenced by a variety of factors, including neighborhood and traffic safety, real safety (e.g., collisions and injuries), and perceived safety (e.g., a parent's perception) (McMillan, 2007). According to previous research, traffic and the built environment also influence objective traffic safety (child-pedestrian collisions) (Hwang et al., 2017; Jamshidi et al., 2017; Rothman, To, et al., 2014).

The results of objective traffic safety for children reflected that high vehicle speed and high traffic volume, as well as high density of traffic lights and the absence of signs were the most important factors contributing to injuries (Amiour et al., 2022a). The influence of traffic danger in this study will use a tool that aims to estimate objective traffic danger based on scientific findings. The

research presented in this paper focuses on children's walking as the most fundamental mode of transport, but it should be acknowledged that traffic danger likely significantly limits children's use of bicycles due to the considerable danger it imposes.

Children's walking accessibility can be negatively affected by traffic-related danger (Rothman, Buliung, et al., 2014). As a result of such danger, children's access can be limited. With reduced accessibility, children become dependent on adult transportation, resulting in a reduction in autonomy which could negatively affect their health and well-being (Waygood et al., 2020). Prior studies introduce various factors that might influence children's travel, such as speed limits, traffic volumes, pedestrian infrastructure, and road characteristics (Aliyas, 2022; Amiour et al., 2022a; Cloutier et al., 2021) which will be discussed as follows:

4.2.4.1 Speed

Excessive vehicle speeds pose a significant threat to the safety of children. A prior study found that vehicle speed directly influences the severity of pedestrian injuries among children (Oliver et al., 2015). Also, traffic volume and speed have been found to be significantly correlated with pedestrian injuries among children in several studies (Amiour et al., 2022a; Cloutier et al., 2021).

4.2.4.2 Road classifications

Road classification is a proxy measure for how much traffic (and how fast) the roads have been designed for. As such, it often relates to the width of lanes and the number of lanes along with traffic volumes. A previous research found that children were more likely to suffer injuries from crashes on wide roads (DiMaggio et al., 2016). Also, another study highlighted the importance of pedestrian-friendly infrastructure, such as well-designed sidewalks and pedestrian crossings, in reducing traffic collisions involving children (Cloutier et al., 2017). Prior studies found that main roads, including arterials and collectors, lead to injuries among children (Rothman et al., 2015; Rothman et al., 2021). According to a case-control study in Oakland, USA, children aged 5-15 injured in motor vehicle collisions are affected by the type of street they cross on their way to school (Tester et al., 2004). Additionally, collector roads were associated with more motor vehicle collisions involving children pedestrians than local roads (Rothman et al., 2015).

4.2.4.3 Traffic control measures

Traffic control measures relate to features of the road environment such as traffic lights and stop signs. The density of traffic lights has been found to relate to an increase in child collisions (versus an absence of traffic lights) (Rothman, Buliung, et al., 2014). This may be due to several factors, such as traffic lights being located on busy streets. The absence of stop signs has been linked to child pedestrian crashes in other studies (Bennet et al., 2015; Blazquez et al., 2013).

4.2.5 Summary

The literature review highlighted key components of this research on child-relevant destinations, how far children typically travel independently on foot, and the key components of traffic danger which is often cited by parents as a reason to restrict children's autonomy. Transportation systems should allow for access for all residents and by ignoring the impact of traffic danger on children's ability to travel autonomously, previous research is likely considerably overestimating their accessibility. The research hypothesis is that children's accessibility to diverse child-relevant destinations will be considerably decreased as a result of taking the limiting factor of traffic danger into account.

4.3 Methodology

This research was conducted across the City of Montreal. The City of Montreal is divided into 19 boroughs and exhibits a variety of land uses and transportation infrastructures. Central boroughs are characterized by dense residential, commercial, and public spaces. A vast network of public transportation is located by this central area, which historically served as the center of urban growth, including the Montreal Metro, which forms an important link between the city's various neighborhoods.

In contrast, peripheral boroughs are predominantly residential, with a high percentage of families with children. Besides their focus on residential neighborhoods, these boroughs provide suburban connectivity through arterial roads. A number of major roadways link the city's boroughs together, which provide east-west movement. Figure 5-2 illustrates the spatial distribution of children's destinations in the City of Montreal(Desjardins et al., 2022). The distribution of destinations is

often clustered in the central areas though leisure, green spaces, and educational destinations are more dispersed across the city.

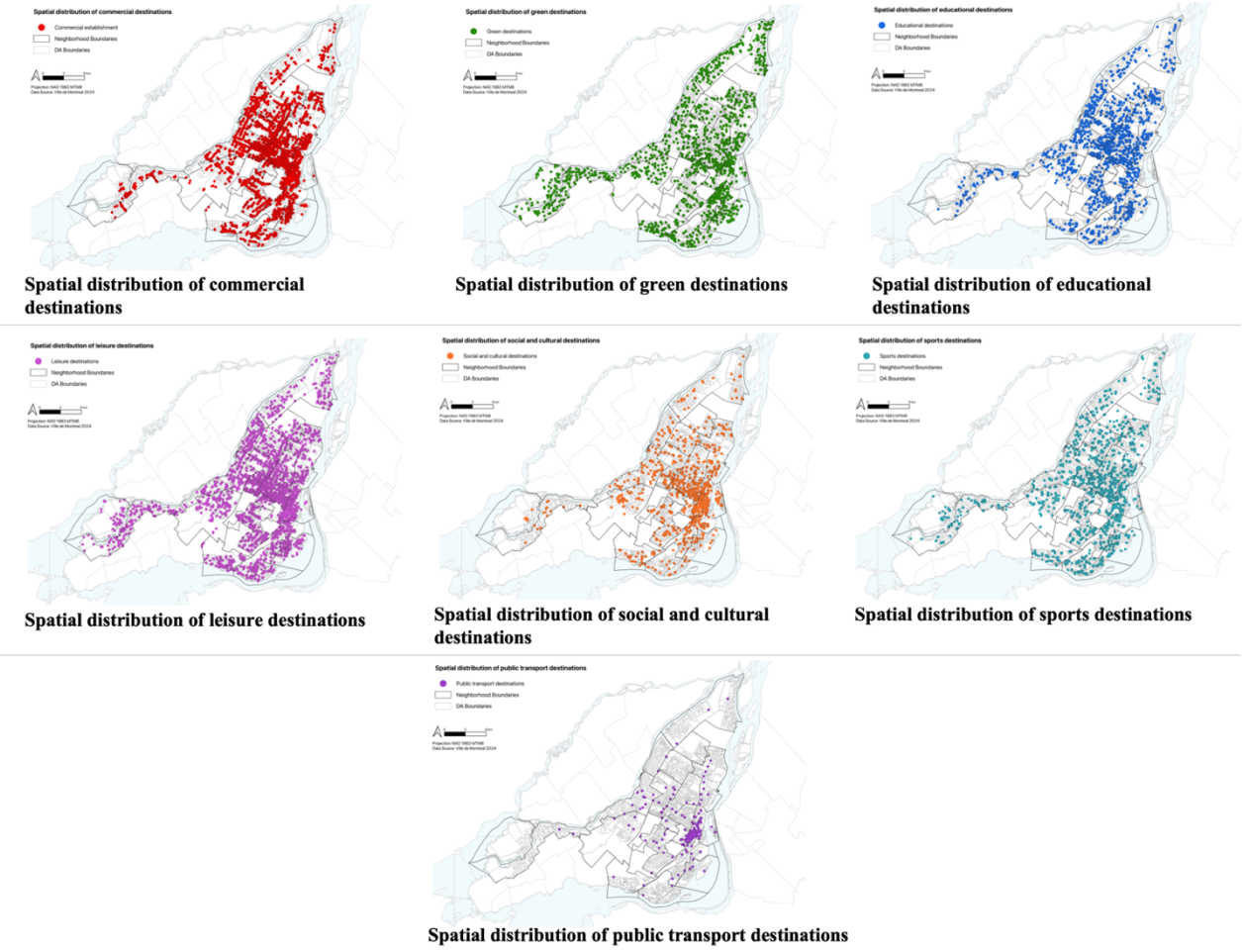


Figure 4-2 Spatial distributions of destinations by categories in the city of Montreal

This study follows three key steps that will be explained in detail following a brief overview of each. First, we recruited experts from multiple fields to determine the level of danger for all road segments in the City of Montreal. Since traffic danger indicators for segments are more complete and more precise than intersection-level data, the focus in this study is on segments rather than intersections (Meir et al., 2015; Rothman, Buliung, et al., 2014). This is mainly due to the fact that traffic danger components such as street parking and traffic direction impact children's safety (Meir et al., 2015; Rothman, Buliung, et al., 2014). Using segments enhances the accuracy of the analysis by including these important factors at a finer level of detail (Ziakopoulos & Yannis, 2020). Also,

along streets (segments), children engage in diverse activities, such as walking, biking, and playing (Furneaux & Manaugh, 2019). Finally, the intersection danger is highly related to the type of roads that intersections are linked to them. As such, the assessment of traffic danger on segments provides a comprehensive view of the potential traffic exposure risks that children might have during their trips.

Second, a systematic review (Desjardins et al., 2022) on children's destinations was used to determine the child-relevant destinations. That study identified the most important non-school travel destinations for children. The destinations were categorized, and that information was used to inform the calculation of accessible child-relevant destinations.

Finally, the accessibility results were examined before and after considering the level of traffic danger of the segments. This is an essential step for reflecting children's accessibility to multiple amenities. Accessibility was measured in 1-km walking distances using only streets with sidewalks. In a Canadian context, 1-km is reasonable as a limit as the probability of an independent trip drastically drops after 1-km (Cervesato & Waygood, 2019).

4.3.1 Measuring the level of traffic danger

4.3.2 Traffic danger survey

To develop a means of estimating traffic danger, the independent input of experts was used. A survey was published through Lime Survey and was sent to 14 participants (associated with the larger Children's Independent Mobility Environments project) during the second week of October 2022. The participants were experts from different fields (traffic safety, children's travel, urban design, travel behavior, children's rights, and psychology).

In total, nine questions were asked within two sections of the survey. In the first section, the categories of each indicator of traffic danger were rated individually on a Likert scale from "very safe or ideal" (score of 1) to "Avoid/ too dangerous" (score of 9). The choice of indicators was a result of first identifying relevant variables (e.g., (Amiour et al., 2022a)) and then identifying available data. The nine indicators were:

- Speed limit (This indicator serves as a measure for practiced speed).

- Road classification (This indicator is a measure for street design and traffic volume, depending on the type of service the road provides and is used for data and planning purposes).

The following is a description for each road class (OpenDataMontreal, 2023):

- Main arterial road: A major road that connects key areas within a city and is designed for large volumes of traffic. Speed limits are typically 50 km/h on such infrastructure.
- Secondary arterial road: Distributes traffic to smaller roads and local areas to support the main arterial roads. In Montreal, the speed limit of such infrastructure is set to 40 km/h
- Collector road: A road that collects traffic from local roads and directs it to arterial roads. The speed limit of these roads may be 30 km/h or 40 km/h.
- Local road: Access to residences, businesses, and other local destinations is provided by this road. In Montreal, the speed limits for these roads is 30 km/h or less.
- Back lane: Access roads to the back of a building, typically serving residential or commercial properties. Speed limits vary, though many have speed limits or 20 km/h or less.
- Pedestrian street: Streets specifically designed for pedestrian use, usually found in urban or shopping areas. As vehicular traffic is not allowed, no speed limit is given (cyclists are required to either dismount or travel at speeds close to pedestrians).

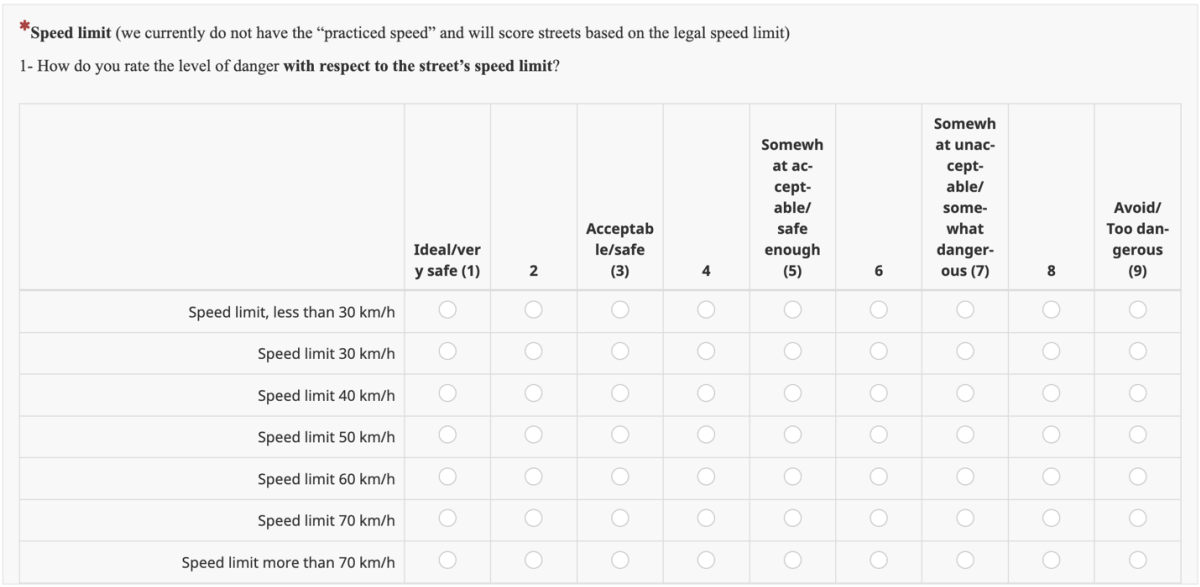
- Traffic direction (one-way or two-way),
- Traffic control measures (traffic light with pedestrian light, traffic light, or stop sign), and
- On-street parking (related to visibility).

Each indicator had different levels or categories which is provided in Table 4-1.

Table 4-1 The description of traffic danger indicators related to the segments

Indicator	**Category**
Speed limit	Less than 30 km/h
	30 km/h
	40 km/h
	50 km/h
	60 km/h
	70 km/h
	More than 70 km/h
Road class	Main arterial road
	Secondary arterial road
	Collector
	Local road
	Back lane
	Pedestrian street
Direction (One-way or Two-way)	The street is one-way
	The street is two-way
Traffic control devices at intersections	The presence of stop signs
	The presence of traffic light
Street parking	The presence of street parking
	No street parking

An example of the posted speed limit indicator categories is shown in Figure 4-3.



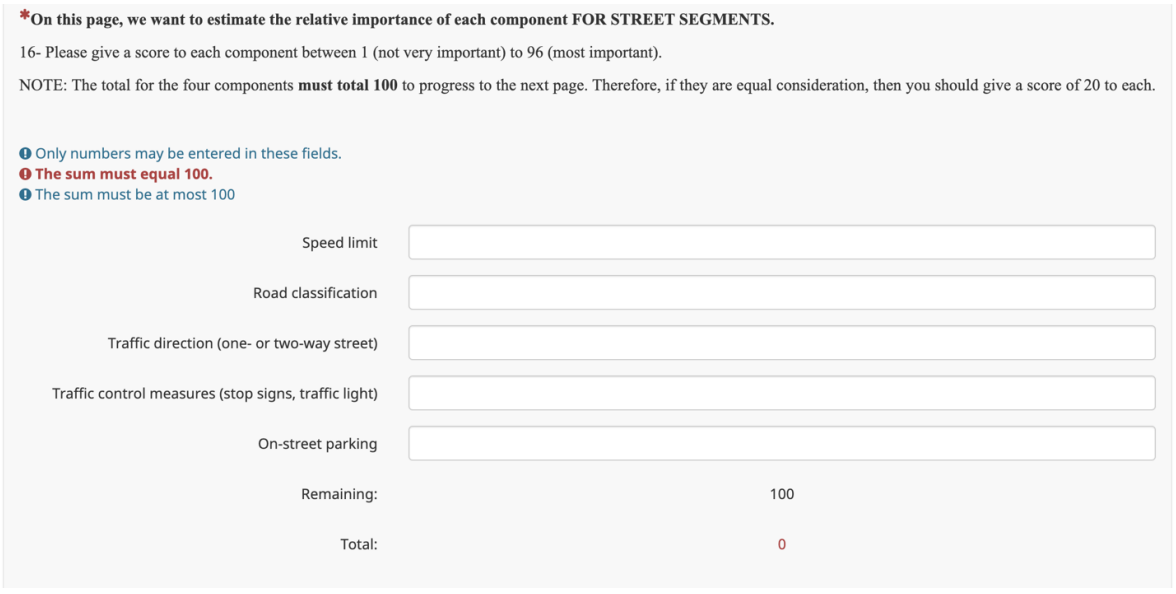
*Speed limit (we currently do not have the "practiced speed" and will score streets based on the legal speed limit)

1- How do you rate the level of danger **with respect to the street's speed limit**?

	Ideal/very safe (1)	2	Acceptable/safe (3)	4	Somewhat acceptable/ safe enough (5)	6	Somewhat unacceptable/ somewhat dangerous (7)	8	Avoid/ Too dangerous (9)
Speed limit, less than 30 km/h	○	○	○	○	○	○	○	○	○
Speed limit 30 km/h	○	○	○	○	○	○	○	○	○
Speed limit 40 km/h	○	○	○	○	○	○	○	○	○
Speed limit 50 km/h	○	○	○	○	○	○	○	○	○
Speed limit 60 km/h	○	○	○	○	○	○	○	○	○
Speed limit 70 km/h	○	○	○	○	○	○	○	○	○
Speed limit more than 70 km/h	○	○	○	○	○	○	○	○	○

Figure 4-3 An example of a question (speed) for assessing the danger level of each category

In the second part of the survey, respondents were asked to estimate the relative importance of the traffic danger components from section 1. A method of assigning weights to variables based on their perceived significance was used following previously applied methods (Al Shammas & Escobar, 2019). Each component had to have at least a score of 1 and they were not to exceed 100 for all criteria (Figure 4-4).



*On this page, we want to estimate the relative importance of each component FOR STREET SEGMENTS.

16- Please give a score to each component between 1 (not very important) to 96 (most important).

NOTE: The total for the four components **must total 100** to progress to the next page. Therefore, if they are equal consideration, then you should give a score of 20 to each.

ⓘ Only numbers may be entered in these fields.
ⓘ **The sum must equal 100.**
ⓘ The sum must be at most 100

Speed limit	
Road classification	
Traffic direction (one- or two-way street)	
Traffic control measures (stop signs, traffic light)	
On-street parking	
Remaining:	100
Total:	0

Figure 4-4 An assessment of the relative importance of each component of traffic danger

4.3.3 Calculation of traffic danger for each segment

In this analysis we did not consider highways and private streets because there is no public pedestrian access on these road classes. The traffic danger scores for each road segment were calculated using the function "Weighted cost" (Al Shammas & Escobar, 2019) in PostGIS (DBeaver Enterprise 23.0.0). By either setting a high penalty for segments with a certain attribute or not selecting certain segments, this function restricts access to segments of a certain type. In this study, the estimated traffic danger was used to assign a penalty or restrict use of that segment due to danger. QGIS (3.24) was used for visualizing the results.

A simple summation was used based on the danger rating and relative weight (Eq. 4.1).

$$d_j = \sum_{i}^{n} r_{ij} \times w_{ij} \tag{4.1}$$

Where *d* is the danger of segment *j*, *r* is the danger rating (average score between 1 and 9), *w* is the relative weight (average score between 1 and 96), and *i* is one of the components (speed limit, road classification, traffic control measure, street direction, and street parking). Due to a lack of data related to the speed limit and traffic control devices not all segments could be considered.

The danger scores are first calculated for each segment based on eq.1. The total score is then normalized to a score from 0 to 100 using the min-max normalization method. Next, Jenks Natural Break method is used to identify four classes. This process identifies break points based on how similar values are grouped, and the differences between groups are maximized. The classes are then labeled based on the results.

4.3.4 Identifying child-relevant destinations

As a second step, we identified the destinations that children travel to during their daily travels based on a systematic review (Desjardins et al., 2022). Children's destinations are classified into the following categories based on previous studies and available data: education (including schools and libraries), sports activities (including indoor and outdoor sport activities), leisure activities (including activities for relaxation or pleasure), green spaces (such as different types of parks at different urban or neighborhood levels), social and cultural places (places with the potential of having cultural activities or having social interactions), commercial (commercial establishments

such as shops, stores, malls), and public transport (metro or train stations). Based on the prior review (Desjardins et al., 2022), some of the children's destinations are related to different activities at the same time (such as cinema and commercial streets which could be related to both social and leisure categories). Therefore, these destinations are placed in different categories. Also, there are some places that are not necessarily for children aged 8-12, including playgrounds for children ages 18 months to 5 years old and preschools. These destinations are chosen because they fall within children's activity space or territorial range (Desjardins et al., 2022). As such, children can potentially visit these places on their daily trips or while accompanying their younger siblings. The details of child-relevant destinations available in the City of Montreal data are provided in Appendix A[1].

4.3.5 Measuring children's accessibility

The information from the previous steps (street network danger, child-relevant destinations) was used to estimate children's accessibility. To measure the accessibility of children's destinations, we used a cumulative accessibility measure (Geurs & van Wee, 2004), which counts the number of destinations that can be accessed within a specific walking distance threshold. Considering its ease of operationalization and interpretation, this measure is commonly used to quantify accessibility across a region (Boisjoly & El-Geneidy, 2017b). The accessibility measure of the current study is calculated using the centroid of each DA to generate a service area using 1-Km walking distances.

In order to measure the accessibility in PostGIS, all the destinations have turned to points as the centroid of their location. For linear destinations such as pedestrian streets, urban promenades, or bike paths (which were the paths inside the parks), the approach was the same mainly because using the centroid reduces spatial complexity and makes it possible to use destinations across different types in a consistent manner.

The 1 km service area is determined by network-based distances. The extent to which this area can be reduced due to traffic danger depends on a traffic danger score which is calculated using a weighted sum function for each road segment. Therefore, two service areas are created to examine the extent to which children's accessibility is restricted when dangerous segments are considered

[1] We reviewed the list of destinations provided by the City of Montreal, and we removed those that weren't relevant to children's daily travel.

as a barrier. One service area that includes all segments is the default measure when no limitations due to traffic danger are considered which is the standard practice when calculating adults' accessibility (Boisjoly & El-Geneidy, 2017a). The second service area applies the traffic danger score to exclude segments that are too dangerous. Following that, we counted the number of accessible destinations by intersecting the service area with the destination points and summing the number of destinations in each service area. Consequently, the accessibility score is a count of the number of child-relevant destinations within the service area that can be reached by walking distance from the centroid of each DA using infrastructure that is not too dangerous.

4.3.6 GIS data

The data for this study come from two primary sources: Open Data Montreal and Statistics Canada. Open Data Montreal is a data portal managed by the City of Montreal and shapefiles downloaded from there were used to geo-locate multiple categories of destinations for children (OpenDataMontreal, 2023). Also, the data regarding traffic safety measures and road segments were sourced from the City of Montreal.

To observe the children's accessibility to multiple destinations based on their walking distance in a detailed scale, the Dissemination Area (DA) has been chosen as the spatial unit. The DA is the smallest geographical area in which the entire census data is disseminated by Statistics Canada. It consists primarily of neighboring dissemination blocks (StatisticsCanada). Each DA contains between 400 and 700 individuals. Due to the lack of data for the traffic safety measures and destinations, the analysis is only done for the City of Montreal though other municipalities exist on the island of Montreal. As such, not all built-up areas of the Island of Montreal are included in the analysis. Those areas are presented as empty in the maps. All analysis was done in PostGIS (DBeaver Enterprise 23.0.0) and visualized in QGIS (3.24).

4.4 Results

4.4.1 Traffic danger score on each segments

The experts indicated in the survey that danger increases significantly above posted speed limits of 40 km/h. Arterial roads received the highest danger score for road class, while collector roads were

also identified as dangerous. The survey results for street direction were inconclusive, with one-way and two-way streets perceived to have a similar level of danger. Overall, traffic signals were judged to be safer than stop signs, except when there was no pedestrian signal.

The final value for each category (from 1 to 9) was determined based on the greatest consensus (frequency of a value) for each score. The results for each category can be found in Table 4-2.

Table 4-2 Survey's result for traffic danger indicators related to the segments

Indicator	Category	Value	Frequency of each value	Average relative importance
Speed limit	Less than 30 km/h	1	12	42.15
	30 km/h	2	8	
	40 km/h	3	5	
	50 km/h	7	7	
	60 km/h	7	5	
	70 km/h	9	9	
	More than 70 km/h	9	13	
Road class	Main arterial road	9	8	18.84
	Secondary arterial road	7	5	
	Collector	5	5	
	Local road	3	6	
	Back lane	2	6	
	Pedestrian street	1	9	
Direction (One-way or Two-way)	The street is one-way	3	5	9.76
	The street is two-way	3	4	
Traffic control devices at intersections	The presence of stop signs	5	5	14.84
	The presence of traffic light	3	6	
Street parking	The presence of street parking	3	5	12.15
	No street parking	3	6	

According to the results of relative importance, the most crucial traffic measure for children is the speed limit, with an average relative importance of 42.15 (out of 100). This indicates that survey participants rated the speed limit as the most critical factor when considering traffic danger. The road class followed with an average relative importance of 18.84, which suggests that the road's classification has some significance when it comes to children's safety. The type of traffic control measure and street parking received relatively similar ratings, with an average relative importance of 14.84 and 12.15, respectively. Finally, the direction (one-way or two-way) received an average relative importance of 9.76, indicating that the participants judged this as the least important component for estimating traffic danger.

Each road segment was classified into one of four classes based on the normalized danger level. The results of the danger level classification analysis are presented in Figure 5 across all boroughs where appropriate data was available. Following the application of Jenks Natural Breaks, the four classes had these danger level ranges: very safe/ideal (0 to 3), acceptable (3 to 16), somewhat dangerous (16 to 44), and too dangerous (44 to 100). As can be seen, many road segments are classified as very safe or acceptable (Class 1 or 2). The City of Montreal reduced the speed of all residential streets to 30 km/h and secondary arterials to 40 km/h in 2019 to improve safety for its citizens. Had this study been conducted before that change, the previous speed limit of 50 km/h would have painted the map with more red due to higher levels of traffic danger.

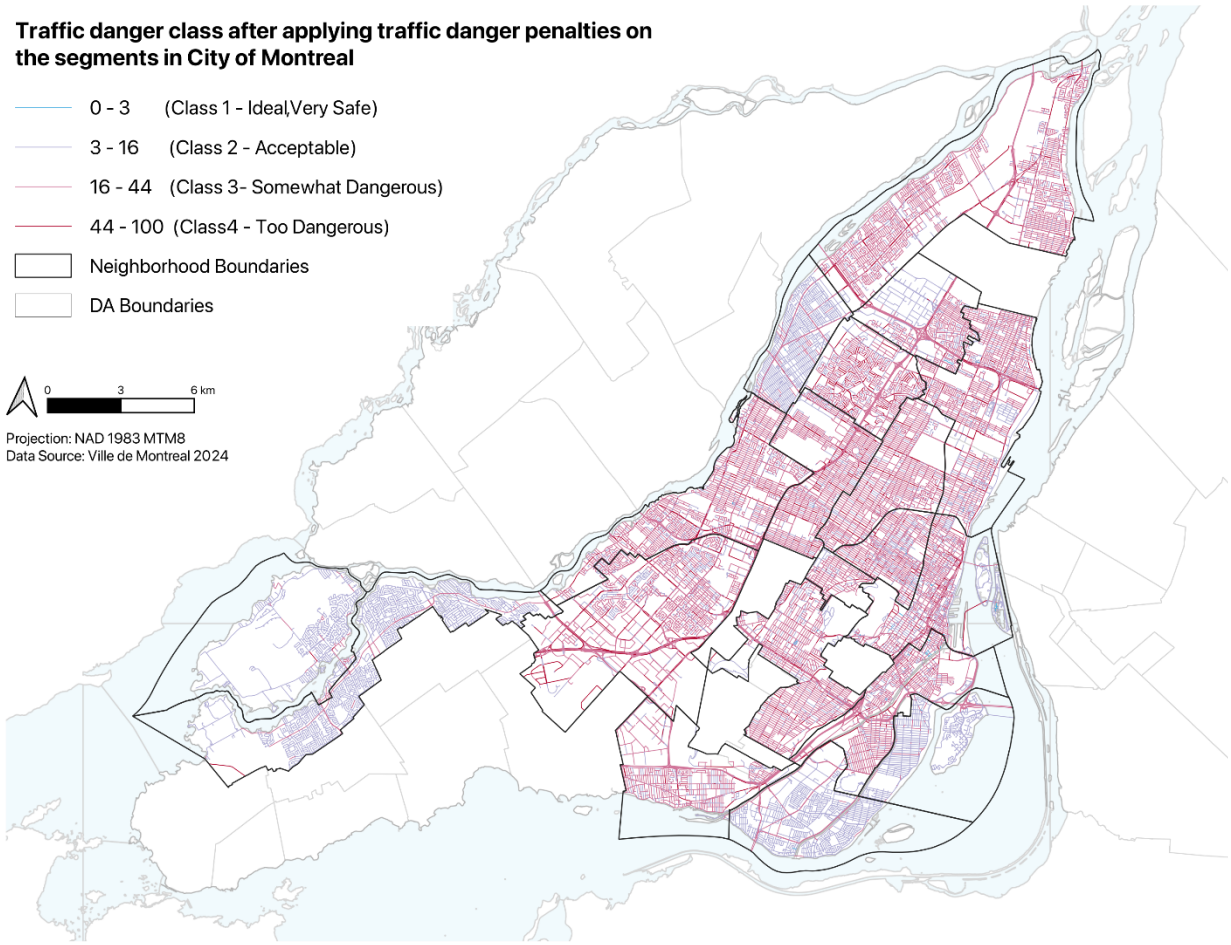


Figure 4-5 Traffic danger classes for all segments with available data

4.4.2 Service areas

After having obtained the traffic danger classes for all segments, the service areas accessible within 1-km walking distance from a DA centroid were generated under two scenarios: one without considering traffic danger and the other with restrictions and penalties imposed due to traffic danger. The service areas were network-based as it was explained earlier.

Figure 4-6 demonstrates an example of how the service area shrinks from a centroid of a specific DA (yellow area) after eliminating segments that are deemed to be too dangerous. For 1-km walking distance, the area of the illustrated service area (the polygon) after adding traffic costs decreased by 68% (from 25.32 m^2 in a general condition to 7.9 m^2 after applying the penalties to the segment).

Figure 4-6 Generating service areas in 1-km walking distance before and after adding traffic danger penalties to the segments.

4.4.3 Accessibility measure

The minimum, maximum, and standard deviation for accessibility, with and without traffic danger penalties, for all the categories of destination are shown in Table 4-3. Maps are used to illustrate how accessibility varies within 1-km walking distance for each category of destination.

Table 4-3 Results of analysis for accessibility to child-relevant destinations for children aged 8-12 based on 1-km reasonable walking distance

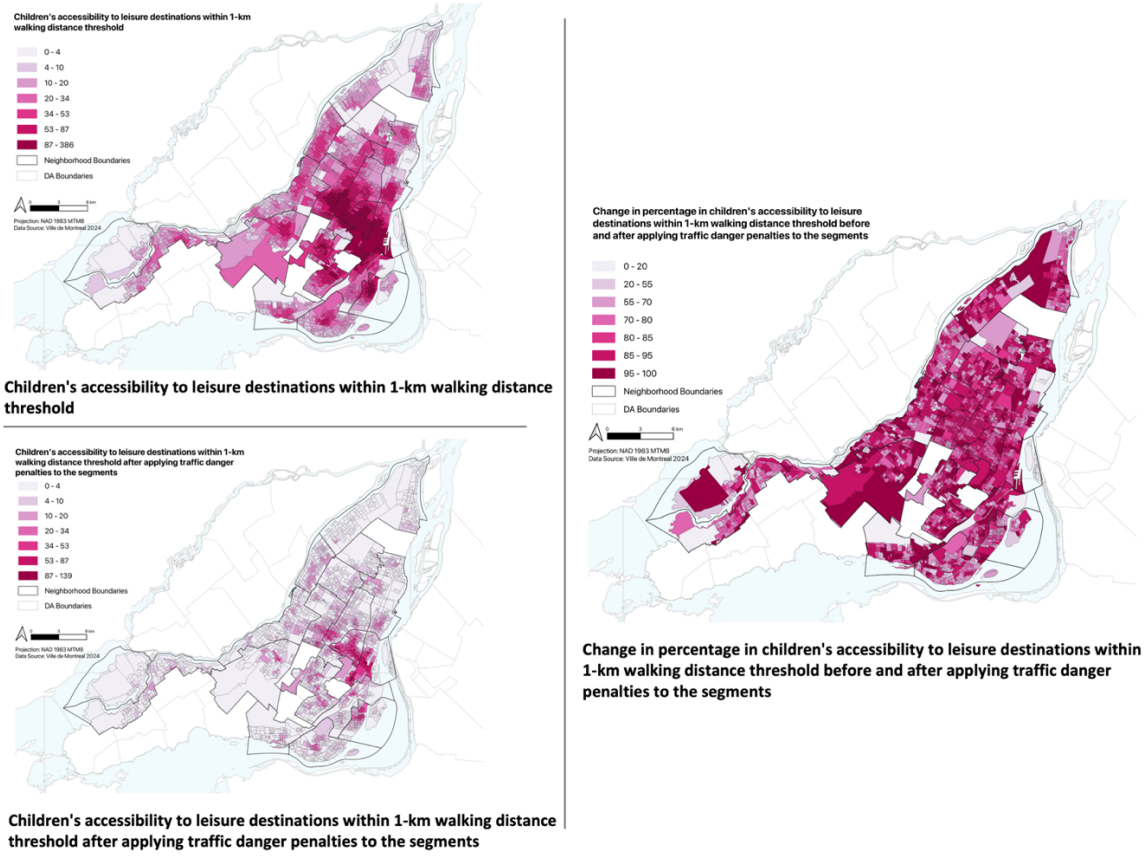
	Accessibility to Commercial destination without penalties	Accessibility to Commercial destination with penalties	Accessibility to Educational destination without penalties	Accessibility to Educational destination with penalties	Accessibility to Green destination without penalties	Accessibility to Green destination with penalties	Accessibility to Leisure destination without penalties	Accessibility to Leisure destination with penalties	Accessibility to Social destination without penalties	Accessibility to Social destination with penalties	Accessibility to Sport destination without penalties	Accessibility to Sport destination with penalties	Accessibility to Public Transport destination without penalties	Accessibility to Public Transport destination with penalties
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max	337	131	65	18	100	31	386	139	205	64	41	13	42	10
SD	58.43	13.31	10.94	2.69	12.11	2.79	61.06	13.27	18.25	3.57	6.96	1.93	3.99	0.80
Mean	58.40	10.55	16.36	3.13	14.39	2.81	52.84	9.37	10.98	2.01	11.13	2.13	1.57	0.31
Median	41	6	14	2	11	2	32	5	5	1	10	2	0	0
Difference in mean with and without penalties	206		47		69		247		141		28		32	
Percent. difference with Mean	61%		72%		69%		64%		69%		68%		76%	

The impact of traffic danger penalties on measures of children's accessibility becomes evident by looking at the mean accessibility within 1-km walking distance threshold. Adding penalties to the segments has a large influence on the results, reflecting the extent to which children's accessibility could be limited when traffic danger is considered. Considering each group of destinations separately, the mean accessibility measures are highest for commercial and leisure destinations with and without penalties, primarily due to the presence of numerous local stores, and local leisure activities. The mean general (or adult) accessibility for leisure activities is 52.84; however, when traffic danger is considered, the mean for CIM drops to 9.37. Commercial destinations also follow the same pattern. Before adding the penalties, the mean general accessibility is 58.40, but with traffic danger considerations, CIM accessibility drops to 10.55. It is also possible to observe that the percentage decrease is both large and similar in magnitude (61-76%) for all destination categories. Also, the results reflect that the percentage reduction is quite similar regardless of the destinations, highlighting the influence of traffic danger penalties on reducing children's accessibility in general.

4.4.3.1 Leisure Destinations

Accessibility to leisure destinations[2] is shown in Figure 4-7 without considering traffic danger (top left figure), with traffic danger as a limiting factor (bottom left figure), and with the change on percentage in accessibility before and after applying traffic danger (right). After adding the traffic danger score to the segments, children in the peripheral boroughs often have the second lowest access (zero to four opportunities) to leisure destinations. In these areas the percentage of change in accessibility before and after applying traffic danger is more than 80%.

[2] Here are some leisure destinations that are listed in Appendix C: Playgrounds, Cafes, Cinemas, Restaurants, Fast Food establishments, Ice rinks, and Skating rinks.



Children's accessibility to leisure destinations within 1-km walking distance threshold

Children's accessibility to leisure destinations within 1-km walking distance threshold after applying traffic danger penalties to the segments

Change in percentage in children's accessibility to leisure destinations within 1-km walking distance threshold before and after applying traffic danger penalties to the segments

Figure 4-7 Children's accessibility to leisure destinations before (top left) and after (bottom left) applying penalties to segments, and the change on percentage in accessibility (right)

4.4.3.2 Green Spaces Destinations

Children's accessibility to green space destinations[3] is shown in Figure 4-8. Before adding the penalties to the segments, some areas in peripheral boroughs can reach 4 to 7 green destinations within 1 Km. In downtown and central neighborhoods, accessibility is often more than 7. However, once the traffic danger penalties are considered, only a very few areas retain high accessibility with most areas having at most 4 to 7 opportunities. Consequently, there is less change in percentage in accessibility before and after applying traffic danger in central neighborhoods.

[3] Here are some green destinations that are listed in Appendix C: Neighborhood park, Linear park, Metropolitan park, Nature park, Urban park.

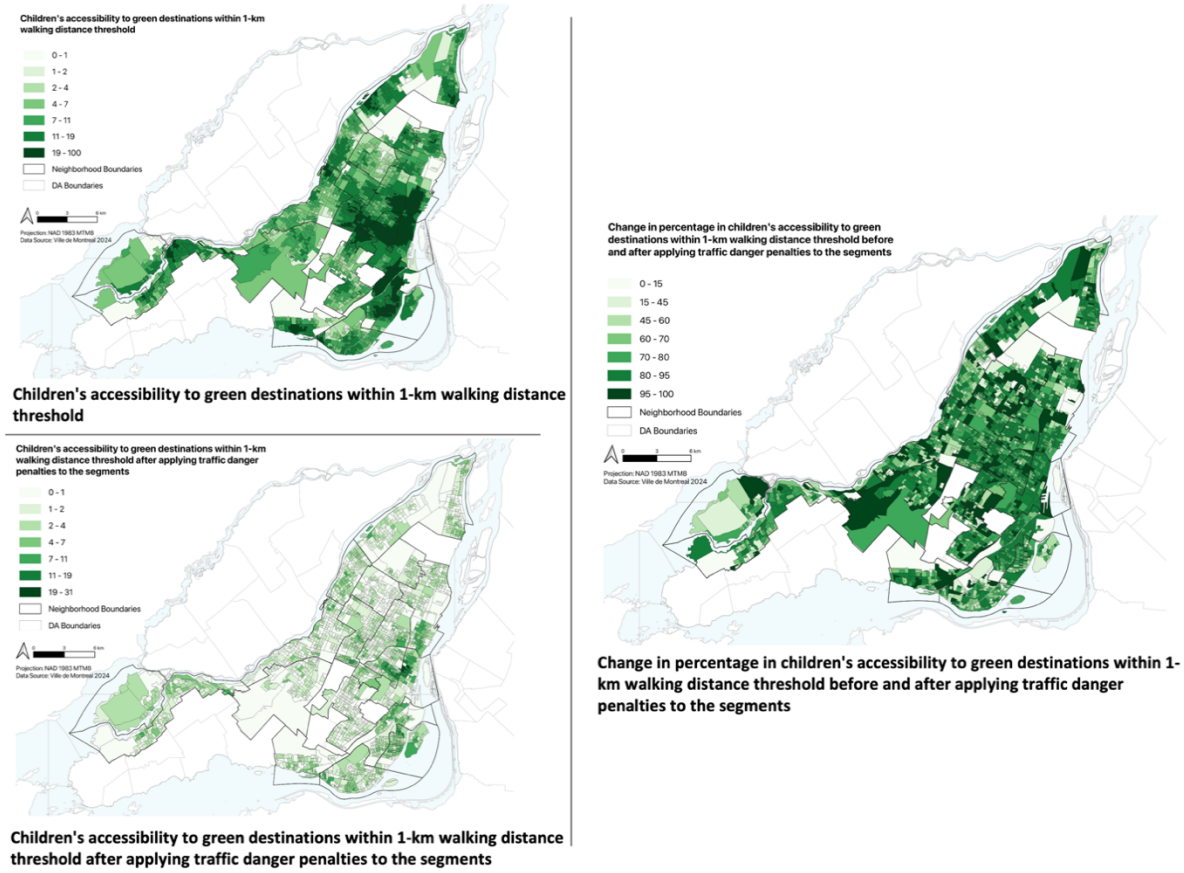


Figure 4-8 Children's accessibility to green destinations before (top left) and after (bottom left) applying penalties to segments, and the change on percentage in accessibility (right)

4.4.3.3 Commercial Destinations

Children's accessibility to commercial destinations[4] is shown in Figure 4-9. Adding traffic danger penalties to the segments decreases the number of commercial opportunities considerably. For example, there are boroughs with more than 36 local commercial stores within 1-km of the center of each DA, which are accessible for children. After applying penalties to the segments, the available commercial opportunities drop to the categories of 0- 5 or 5 to 12. Similar to the previous destinations, children in central areas can access at least one local store after penalties are applied, and maximum opportunities in some areas are 50 or more. Also, in peripheral boroughs, the change

[4] Here are some commercial destinations that are listed in Appendix C: Bakery, Chocolate shop, Convenience Store, Grocery, Supermarket

in percentage shows more than 85% of difference before and after applying traffic danger, whereas in central areas, the difference is around 45 to 60%.

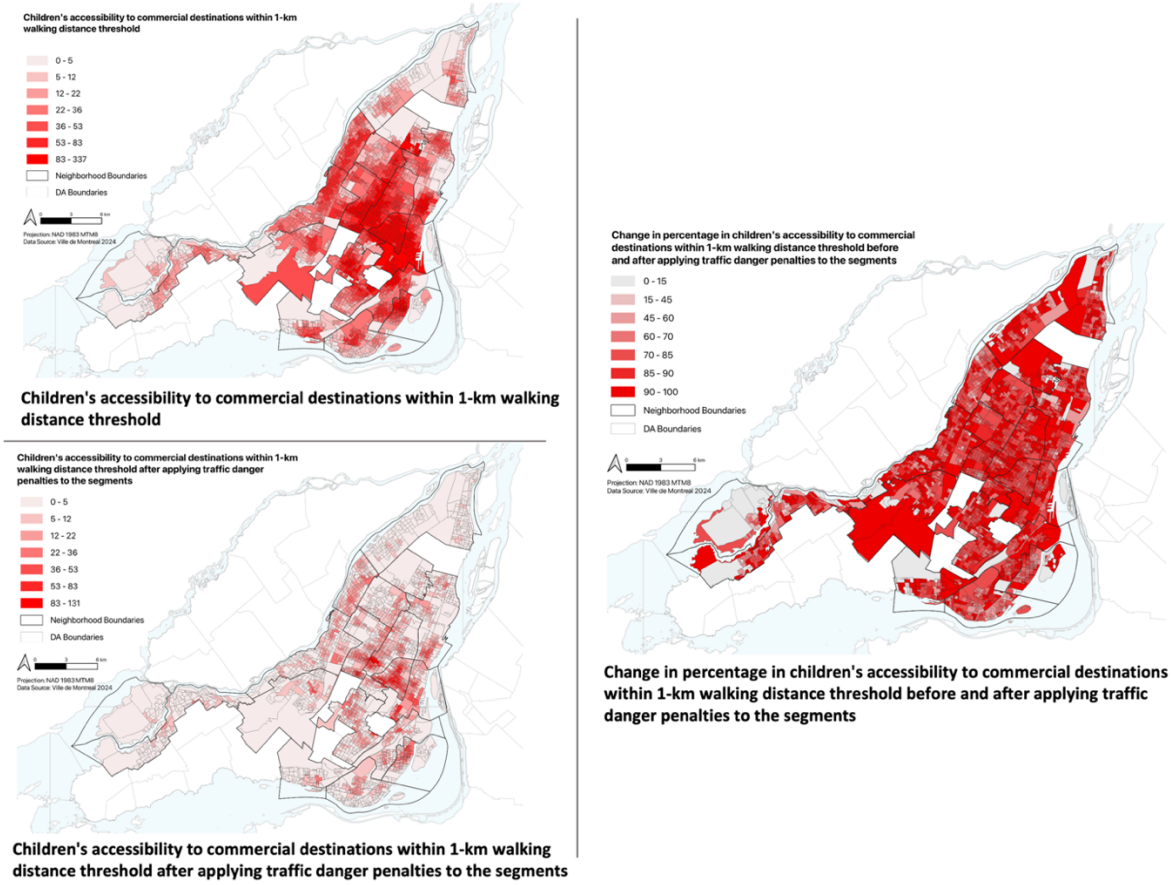


Figure 4-9 Children's accessibility to commercial before (top left) and after (bottom left) applying penalties to segments, and the change on percentage in accessibility (right)

4.4.3.4 Social and Cultural Destinations

Children's accessibility to social and cultural destinations[5] is shown in Figure 4-10. Before adding the penalties to the segments, most areas have at least some accesses to such destinations. However, once traffic danger is considered, most of the peripheral boroughs have no access as a result of arterial roads and high-speed streets. The percentage of change in accessibility reflects more than 70 % of difference in peripheral boroughs. The exception to this are the central boroughs

[5] Here are some social and cultural destinations that are listed in Appendix C: Community organization and recreation centre, Museum, Pedestrian street

with the highest number of social and cultural destinations and less change in percentage of accessibility.

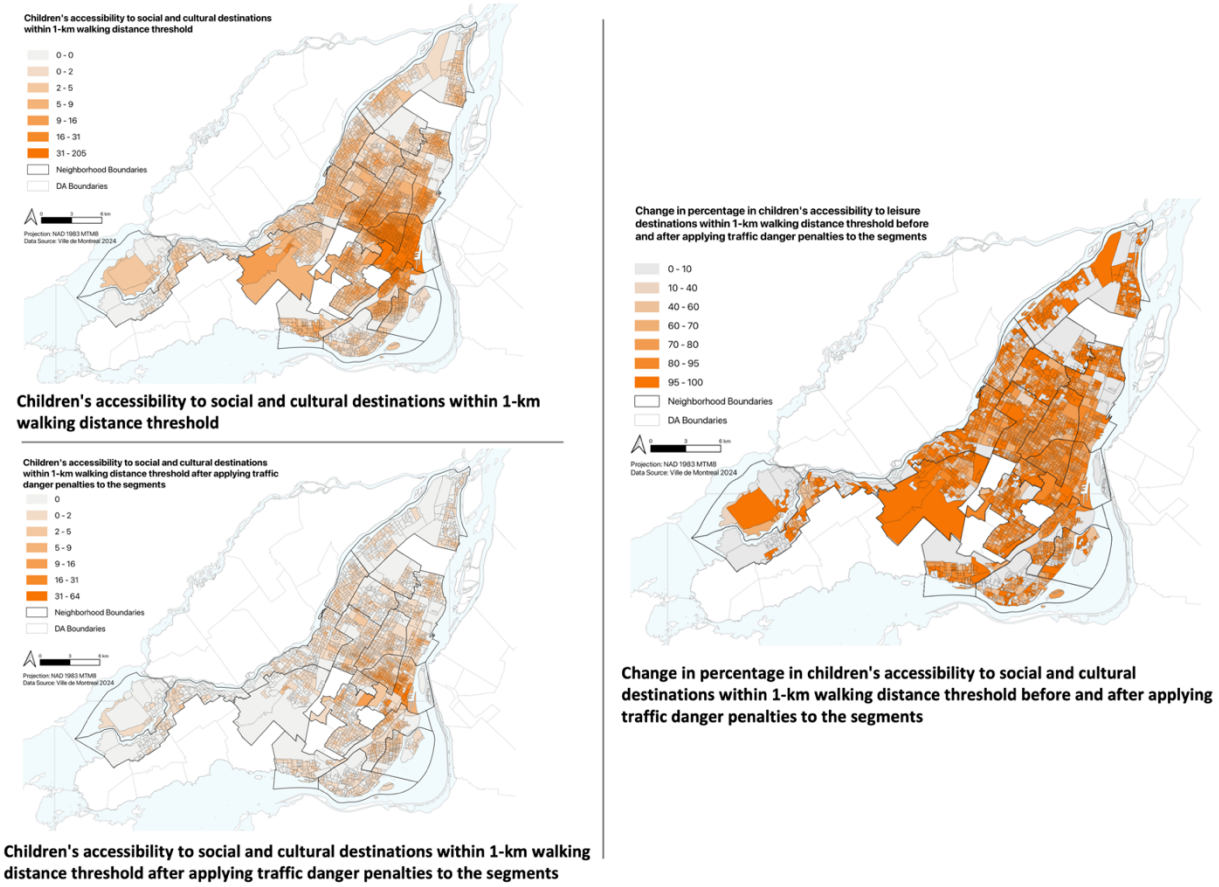


Figure 4-10 Children's accessibility to social and cultural destinations before (top left) and after (bottom left) applying penalties to segments, and the change on percentage in accessibility (right)

4.4.3.5 Sports Destinations

Children's accessibility to sport destinations[6] is shown in Figure 4-11. In most boroughs, there were more than 5 sports destinations before traffic danger penalties were added. As a result of applying penalties to the segments, the number of opportunities drops to less than five. In areas near arterial roads, it drops to two, one or zero in some cases. The percentage of change in accessibility in these areas is more than 60%.

[6] Here are some sport destinations that are listed in Appendix C: Different types of indoor and outdoor sports (Basketball, soccer, cricket), Bike path, Indoor and outdoor pool

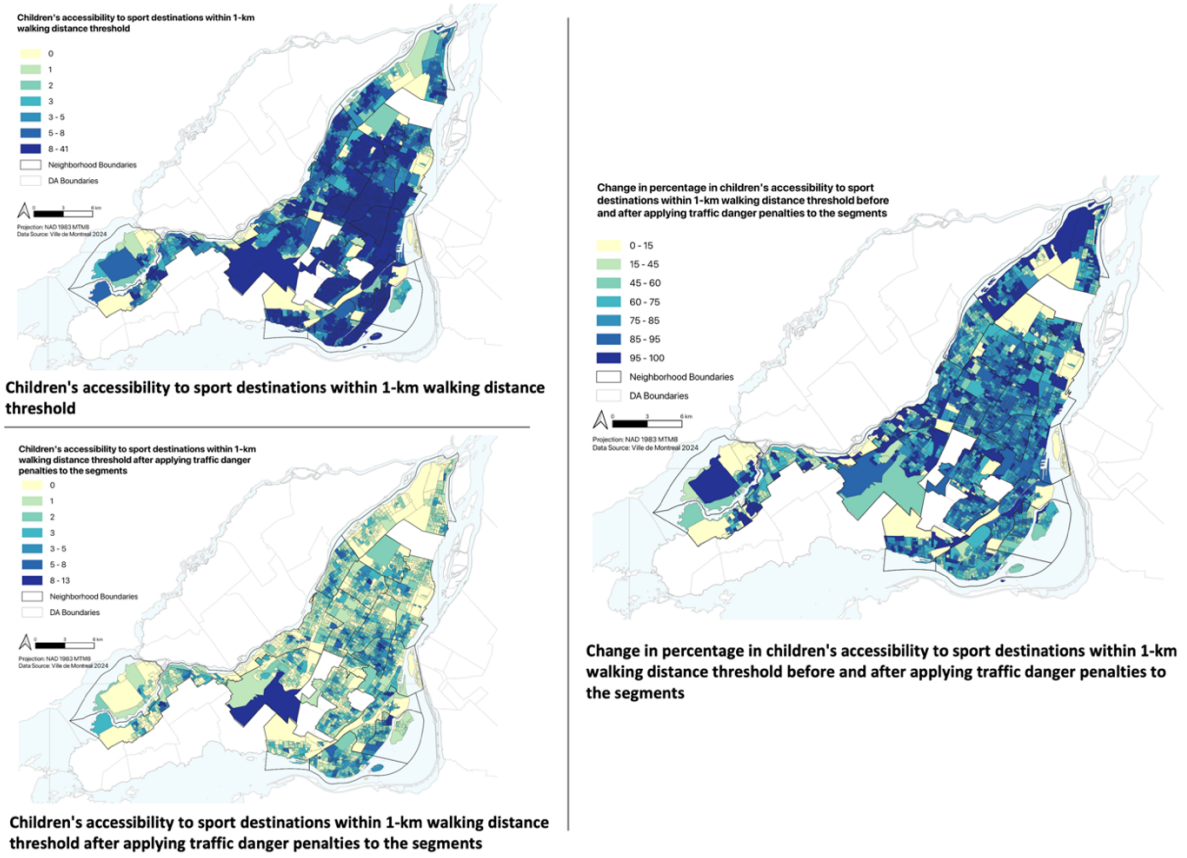


Figure 4-11 Children's accessibility to sport destinations before (top left) and after (bottom left) applying penalties to segments, and the change on percentage in accessibility (right)

4.4.3.6 Educational Destinations

Children's accessibility to educational destinations[7] is shown in Figure 4-12. Before adding the penalties, the number of educational destinations that children can reach is mainly between the range of 8 to 12 and more than 12 opportunities. However, adding penalties to segments will decrease this range to 2 and 4 to 6 numbers of accessible educational destinations. As it was mentioned, in the boroughs with the presence of highway or main arterial road, this difference is much more visible.

[7] Here are some educational destinations that are listed in Appendix C: Primary school, Secondary and vocational school, Library

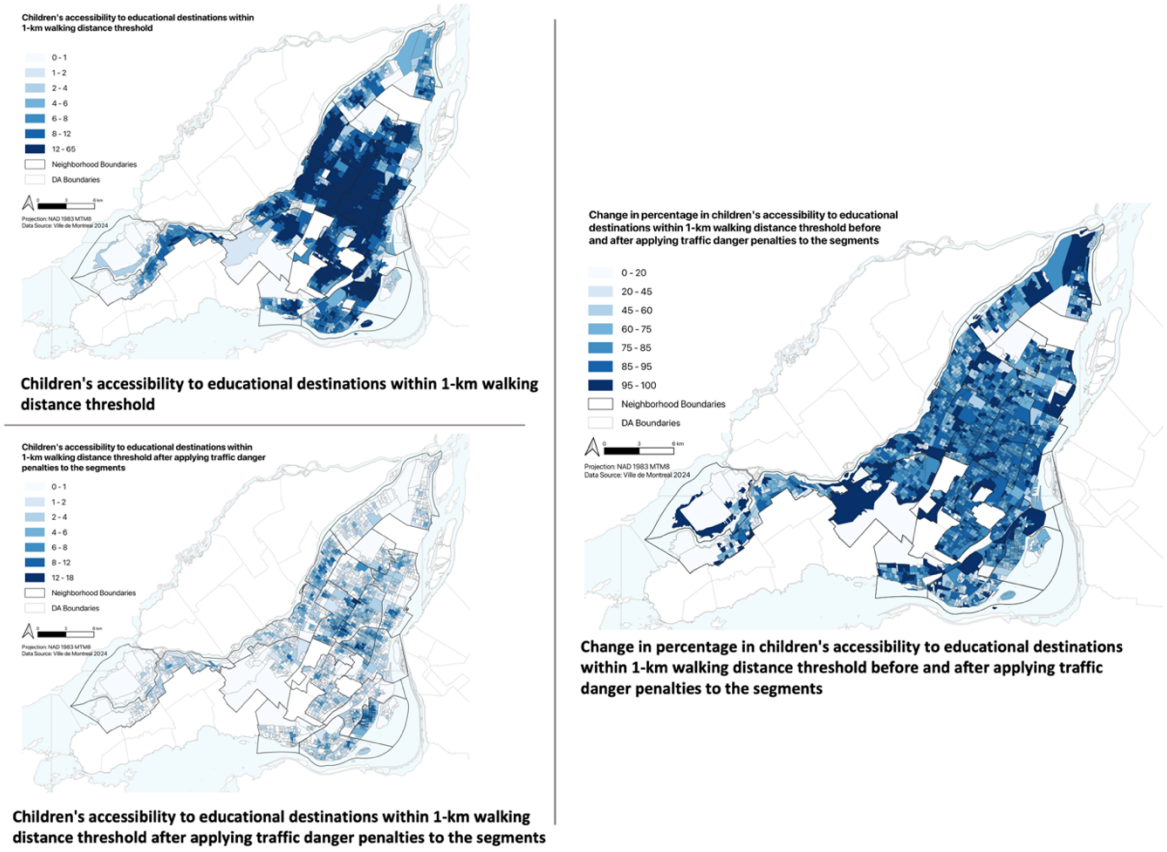


Figure 4-12 Children's accessibility to educational destinations before (top left) and after (bottom left) applying penalties to segments, and the change on percentage in accessibility (right)

4.4.3.7 Public Transport Destinations

Children's accessibility to public transport destinations[8] is shown in Figure 4-13. Before adding traffic safety penalties, in the central part of the City of Montreal, like downtown, where there is a high density of public transit destinations, children could have access to more than 3 numbers of public transit stations. However, after applying penalties, while the central areas still have accessibility to more than 3 numbers of public transit, in peripheral boroughs this number drops to 0 or only 1 public transit stations. In most DAs, there is a difference in accessibility of more than 80% before and after applying traffic penalties.

[8] Here are some public transport destinations that are listed in Appendix C: Metro station, Bus terminal, Mobility pole, Taxi and Train station

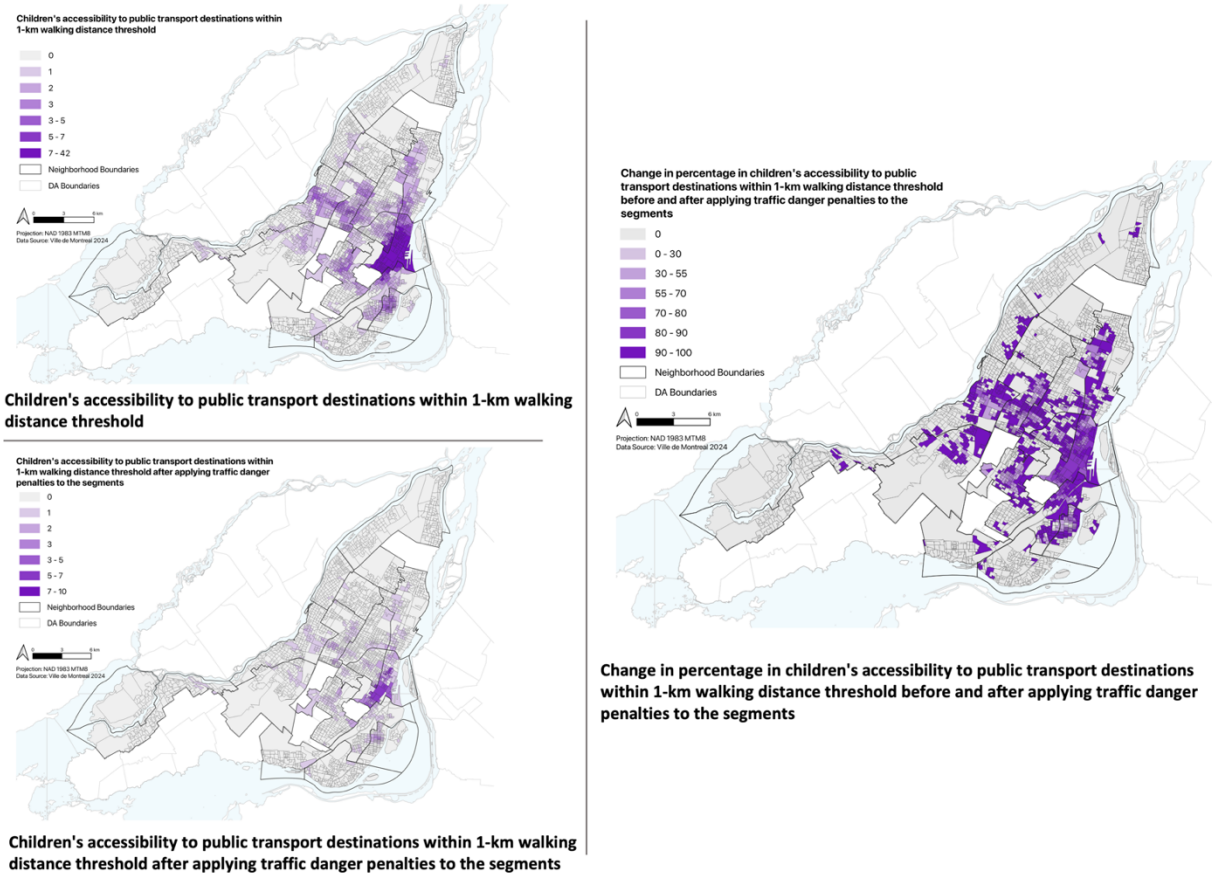


Figure 4-13 Children's accessibility to public transport destinations without considering traffic before (top left) and after (bottom left) applying penalties to segments, and the change on percentage in accessibility (right)

4.5 Discussion

Parents often cite traffic danger as a reason to restrict children's independent travel (Amiour et al., 2022a; Guliani et al., 2015). By focusing on traffic danger that could influence children's travel and identifying children's destinations, this study developed a framework for measuring children's accessibility within 1-km walking distance in a Canadian context. Experts' input was used to estimate traffic danger on segments. With respect to having equitable access for children, the results demonstrate how traffic danger limitations significantly reduce children's opportunities. This reflects the importance of prioritizing child-friendly urban design and safety measures to ensure equitable access to their daily facilities.

In general, our results showed that when traffic danger penalties are considered, the mean accessibility to all destinations goes down as expected. Only neighborhoods in the downtown

retain with high levels of accessibility. These central boroughs are the areas where the land-use is mixed resulting in many more opportunities for children, such as local stores, parks, and green spaces, pedestrian streets, and public squares. This is in line with a prior study that greater walkability and mobility combined with greater affordances (the variety of opportunities that exist for the child in the environment) could support children's accessibility (Desjardins et al., 2022).

Accessibility in peripheral areas is typically quite low for almost all destination types once traffic danger was considered. This is a result of a combination of two factors: 1) the diversity of destinations is low; 2) the presence of infrastructure such as highways and arterials.

According to the result of the survey, the experts identified speed as the most important factor for traffic danger. Also, the input of the survey reflects that among different road classes, the main arterial road and the second arterial road are the most dangerous streets for children to travel. As a result of the high speed of road classes such as highways and arterials in these areas, children's independent travel is likely limited. Prior studies found that high speed segments were related to both objective danger and perceived danger for children's travel (Amiour et al., 2022a).With greater speeds there is a greater risk of death or severe injury (non-linear increase after roughly 30 km/h). Further, the stopping distance increases non-linearly and drivers have a narrower focus on where their attention goes (Huguenin-Richard, 2010). For example, the number of accessible commercial destinations drops around the highways or main arterial roads, which are identified as dangerous roads for children in our traffic danger analysis survey which is aligned with previous finding research (Cloutier et al., 2021).

This study examined a number of different types of destinations. The cumulative accessibility score does not necessarily reflect the importance of different destinations. For example, parks and green spaces have a high level of affordance for children (Chaudhury et al., 2019; Tillmann et al., 2018) that facilitate various activities that improve their well-being such as their physical and social well-being (Robillard et al., 2023; Waygood et al., 2020). As such, the individual analysis of each type of destination can help policy makers focus on where the greatest importance might exist. A weighting system for destinations might be created through input from children and parents, by basing the weighting on research related to benefits to children, or simply by letting individuals consider their own needs.

These findings highlight how children's accessibility is likely to be affected by traffic danger, serving as an important measure of reflecting children's accessibility in reaching various destinations. Children walk more than other groups (Morency et al., 2007; Tavakoli et al., 2022) , and they also possess a number of characteristics that can lead to greater traffic danger, including smaller stature (hard to see over parked cars, hard to be seen over parked cars), slower walking speeds than adults, less experience dealing with traffic, and cognitive development. Further, with respect to these differences, parents often restrict young children's freedom of travel due to traffic danger (Mitra, 2013). As a consequence, children's right to travel safely and freely is more likely to be compromised by traffic danger than that of adults. As far as environmental justice is concerned, previous authors have pointed out how children are not responsible for the problem (traffic danger) but are likely to be disproportionately affected by it (Pabayo et al., 2012). Environmental justice in this context refers to the concept of an "unequitable exposure to a good or a harm" (Stewart, 2020). Further research should examine this perspective in more detail.

It is essential to address traffic danger to ensure that children have fair and equitable access to a variety of places. Previous research on accessibility has assumed that any road segment, or any road segment with sidewalks (Robillard et al., 2023) is appropriate for children. However, as various research on children's independent mobility and traffic safety has identified (Amiour et al., 2022b), traffic danger is an important consideration for parents when deciding whether or not to allow their children to travel independently. This approach used spatial analysis based on input from experts to estimate traffic danger and propose a framework to develop related accessibility measures. Policymakers, planners, and practitioners can use this methodology to determine which areas require interventions to reduce traffic danger. In addition, they can identify the potential places of interventions where children might find few destinations to travel daily.

Another consideration that can limit children's independence is perceptions of social danger such as stranger danger (Mitra et al., 2014). This study did not consider the impact of stranger danger for several reasons. One, children who travel independently consistently report being much more concerned about the ever present traffic danger than stranger danger in studies in Canada (Fusco et al., 2012) and the UK (Joshi et al., 1999) though studies in the US find parents who drive children report it more (McDonald & Aalborg, 2009). As well, a review of the evidence finds that although evidence finds that abduction by a parent represents the vast majority of child abductions (Tillyer et al., 2015), abductions by a stranger are thankfully rare (Shutt et al., 2004).

Other research has found that the perception of social danger might be influenced by the modes one uses (Gatersleben et al., 2013) and that parents who drive their children are more likely to be concerned about social danger, while parents in the same area who allow their children to travel independently do not report the same concern (Curtis et al., 2015). This is not to say that such worries do not impact some parents' decisions (Foster et al., 2015), but that traffic danger represents a daily danger to children that results in death and is the one that children report more often being worried about, and was thus the point of focus here. As well, it is not clear how social danger (as opposed to concern) would be modelled. However, future research could examine how such considerations might be incorporated.

The results of this work have implications for transport policy. Previously, a measure of how traffic danger might impact children's freedom did not exist. Without such tools, previous work that found that parents and children were highly concerned about and feared traffic danger and thus limited their freedoms to travel independently remained an abstract concept. As the United Nations Convention on the Rights of the Child (UNCRC, 1988) states, children should be consulted on any development that negatively impacts their quality of life. Our results on how traffic limits children's travel needs and capacities can motivate both a better consideration to children's travel needs and capacities, but also their direct involvement in discussions of transport infrastructure.

4.6 Conclusion

This research estimated children's accessibility to child-relevant destinations within a 1-km walking distance for two situations: 1) when traffic danger is ignored; 2) when traffic danger's limiting influence is considered. By comparing accessibility with and without traffic danger, this study demonstrates how accessibility to amenities can be significantly impacted by limitations due to traffic danger when it comes to reaching meaningful destinations. By using this approach, a residential area can be assessed for its ability to support children's independent mobility (CIM), which is about having a trip without adult supervision, so that children can reach their destinations. The results could be combined with other considerations such as the number of children impacted or neighborhood deprivation levels to identify priority areas to improve traffic safety.

Using a survey, different traffic and road characteristics were scored and weighted to calculate a traffic danger score. Additionally, specific destinations for children were identified based on prior literature. Children's accessibility to local destinations was measured by generating two service

areas before and after applying traffic-danger penalties. As a result of traffic danger, the service area (based on a reasonable walking distance of a child aged 8-12) and the number of accessible destinations for children were significantly (over 75 %) reduced. According to the results, children have the greatest accessibility to commercial and leisure destinations and the lowest accessibility to public transport once traffic danger penalties were added to the road segments analyzed. Depending on a city's policy objectives, this approach can help identify how to improve children's quality of life in cities. The systematic nature of this analysis suggests that similar methodologies may be adapted and applied in other contexts. Our methodology could be adjusted to reflect different traffic measures, destinations (based on context and data availability), and walking distances.

A few limitations exist. Some open data limitations exist when measuring traffic danger, such as street width, number of lanes, or traffic volume.

This study presents an exciting first step towards many possible future studies. How this measure of accessibility relates to objective measures of children's independence could be examined. Further, and whether it is an accurate reflection of how children believe an environment supports (or limits) the diversity of daily activities possible in their neighborhood could be analyzed through discussions with children. The tool should allow for equity analysis in access to amenities by income levels, education levels, racial minorities, and the number of children impacted. Such research could help identify areas where targeted intervention may be needed to ensure equitable access for children. The tool could be used to provide further and more detailed policy implications related to children's traffic danger and accessibility. The identification of priority areas to improve could support the development of targeted policies and actions that enhance children's accessibility to their key destinations.

Other types of participants could further bolster results from future studies. Participants in this study were experts from various fields, primarily from academia with direct involvement in the project. To gain a complete understanding of this topic, future research should involve planners and practitioners. Future directions could include using different tools to include different stakeholders and improve traffic danger scores. Since parents are key stakeholders, it is important to include them in understanding children's destinations and their concerns about traffic. Taking children's input into account is also crucial since they have a unique experience as the main user.

The input of parents and children can better inform the choice of what level of danger begins to restrict travel and which completely restricts travel.

The key contributions of this study are: First, it estimated traffic danger on segments as a key barrier to children's independent mobility. Additionally, it measures walking accessibility by considering child-relevant destinations within a reasonable distance without taking into account the potential of traffic danger to limit children's travel and then compare this with accessibility when traffic danger is considered. Based on the traffic danger scores, it showed to which destinations children have the greatest or the least accessibility. Finally, this study highlights the influence of traffic danger on accessibility to essential urban resources, providing valuable insight to urban planners and policymakers seeking to create a more inclusive and child-friendly urban environments.

CHAPTER 5 FURTHER DISCUSSION AND METHODOLOGICAL CONSIDERATION ON MEASURING CHILDREN'S WALKING ACCESSIBILITY

The previous chapter provided an in-depth analysis of traffic danger's impact on children's accessibility, but there are additional factors to consider: first, it was important to find an effective methodology for measuring children's accessibility and how to apply traffic danger scores on the segments. Second, as a reasonable distance that a child can walk varies by age, the accessibility analysis was conducted for three different walking distances. However, due to the journal's word limitations, the study focused on 1000-meter walking distance. As a general benchmark, this distance is commonly used in other studies related to children between the age of 8 and 12 (Cervesato & Waygood, 2019).

Here are details about these two factors:

5.1 Challenges in integrating traffic danger into accessibility

Identifying an appropriate method to apply the traffic danger score on each segment and calculate children's accessibility was a significant challenge in the first step of the research. Therefore, we identified different methodological options and discussed the potentials of each approach.

One of the most popular methods to measure accessibility is by using 'r5r'. 'r5r' is a R package which is designed to provide rapid realistic routing over multimodal transportation networks, which include walking, biking, public transportation, and driving. It provides a user-friendly interface for the R5 routing engine, developed by Conveyal and known as Rapid Realistic Routing on Real-world and Reimagined Networks (R5) (Pereira, 2021). Through parallel computing, this engine is particularly useful for calculating travel time matrices and generating detailed routing analyses. 'r5r' uses data directly from OpenStreetMap (OSM) to construct detailed and accurate routing networks. The user can input OSM data in pbf format along with General Transit Feed Specification (GTFS) data for public transport routes to create a comprehensive multimodal transport network. With this integration, 'r5r' can accurately reflect the actual conditions of the real world in its routing analyses (Pereira, 2021).

For measuring traffic danger penalties to calculate children's' accessibility, we used Open Data Montreal Network because by the time of starting this analysis the data regarding the indicators for segments was more complete compared to OpenStreetMap. OpenStreetMap is a valuable tool for collaborative mapping; however, in 2022 when the developing of the tool started, its infrastructure data remains incomplete. Despite the efforts of contributors, traffic danger data information such as street lane or speed limit was lacking in many regions. By working with OpenData Montreal Network, first I tried to import this dataset as pbf format to 'r5r'. However, I noticed that the tagging systems of OSM and OpenData Montreal differed significantly except for the names of streets. The tagging system refers to labeling and categorizing specific attributes and characteristics of map elements, such as roads and intersections. For using OpenData Montreal it was not possible to use the OSM tags.

Several alternatives were discussed with the developer of r5r, including tweaking the tags or utilizing other R packages such as dodgr_package or sfnetworks. While trying to implement these alternatives and adapt changes to OSM, it became evident that making any modifications to OSM resulted in the packages becoming unusable, even with only minor changes. In conclusion, I discovered that these packages are designed to work exclusively with OSM data that has not been modified. Specifically, Conveyal developed and enhanced these tools to meet different research needs relating to accessibility analyses. While 'r5r' provide excellent performance in different intended applications - namely, with an unmodified OSM network - the tool cannot incorporate more sophisticated customizations such as a traffic danger score.

There was also the option of using ArcGIS Pro, by using a Python notebook, and running Python code via R. However, the size of the dataset, which included both the network data and a large number of points of interest (20370 points of destinations), was a significant challenge as a limitation of ArcGIS Pro is that it can only process up to 3000 rows at a time. The processing time for this task was not reasonable within the time constraints of this research.

Therefore, as was explained in the previous chapter, all data was imported through DBvear to manage this large dataset efficiently. A weighted cost function, necessary for applying the traffic danger score, was calculated using PostGIS and visualized by using QGIS. The methodological process of this step has been provided in the Figure 5.1.

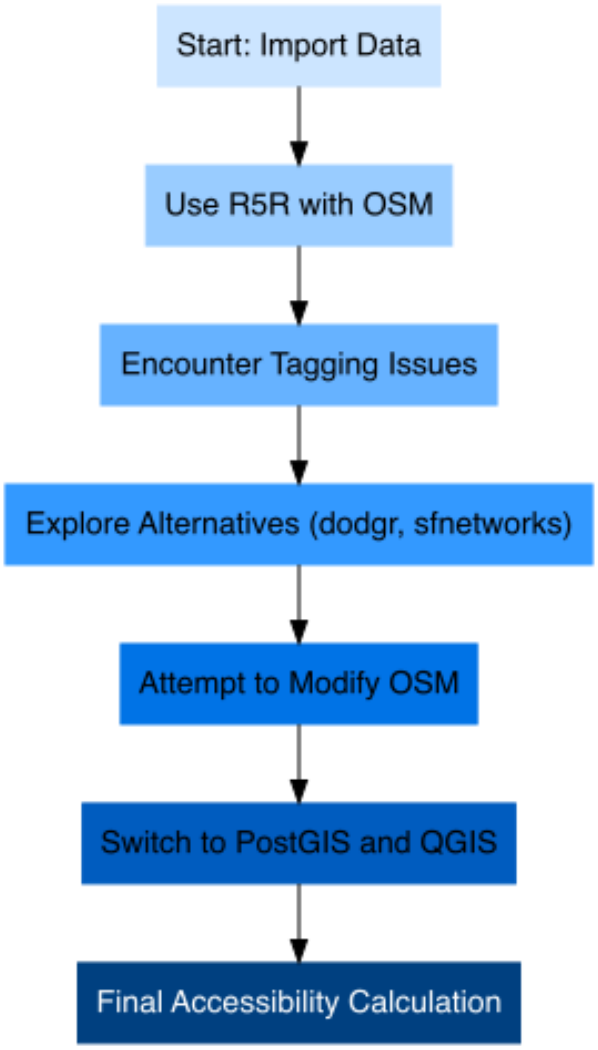


Figure 5-1The methodological process of measuring children's walking accessibility

5.2 Analysis of Different Walking Distances in Measuring Children's Accessibility

A detailed analysis of children's accessibility based on walking distances was conducted in addition to the results provided in Chapter 4. By measuring accessibility at three different distances, we can gain a deeper understanding of how traffic danger affects children of different mobility potential.

As explained in the previous chapter, the cumulative accessibility measure was used based on the centroid of each DA to generate a service area using the three different reasonable walking distances of 640 meters, 1000 meters, and 1396 meters based on previous findings (Cervesato & Waygood, 2019; Páez et al., 2012). The minimum, maximum, and standard deviation for

accessibility for each destination category is shown in Table 5-1, 5-2, and 5-3. In the next section, maps are used to illustrate how accessibility varies for each walking distance by category of destination.

Table 5-1 The results of the accessibility to children's destinations, with and without traffic safety penalties for 640 meters

	Walking Distance Thresholds (meters)	Accessibility Commercial destination without penalties	Accessibility Commercial destination with penalties	Accessibility Educational destination without penalties	Accessibility for Educational destination with penalties	Accessibility for Green destination without penalties	Accessibility for Green destination with penalties	Accessibility for Leisure destination without penalties	Accessibility for Leisure destination with penalties	Accessibility for Social destination without penalties	Accessibility for Social destination with penalties	Accessibility for Sport destination without penalties	Accessibility for Sport destination with penalties	Accessibility for Public Transport destination without penalties	Accessibility for Public Transport destination with penalties
Min	**640**	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max		200	71	39	15	38	14	239	70	81	37	23	11	22	6
SD		25.31	6.90	5.53	1.92	3.11	1.02	29.08	7.71	7.45	1.91	3.87	1.54	1.77	0.43
Mean		22.29	4.69	7.24	1.60	2.86	0.63	23.58	5.00	3.81	0.77	5.17	1.06	0.61	0.10
Median		15	2	6	1	2	0	14	2	1	0	5	0	0	0
Difference in average with and without penalties		17.60		5.64		2.22		18.58		3.04		4.11		0.51	
Percentage in difference compared to average		79%		78%		78%		79%		80%		80%		83%	

Table 5-2 The results of the accessibility to children's destinations, with and without traffic safety penalties for 1000 meters

	Walking Distance Thresholds (meters)	Accessibility Commercial destination without penalties	Accessibility Commercial destination with penalties	Accessibility Educational destination without penalties	Accessibility for Educational destination with penalties	Accessibility for Green destination without penalties	Accessibility for Green destination with penalties	Accessibility for Leisure destination without penalties	Accessibility for Leisure destination with penalties	Accessibility for Social destination without penalties	Accessibility for Social destination with penalties	Accessibility for Sport destination without penalties	Accessibility for Sport destination with penalties	Accessibility for Public Transport destination without penalties	Accessibility for Public Transport destination with penalties
Min	**1000**	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max		299	127	64	20	50	22	383	129	177	62	41	20	41	11
SD		51.36	13.9	10.83	3.41	5.97	1.89	60.42	15.59	16.11	3.74	7.04	2.57	3.97	0.81
Mean		50.37	10.95	16.31	3.64	6.57	1.46	53.33	11.42	8.79	1.75	12.11	2.47	1.52	0.25
Median		35	6	14	3	5	1	33	6	3	0	11	2	0	0
Difference in average with and without penalties		39.42		12.67		5.11		41.91		7.04		9.64		1.27	
Percentage in difference with average		78%		78%		78%		79%		80%		80%		83%	

Table 5-3 The results of the accessibility to children's destinations, with and without traffic safety penalties for 1396 meters

	Walking Distance Thresholds (meters)	Accessibility Commercial destination without penalties	Accessibility Commercial destination with penalties	Accessibility Educational destination without penalties	Accessibility for Educational destination with penalties	Accessibility for Green destination without penalties	Accessibility for Green destination with penalties	Accessibility for Leisure destination without penalties	Accessibility for Leisure destination with penalties	Accessibility for Social destination without penalties	Accessibility for Social destination with penalties	Accessibility for Sport destination without penalties	Accessibility for Sport destination with penalties	Accessibility for Public Transport destination without penalties	Accessibility for Public Transport destination with penalties
Min	**1396**	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max		453	181	102	32	69	38	764	178	258	82	60	25	68	15
SD		87.76	23.49	18.77	5.4	9.8	3.12	107.24	26.81	29.17	6.38	11.65	3.9	7.46	1.36
Mean		91.78	20.28	29.64	6.75	12.2	2.73	97.9	21.35	16.49	3.33	22.42	4.74	2.98	0.48
Median		66	13	26	6	9	2	59	12	6	1	21	14	1	0
Difference in average with and without penalties		71.5		22.89		9.47		76.54		13.16		17.68		2.5	
Percentage in difference with average		78%		77%		78%		78%		80%		79%		84%	

To examine different walking distance threshold, we simplified the area around each walking distance to a circle, with and without applying traffic danger. Therefore, several key ratios are used in the analysis:

Radius Ratio is the ratio of a given walking distance to a base distance (in this case, 640 meters). By comparing this ratio to the minimum distance (640 meters), one can determine how much greater the walking distance is. To better understand relative differences between accessibility measures at various spatial scales, I calculated this ratio radius. Using 1000 meters as an example, the radius ratio to 640 meters is 1.56.

Area Ratio calculated as the square of the radius ratio, explains the proportional increase in area as walking distance increases. As an example, the area ratio for 1000 meters and 640 meters is 2.44.

Distance Impact Factor without Traffic Danger compares the mean accessibility at a given distance to the mean accessibility at the minimum distance (640 meters) without applying traffic danger.

Distance Impact Factor with Traffic Danger compares the mean accessibility at a given distance to the mean accessibility at the minimum distance (640 meters) with applying traffic danger.

The results have been provided in Table 5.4.

Table 5-4 Impact of walking distance on accessibility for various destination types before and after applying traffic danger

Walking Distance Thresholds (meters)	**640**	**1000**	**1396**
Area of each walking distance	1286796.35	3141592.65	6122386.03
Radius ratio	1.00	1.56	2.18
Area ratio	1.00	2.44	4.76
Accessibility for green destination			
Mean in accessibility without applying traffic danger	2.86	6.57	12.20
Mean in accessibility after applying traffic danger	0.63	1.46	2.73
Distance Impact Factor without Traffic Danger	1.00	2.30	4.27
Distance Impact Factor with Traffic Danger	1.00	2.32	4.33
Accessibility for commercial destination			
Mean in accessibility without applying traffic danger	22.29	50.37	91.78
Mean in accessibility after applying traffic danger	4.69	10.95	20.28
Distance Impact Factor without Traffic Danger	1.00	2.26	4.12
Distance Impact Factor with Traffic Danger	1.00	2.33	4.32
Accessibility for educational destination			
Mean in accessibility without applying traffic danger	7.24	16.31	29.64
Mean in accessibility after applying traffic danger	1.60	3.64	6.57
Distance Impact Factor without Traffic Danger	1.00	2.25	4.09
Distance Impact Factor with Traffic Danger	1.00	2.28	4.11

Table 5-4 Impact of walking distance on accessibility for various destination types before and after applying traffic danger (continued)

Walking Distance Thresholds (meters)	**640**	**1000**	**1396**
Area of each walking distance	1286796.35	3141592.65	6122386.03
Radius ratio	1.00	1.56	2.18
Area ratio	1.00	2.44	4.76
Accessibility for leisure destination			
Mean in accessibility without applying traffic danger	23.58	53.33	97.9
Mean in accessibility after applying traffic danger	5	11.42	21.35
Distance Impact Factor without Traffic Danger	1	2.26	4.15
Distance Impact Factor with Traffic Danger	1	2.28	4.27
Accessibility for social and cultural destination			
Mean in accessibility without applying traffic danger	3.81	8.79	16.49
Mean in accessibility after applying traffic danger	0.77	1.75	3.33
Distance Impact Factor without Traffic Danger	1	2.31	4.33
Distance Impact Factor with Traffic Danger	1	2.27	4.32
Accessibility for public transport destination			
Mean in accessibility without applying traffic danger	0.61	1.52	2.98
Mean in accessibility after applying traffic danger	0.1	0.25	0.48
Distance Impact Factor without Traffic Danger	1	2.49	4.89
Distance Impact Factor with Traffic Danger	1	2.5	4.8

This analysis shows that accessibility increases with distance roughly relevant to the simplified ratio of area. Distance Impact Factors with Traffic Danger range between approximately 2.3 (comparing 1000 meters to 640 meters) and 4.3 (comparing 1396 meters to 640 meters) for all categories and distances. The simplified area ratios are 2.44 and 4.76. Consistent patterns between those without traffic danger and those with the traffic danger penalty indicate a uniform effect of traffic danger. As distance increases, accessibility scores increase proportionally without and with traffic danger. It appears that using different distances has no considerable impact other than what would be expected. Distance has an impact on the results as long as a sufficient number of destinations are known, confirming that larger distances lead to more destinations and therefore higher accessibility scores. The comparisons indicate that a reasonable distance should be used to study the population.

For different age groups and types of destinations, further research is needed to determine the levels of access and danger that are sufficient.

In the next section, in addition to the maps of accessibility for each destination, we calculated the percentage of Dissemination Areas (DAs) in each class by dividing the number of DAs within that class by the total number of DAs within the specified distance threshold and multiplying by 100. For a given distance threshold, this process converts the number of DAs in each class into a percentage. The results are presented in Table 5-5.

Table 5-5 Percentage of Dissemination Areas (DAs) by Accessibility Classes and Distance Thresholds for Destination Categories

	Percentage of Dissemination Areas (DAs) by Accessibility Classes and Distance Thresholds for Destination Categories					
	Walking Distance Thresholds					
	640		**1000**		**1396**	
Accessibility Classes	**Commercial - without penalties**	**Commercial - with penalties**	**Commercial - without penalties**	**Commercial - with penalties**	**Commercial - without penalties**	**Commercial - with penalties**
0	7.56	31.09	2.32	17.15	0.82	9.66
>0 and <=5	19.32	40.75	7.63	29.63	2.96	19.89
>5 and <=10	13.73	15.58	8.45	18.15	3.24	14.76
>10 and <=20	21.28	7.84	14.37	19.14	9.09	21.11
>20 and <=30	13.98	3.39	12.23	8.16	8.63	12.69
>30 and <=40	8.16	1.03	10.52	2.71	8.38	8.38
>40	15.97	0.32	44.49	5.06	66.88	13.51
	Educational - without penalties	**Educational - with penalties**	**Educational - without penalties**	**Educational - with penalties**	**Educational - without penalties**	**Educational - with penalties**
0	7.81	40.07	2	19.71	0.61	9.41
1	5.56	19.71	1.71	12.73	0.32	6.92
2	6.77	14.47	2.42	13.3	0.61	7.38
>3 and <=5	24.63	21.18	7.81	29.41	3.28	25.42
>5 and <=10	31.84	4.42	19.79	20.39	8.31	29.27
>10	23.39	0.14	66.27	4.46	86.88	21.6
	Green Spaces - without penalties	**Green Spaces- with penalties**	**Green Spaces - without penalties**	**Green Spaces- with penalties**	**Green Spaces - without penalties**	**Green Spaces- with penalties**
0	11.48	57.47	2.03	32.23	0.64	14.65
1	23.17	30.05	4.92	33.33	0.93	24.53
2	24.49	8.06	8.38	17.54	1.85	22.1
>3 and <=5	29.55	3.92	41.11	13.44	15.94	27.81
>5 and <=8	6.95	0.29	21.25	2.28	24.88	6.56
>8	4.35	0.21	22.32	1.18	55.76	4.35

Table 5-5 Percentage of Dissemination Areas (DAs) by Accessibility Classes and Distance Thresholds for Destination Categories (continued)

	Percentage of Dissemination Areas (DAs) by Accessibility Classes and Distance Thresholds for Destination Categories					
	Walking Distance Thresholds					
	640		**1000**		**1396**	
Accessibility Classes	**Leisure Destinations- without penalties**	**Leisure Destinations- with penalties**	**Leisure Destinations- without penalties**	**Leisure Destinations- with penalties**	**Leisure Destinations- without penalties**	**Leisure Destinations- with penalties**
0	3.35	26.6	0.75	11.05	0.29	4.78
>0 and <=5	18.61	47.31	3.64	36.9	0.78	20.5
>5 and <=10	18.72	12.91	7.88	20.53	1.57	20.46
>10 and <=20	24.67	7.66	19.18	15.72	8.34	22.39
>20 and <=30	11.48	3.39	15.65	6.1	10.2	11.87
>30 and <=45	9.45	1.85	18	4.49	16.26	7.88
>45	13.73	0.29	34.9	5.2	62.57	12.12
	Social and Cultural Destinations- without penalties	**Social and Cultural Destinations- with penalties**	**Social and Cultural Destinations- without penalties**	**Social and Cultural Destinations- with penalties**	**Social and Cultural Destinations- without penalties**	**Social and Cultural Destinations- with penalties**
0	35.01	68.34	16.33	52.09	6.17	37.58
1	19	16.4	15.65	17.86	8.88	18.57
>1 and <=3	17.11	9.34	18.4	16.08	17.61	17.65
>3 and <=5	10.27	3.32	13.05	5.2	11.27	9.59
>5 and <=10	8.98	1.96	15.97	5.74	22.53	8.2
>10 and <=20	5.92	0.57	8.95	2.39	14.47	5.56
>20	3.71	0.07	11.66	0.64	19.07	2.85
	Sport Destinations- without penalties	**Sport Destinations- with penalties**	**Sport Destinations- without penalties**	**Sport Destinations- with penalties**	**Sport Destinations- without penalties**	**Sport Destinations- with penalties**
0	9.41	52.8	1.89	28.31	0.61	12.44
1	8.41	20.14	1.32	16.54	0.46	9.7
>1 and <=2	9.7	11.48	1.85	14.72	0.53	10.94
>2 and <=5	31.94	13.4	12.16	28.48	2.28	31.27
>5	40.53	2.17	82.78	11.94	96.11	35.65

Table 5-5 Percentage of Dissemination Areas (DAs) by Accessibility Classes and Distance Thresholds for Destination Categories (continued)

	Percentage of Dissemination Areas (DAs) by Accessibility Classes and Distance Thresholds for Destination Categories					
	Walking Distance Thresholds					
	640		**1000**		**1396**	
Accessibility Classes	**Public Transport Destinations- without penalties**	**Public Transport Destinations- with penalties**	**Public Transport Destinations- without penalties**	**Public Transport Destinations- with penalties**	**Public Transport Destinations- without penalties**	**Public Transport Destinations- with penalties**
0	72.62	92.62	55.44	85.1	40.25	75.86
1	17.11	5.49	18.4	10.02	18.22	15.76
>1 and <=2	5.13	1.28	12.01	2.53	12.37	4.1
>2 and <=4	2.25	0.5	8.59	1.46	18.36	2.21
>4	2.89	0.11	5.56	0.89	10.8	2.07

5.2.1 Commercial Destinations

After applying the traffic danger penalties to the segments, the available commercial opportunities drop to the categories of 0 or 0 to 5. For instance, at a 640 meters walking distance, the percentage of DAs with 0 opportunities increases from 7.55% before applying traffic danger to 31.08% after applying traffic danger. This results in zero opportunities in peripheral boroughs after traffic danger penalties are applied. At a 1000 meters walking distance, the change in number of DAs with 0 opportunities before and after applying traffic danger is from 2.31% to 17.14%. At 1396 m walking distance, this number increases from 0.81% before applying traffic danger to 9.66% after applying this barrier to segments. Figure 5-2 reflects children's accessibility to commercial destinations within three walking distance thresholds.

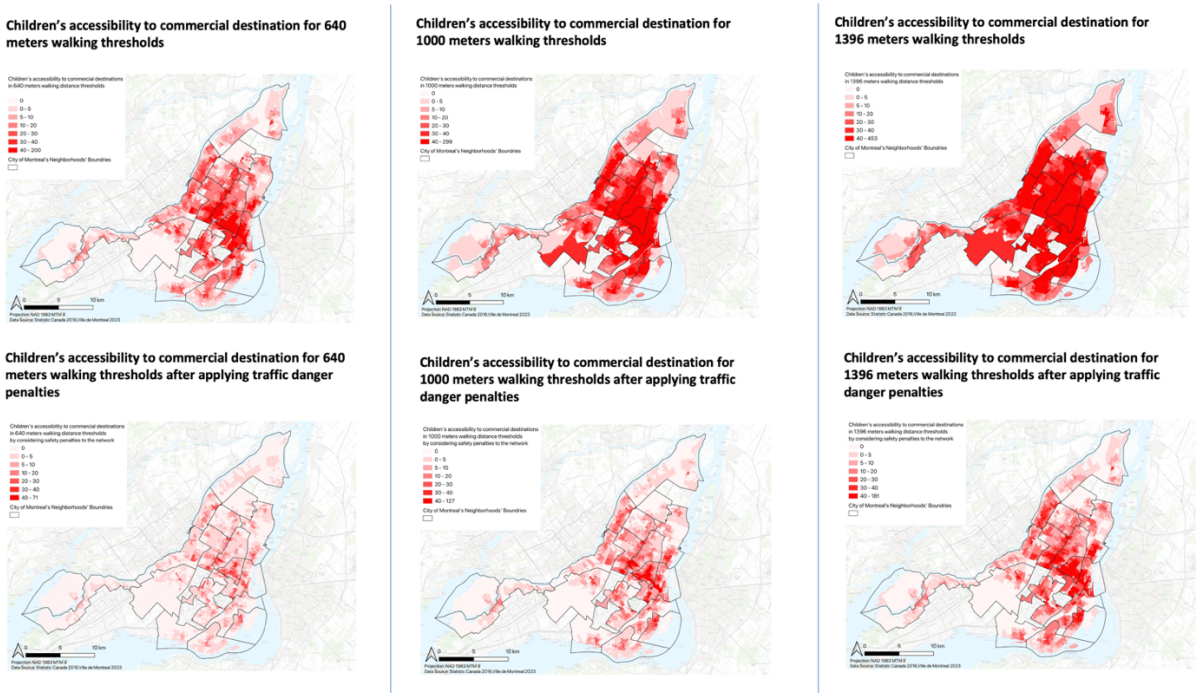


Figure 5-2 Children's accessibility to commercial destinations within three walking distance thresholds without (up) and with (down) applying traffic danger penalties to the segments

5.2.2 Educational Destinations

Before adding the penalties, the number of educational destinations that children can reach within 1000- and 1396-meters walking distance is mainly above five opportunities. However, adding

penalties to segments will decrease this range to three to five and five to 10 numbers of accessible educational destinations. In the peripheral boroughs with the presence of main arterial road this difference is much more visible. As these areas had the higher traffic danger score, the number of available educational destinations for children has been decreased. As such, for those areas, in 640 meters walking distance the number of accessible opportunities after applying traffic danger penalties will drop to 0. The percentage of DAs with 0 opportunities will increase from 7.80% before applying traffic danger to 40.07% after applying traffic danger. For 1000 meters, this number increases from 2% to 19.71%, and for 1396 meters, it increases from 0.61% to 9.41%. Figure 5.3 reflects children's accessibility to educational destinations within different walking distance thresholds before and after applying traffic danger penalties to the segments.

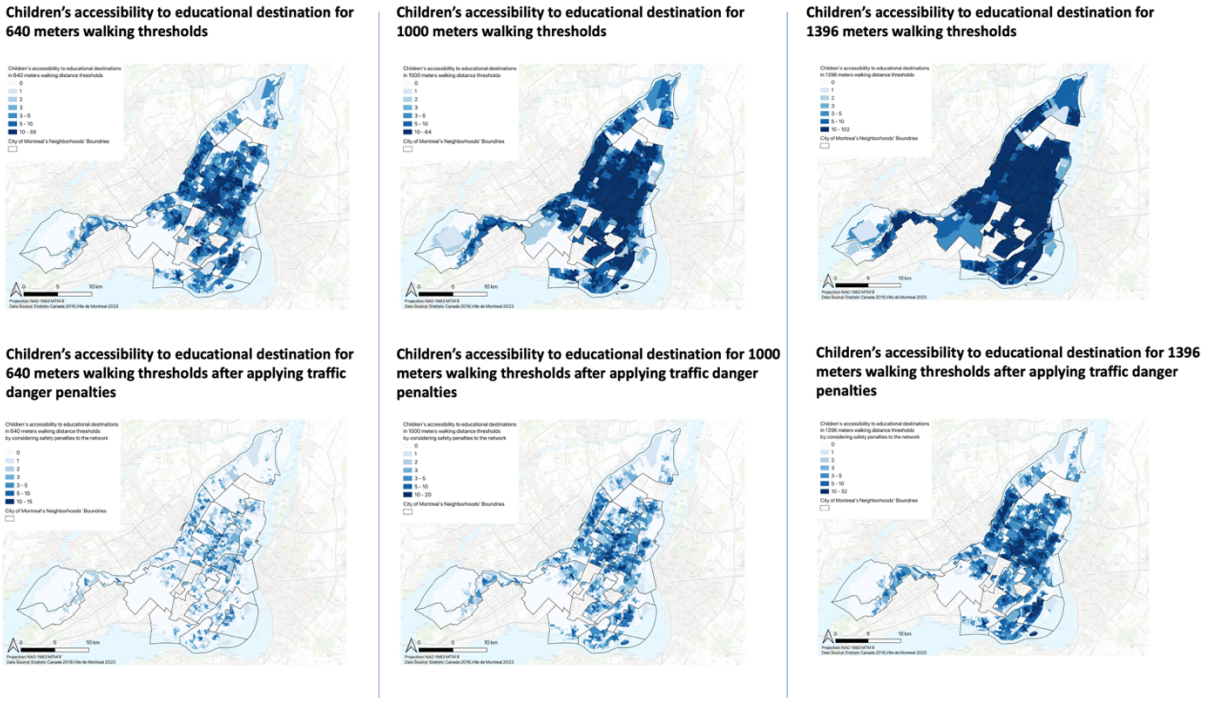


Figure 5-3 Children's accessibility to educational destinations within three walking distance thresholds without (up) and with (down) applying traffic danger penalties to the segments

5.2.3 Green Spaces Destinations

Before applying traffic danger penalties to the segments, children can reach a minimum of five to eight green destinations within 1000 meters and 1396 meters walking distance in peripheral

boroughs, and more than eight mainly in downtown and central neighborhoods. The percentage of DAs with more than 8 opportunities is 22.31% and 55.75% for 1000- and 1396-meters walking distance respectively. However, after applying penalties for the 640 meters walking distance the accessibility in many peripheral boroughs is reduced to only one or zero destinations. The percentage of the number of DAs with 0 opportunities will increase from 11.4% to 57.46% after applying traffic danger for this walking distance. For 1000 meters, this number increases from 2.03% to 32.23%, and for 1396 meters, it increases from 0.64% to 14.65%. Within 1000 to 1396 meters walking distance in the same scenario, there would only be three to five opportunities available for children to reach. Figure 5.4 reflects children's accessibility to green spaces destinations within different walking distance thresholds.

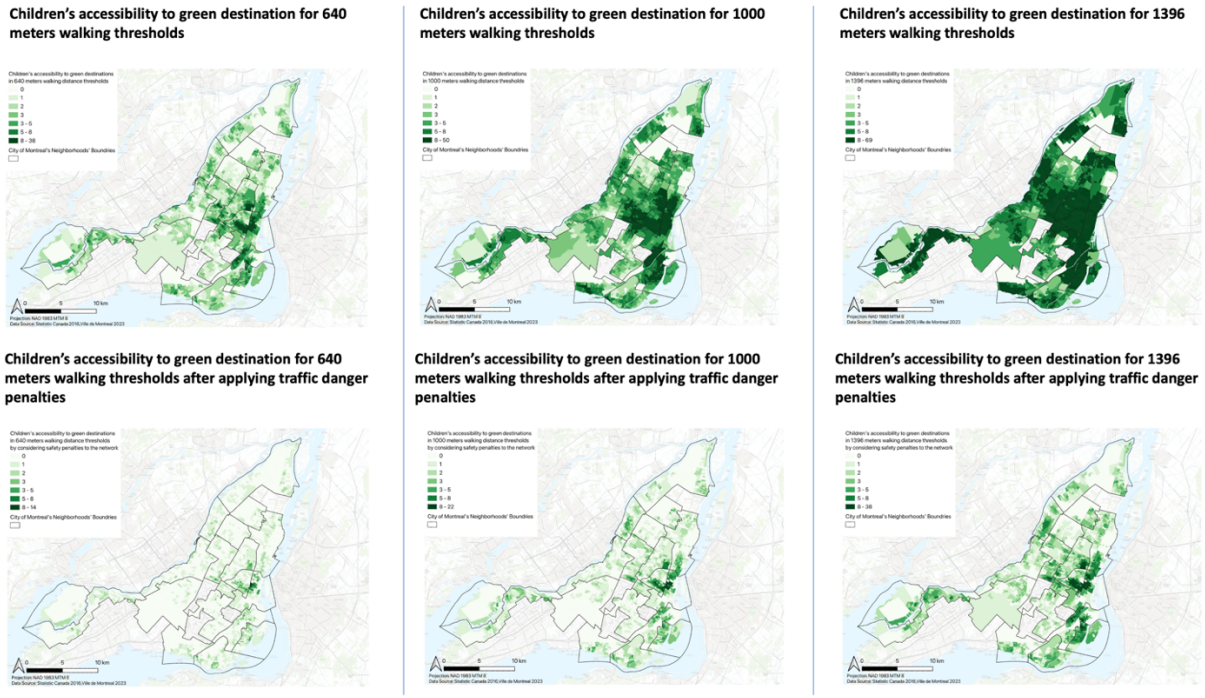


Figure 5-4 Children's accessibility to green spaces destinations within three walking distance thresholds without (up) and with (down) applying traffic danger penalties to the segments

5.2.4 Leisure Destinations

After applying traffic danger penalties to the segments, children will have between one to five leisure destinations to reach leisure destinations in peripheral boroughs at all the three walking distances. For example, the percentage of DAs with 0 opportunities will increase from 3.35% to 26.59% in 640 meters walking distance. For 1000 meters, this number increases from 0.75% to

11.08%, and for 1396 meters, it increases from 0.29% to 4.78%. This is mainly because of the presence of arterial road in those areas, reflecting walking safety measures are the key factor children's travel. In addition, after adding penalties, the central neighborhoods with higher densities have the highest number of opportunities for children in this category. Figure 5.5 reflects children's accessibility to leisure destinations within different walking distance thresholds.

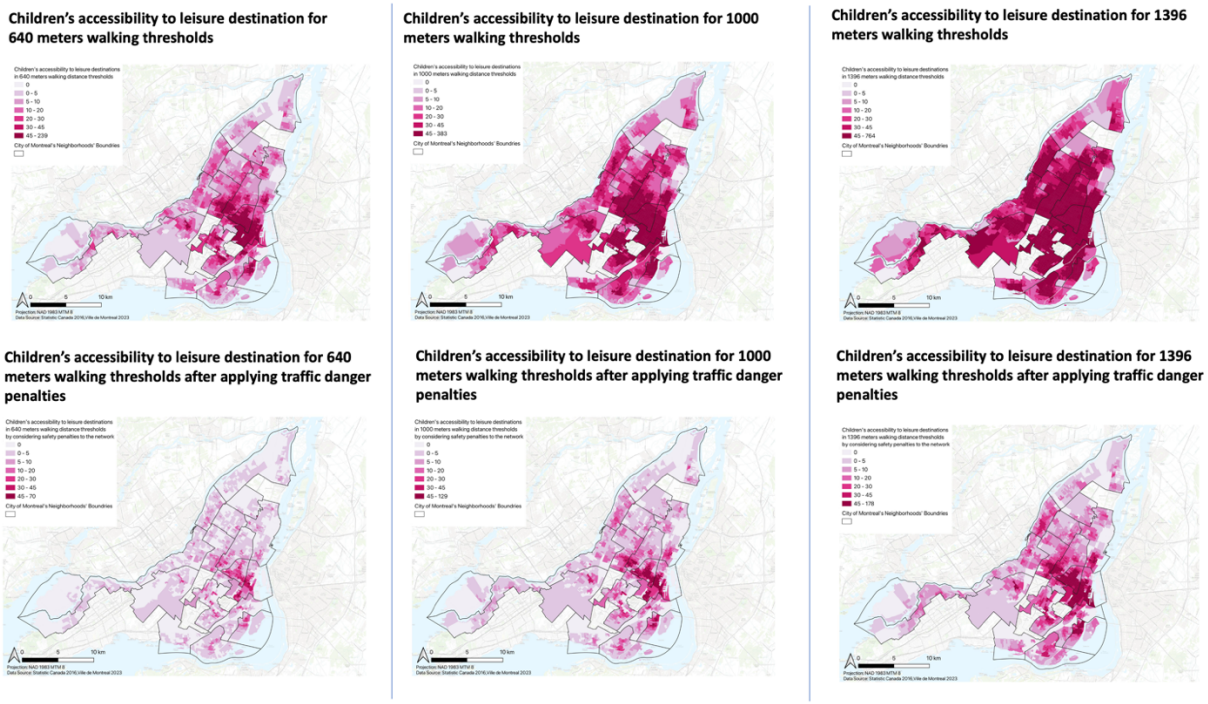


Figure 5-5 Children's accessibility to leisure destinations within three walking distance thresholds without (up) and with (down) applying traffic danger penalties to the segments

5.2.5 Social and Cultural Destinations

After applying penalties most of the peripheral boroughs' accessibility drops to 0. For instance, the percentage of DAs with 0 opportunities after applying traffic danger in 640 meters walking distance will increase from 35% before applying traffic danger to 68.34% after applying traffic danger. This number for 1000 meters walking distance increases from 16.32% to 52.08% and for 1396 meters walking distance increases from 6.16% to 37.57%. In 640 meters walking distance, in central areas the number of available opportunities with the range of 5 to 10 will drop to 3 to 5 and even 1 to 3. The number of accessible social and cultural destinations for children for this walking threshold in peripheral boroughs is mostly 0 or 1. Figure 5.6 reflects children's accessibility to social and cultural destinations within different walking distance thresholds.

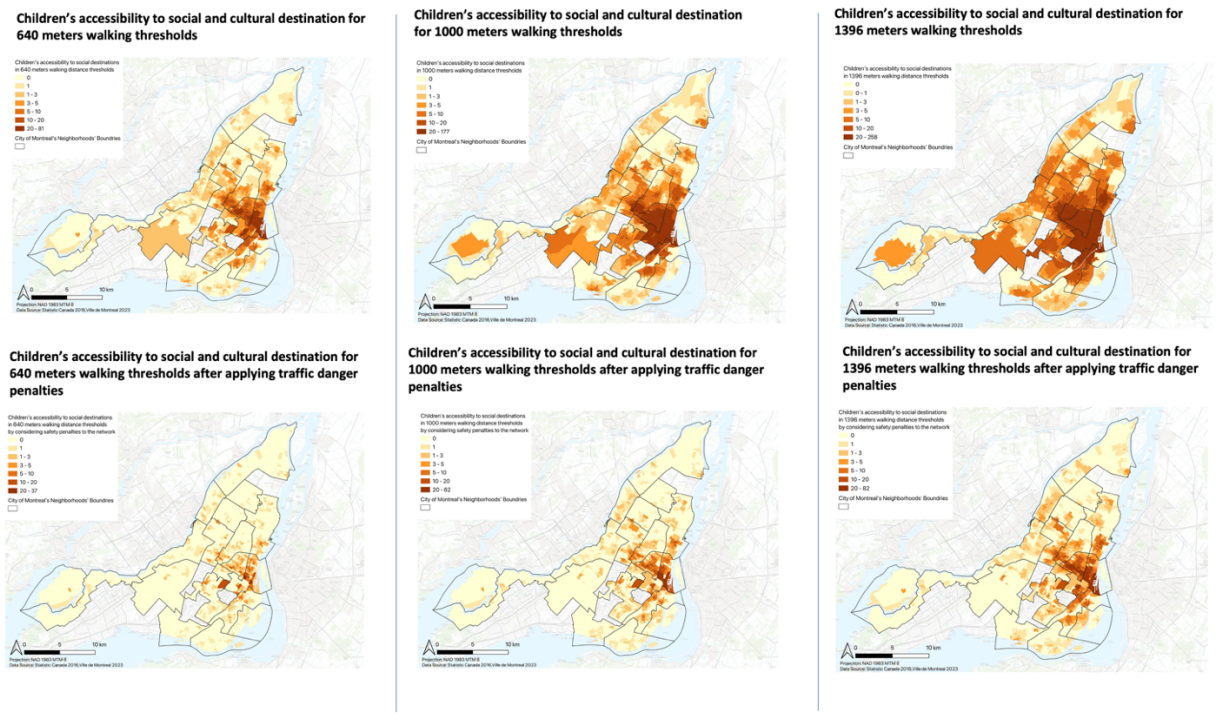


Figure 5-6 Children's accessibility to social and cultural destinations within three walking distance thresholds without (up) and with (down) applying traffic danger penalties to the segments

5.2.6 Sports Destinations

Before adding the penalties in 1000 and 1396-meters walking distance, 82.78% and 96.11% of DAs respectively have accessibility to more than 5 sport destinations. After applying traffic danger penalties to the segments, the number of accessible opportunities for children drops to 0 (for 52.79% of DAs) or 1 (for 20.14% of DAs) within 640 meters of walking distance in most boroughs. For 1000 meters, this number increases from 1.89% to 28.31%, and for 1396 meters, it increases from 0.61% to 12.44%. Also, for 1000 and 1396-meters walking distance the range of accessible opportunities changed mostly between two to five. Figure 5.7 reflects children's accessibility to sports destinations within different walking distance thresholds.

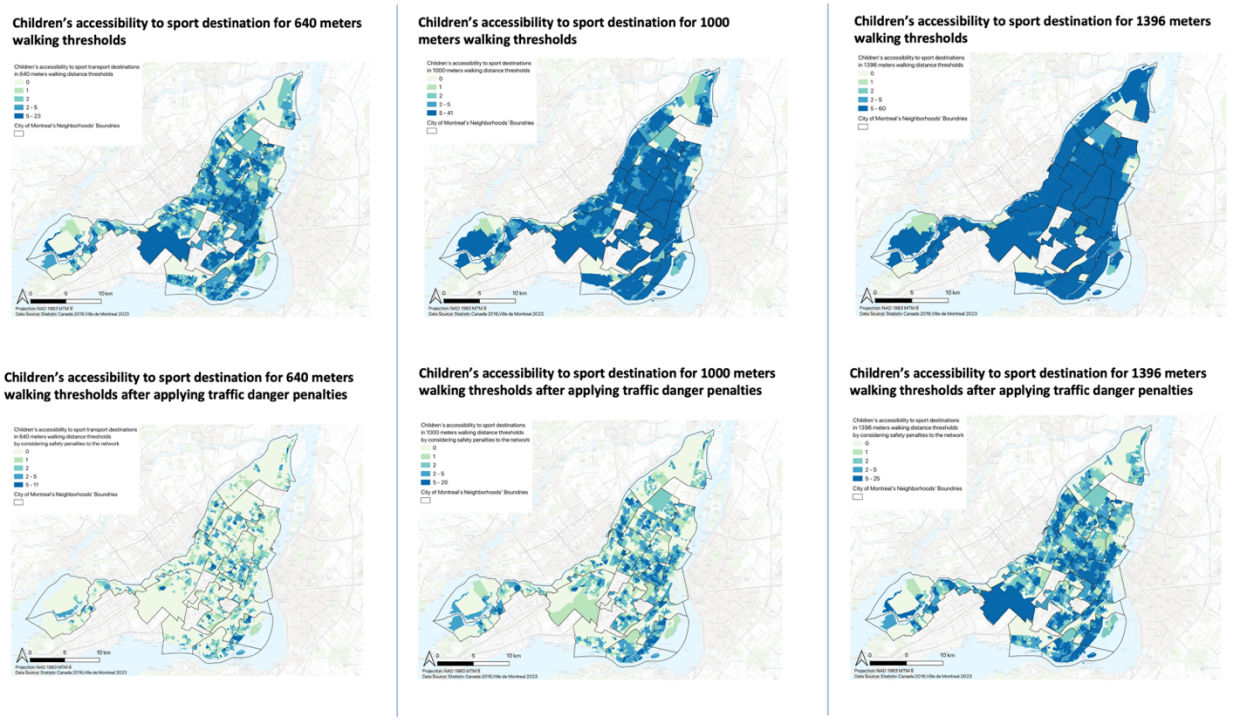


Figure 5-7 Children's accessibility to sport destinations within three walking distance thresholds without (up) and with (down) applying traffic danger penalties to the segments

5.2.7 Public Transport Destinations

After applying the penalties to the segments, the number of available destinations for children drops to two in central boroughs and zero in almost all the peripheral neighborhoods. In a 640-meter walking distance, the percentage of DAs with zero opportunities increases from 72.62% before applying traffic danger to 92.62% after applying traffic danger. Within a 1000-meter walking distance, this percentage increases from 55.43 to 85%. Similar results can be found for a 1396-meter walking distance, where the percentage rises from 40.2% to 75.8%. Figure 5.8 reflects children's accessibility to public transport destinations within different walking distance thresholds.

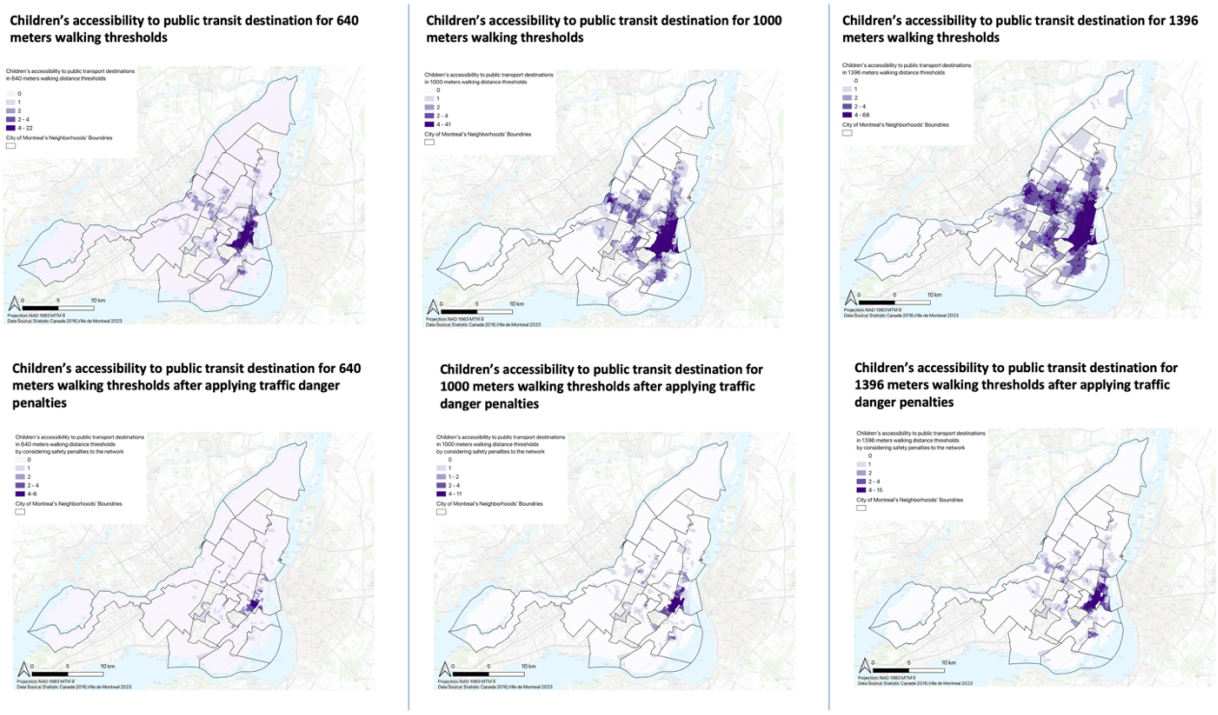


Figure 5-8 Children's accessibility to public transport destinations within three walking distance thresholds without (up) and with (down) applying traffic danger penalties to the segments

5.3 Wilcoxon Signed Rank Test

To test whether the accessibility results are statistically different before and after adding traffic safety penalties for each category of destinations, the Wilcoxon signed rank test was used. Essentially, this test is equivalent to a parametric paired t-test in nonparametric form of the data (Scott, 2008). Also, for repeated measures where the same subjects are evaluated under two different circumstances, this test is highly appropriate (Hallgrimsdottir et al., 2016). As such, each category of destinations, with and without applying traffic danger penalties is considered as a pair to observe the difference in accessibility before and after adding penalties to the segments. Also, for this analysis the minimum and the maximum number of accessible destinations to each destination type was used to reflect to what extent an accessibility measure changes for the extremes. Therefore, the result has not been normalized. Table 5.6 presents the results of Wilcoxon signed rank test. In the Wilcoxon signed rank test, the test statistic (V) indicates how much the two scenarios differ or differ from each other.

Table 5-6 Wilcoxon signed rank test

Wilcoxon signed rank test with continuity correction			
640 (meters) Walking Distance Thresholds			
Variable 1	**Variable 2**	**Test Statistic (V)**	**p-value**
Accessibility for Commercial destination without penalties	Accessibility for Commercial destination with penalties	3265290	< 0.001
Accessibility for Educational destination without penalties	Accessibility for Educational destination with penalties	3161355	<0.001
Accessibility for Green destination without penalties	Accessibility for Green destination with penalties	2588950	<0.001
Accessibility for Leisure destination without penalties	Accessibility for Leisure destination with penalties	3563115	<0.001
Accessibility for Social destination without penalties	Accessibility for Social destination with penalties	1386945	<0.001
Accessibility for Sport destination without penalties	Accessibility for Sport destination with penalties	2963395	<0.001
Accessibility for Public Transport destination without penalties	Accessibility for Public Transport destination with penalties	222111	<0.001
1000 (meters) Walking Distance Thresholds			
Variable 1	**Variable 2**	**Test Statistic (V)**	**p-value**
Accessibility for Commercial destination without penalties	Accessibility for Commercial destination with penalties	3714175	<0.001
Accessibility for Educational destination without penalties	Accessibility for Educational destination with penalties	3711450	<0.001
Accessibility for Green destination without penalties	Accessibility for Green destination with penalties	3605955	<0.001
Accessibility for Leisure destination without penalties	Accessibility for Leisure destination with penalties	3851700	<0.001
Accessibility for Social destination without penalties	Accessibility for Social destination with penalties	2414503	<0.001
Accessibility for Sport destination without penalties	Accessibility for Sport destination with penalties	3711450	<0.001
Accessibility for Public Transport destination without penalties	Accessibility for Public Transport destination with penalties	650370	<0.001

Table 5-6 Wilcoxon signed rank test (continued)

Wilcoxon signed rank test with continuity correction			
1396 (meters) Walking Distance Thresholds			
Variable 1	**Variable 2**	**Test Statistic (V)**	**p-value**
Accessibility for Commercial destination without penalties	Accessibility for Commercial destination with penalties	3857253	<0.001
Accessibility for Educational destination without penalties	Accessibility for Educational destination with penalties	3873936	<0.001
Accessibility for Green destination without penalties	Accessibility for Green destination with penalties	3835065	<0.001
Accessibility for Leisure destination without penalties	Accessibility for Leisure destination with penalties	3913003	<0.001
Accessibility for Social destination without penalties	Accessibility for Social destination with penalties	3234696	<0.001
Accessibility for Sport destination without penalties	Accessibility for Sport destination with penalties	3876720	<0.001
Accessibility for Public Transport destination without penalties	Accessibility for Public Transport destination with penalties	1256905	<0.001

According to the results (Table 6.4), all comparisons between the variables without and with traffic safety penalties are highly significant ($p<0.001$) for all three walking distances to multiple destinations for children. Figure 5.9 reflects the magnitude of the test statistic (V) among all three distances and for all the categories of destinations. (As it was discussed before, each category of destinations with and without considering traffic measure's penalties is considered as a pair group to reflect the difference.)

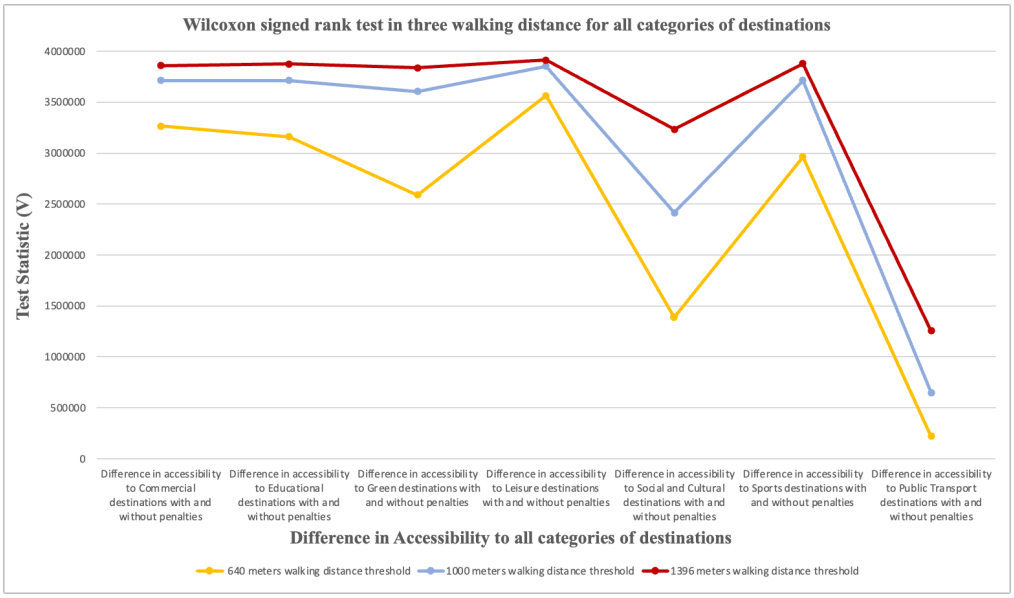


Figure 5-9 The magnitude of the test statistic (V) among all three distances and for all the categories of destinations

According to the Figure 5-9 accessibility to leisure destinations has the highest difference among all three walking distances, whereas accessibility to public transport destinations has the lowest difference. The next highest difference in 640 and 1000-meter walking distance is related to commercial, education, and sports destinations. This order changes for 1396 meters walking distance to sports, education, and then commercial destinations. The test statistics found in this study further support that taking traffic safety penalties into account led to a significant shift in accessibility measures, confirming the statistical significance of the results.

5.4 Discussion and Results of Analysing Different Walking Distance in Measuring Children's Accessibility

As 640 meters is a short walking distance primarily for children of younger ages (Cervesato & Waygood, 2019), the most accessible destinations after applying traffic danger penalties to the segments are the ones which could be called "local places". These destinations are mainly for leisure (playgrounds, fast foods, etc.), commercial (including convenience stores and groceries), and educational (schools). However, adding penalties on segments limited activities and the available opportunities to specific destinations for younger children. For example, there is a decrease in accessibility to some destinations that are distributed more in the central part of the city and not necessarily equally distributed in neighborhood levels, such as social and cultural places (museums for example), or public transit (metro and train stations). Considering that these types of destinations are not necessarily located in residential areas, children's accessibility is likely considerably impacted by the presence of dangerous streets (main arterial road with higher speed limit).

After applying traffic danger penalties to the segments, the commercial, leisure, and educational destinations have the highest accessibility for children using 1000 m. More detailed results for the measures at 1000 m are presented in Chapter 5.

The 1369-meter threshold primarily applies mainly to older children between 11 to 12 years old (Morency et al., 2020). According to Cervesato and Waygood (2019) in Quebec City, the threshold for independent trips during the week was 0.64 km (on foot), but increased to 1.71 km (on foot) at the weekend (Cervesato & Waygood, 2019). This might suggest that the weekday result is likely more a result of elementary schools being close as a primary destination during the week. In contrast, the weekend distances might more accurately show children's capacity to travel to non-school destinations independently.

The different distances did not significantly impact the expected (based on area ratios) results when traffic danger is applied to measure the accessibility. In addition, accessibility increases proportionally with expected outcomes when larger areas are considered. Therefore, as explained earlier, this part suggests that using different distances has no significant impact beyond what would be expected. Based on the distance comparisons, we can suggest using a reasonable distance

for measuring children's walking accessibility, although future analysis may require for further analysis.

CHAPTER 6 ARTICLE 2: "WHERE DO CHILDREN GO?" EXPLORING CHILDREN'S DAILY DESTINATIONS WITH CHILDREN, PARENTS, AND EXPERTS

Zahra Tavakoli[a], Owen Waygood[a], Shabnam Abdollahi[a], Antonio Paez[b].

Accepted for Publication on August 30, 2024, in the:

Urban Planning

Abstract

Background: Research on children's destinations have primarily focused on school trips, yet their lives are more than that. Different destinations contribute to children's quality of life in different ways, but this is rarely examined.

Objective: Focus groups were conducted with different stakeholders to better understand non-school destinations by addressing two key questions: identifying common daily and informal destinations and perceptions of how they relate to children's well-being.

Methodology: Online focus group discussions were conducted with children (aged 8-12), parents (with children aged 7-13), and experts from different cities across Canada in May and June 2023 to obtain diverse opinions about children's destinations. The analysis was conducted based on a prior review to categorize children's destinations, identify informal destinations, green and grey places, and the relation between those destinations to children's well-being.

Results: Discussions with parents, children, and experts highlighted the diversity of destinations relevant to children. Leisure destinations were one of the most mentioned in the discussions. Spaces without specific rules or structures were identified by experts as beneficial for children's cognitive, social, physical, and psychological health. Parents mentioned primarily formal places, whereas children and experts mentioned primarily informal ones. Green destinations were more associated with physical well-being, though children dominantly associated green destinations with psychological well-being as well. All groups dominantly associated grey type destinations with social and cognitive well-being. Using these results, urban planners can develop strategies to improve children's access to their daily destinations that support their well-being.

Keywords

Children’s destinations; Children’s travel; Non-school trips; Focus group; Health and well-being

6.1 Introduction

Children’s travel destinations differ from adults’ due to the distance that they can travel, their walking speed and their autonomy (Cervesato & Waygood, 2019; Cordovil et al., 2015). Therefore, their travel is often much more local. Also, children’s travel can be limited by a number of factors including parents' concerns about traffic safety (Tavakoli et al., Under Revision; Waygood et al., 2020; Waygood, Olsson, et al., 2017); social safety concerns such as “stranger danger” (Fyhri et al., 2011; Mitra, 2013); the existence of sidewalks or the design of streets (Ewing et al., 2004; Mitra, 2013); and the quality of residential blocks (McMillan, 2007; Mitra, Rn., & Faulkner, 2010).

Despite children's trips being more likely to be local, recent research on children's independent travel to non-school destinations suggests that studies should not focus only on school trips (Desjardins et al., 2022). Prior research has found a wide range of destinations where children travel such as outdoor spaces, shopping destinations, relatives’ homes, and buildings with indoor activities (Babb et al., 2017). These studies identified a broad range of destinations beyond home and school, emphasizing that access to diverse daily destinations within a reasonable distance enhances children's mobility (Kyttä, 2004). Children's destinations can also be viewed as green (natural) or grey (man-made) spaces, allowing different activity types. Green spaces are often open spaces that are predominantly natural. These places promote cognitive functioning, mental health benefits, community engagement, and physical activity (Russo & Andreucci, 2023; Vidal & Castro Seixas, 2022). Also, children's spatial experiences and growth are facilitated by man-made or grey destinations that extend their everyday structured environments (Broberg et al., 2013). In addition to promoting exploration, play, and environmental awareness, natural and built environments can meet children's diverse needs.

Having the opportunity to travel to a variety of daily destinations for children is linked to different aspects of well-being domains (Pollard and Lee, 2003), including the physical domain (e.g., physical activity and exercise), psychological domain (e.g., mental, and emotional health), cognitive domain (e.g., learning and exploration), and social domain (e.g., interactions, social

capital, and community connections). In this way, the ability to travel to non-school destinations can contribute to different aspects of their well-being.

A prior scoping review (Desjardins et al., 2022) about non-school destinations for children found that researchers have used a variety of methodologies to identify where children travel. Some commonly used methods are: using questionnaires (Badland et al., 2015; Egli et al., 2020), GPS tracks (Babb et al., 2017) and mapping activities with SoftGIS (Kyttä et al., 2012; Kyttä et al., 2018) or accessibility tools (Badland et al., 2015). However, an important point to note is that many informal destinations may not have been captured in the mentioned methods. These destinations can be gathering spots, hidden play areas, or undiscovered corners of the neighborhood that children frequently go but do not always receive attention in research studies that use formal classifications. Creating child-friendly environments that promote healthy development and active lifestyles requires an understanding of the types of destinations children prefer, whether they are formal or informal, natural, or artificial. In-depth discussions such as focus groups with diverse stakeholders might be one method that could help give a more comprehensive understanding of where children go.

There are two main gaps in current literature regarding child-relevant destinations and their impact on well-being. First, there are valuable insights about how children relate to the environment from research on appropriation (how children make their "own space"), children's placemaking (active shaping of environments) (Lynch, 1981), affordances (environmental features enabling or restricting action) (Kyttä, 2004), or children's activity spaces or territorial range (Babb et al., 2017). However, those studies mostly relied on mapping activities to identify children’s meaningful destinations—something that, as previous studies suggest, can miss destinations that are not documented in GIS data or captured well by a list of formal destinations (Babb et al., 2017; Badland et al., 2015; Broberg et al., 2013; Desjardins et al., 2022). These informal places relate to informal play areas, neighborhood alleys, or friends' houses that likely play an important role in children’s daily lives. Therefore, it is necessary to investigate and recognize these types of destinations to gain a fuller understanding of how they impact children's daily experiences.

Secondly, the relationship between child-relevant destinations and all well-being dimensions has yet to be fully explored and categorized in detail in current state of research. The twin topics of physical well-being (Yang et al., 2023) and social well-being (Gong et al., 2024) have recently

been discussed, but those studies have analyzed only one or two facets of well-being out of several possibilities, and this from the perspective of parents rather than that of children. However, children's perspectives should also be considered, since their opinions may differ from parents' (Smeds et al., 2023). Therefore, it is necessary to understand how different child-relevant destinations relate to well-being more holistically, and from the perspective of different stakeholders to obtain a fuller understanding of children's experiences and needs. Applying this approach could help urban planning and policymaking to create environments that promote children's development and well-being.

Focus groups with diverse stakeholders offer the opportunity for gaining a better understanding of children's destinations and how those destinations might be associated with multiple aspects of well-being. Using this method, several studies have either focused on the perspectives of children (Furneaux & Manaugh, 2019), or both parents and children at the same time (Ergler et al., 2013). Other research conducted focus groups with experts or parents to understand their perspectives on child-related topics (Adler et al., 2019; Vogl, 2023). However, as of yet, no comprehensive comparison of perspectives from children, parents, and experts has been conducted to cover where children go and how those destinations might be related to multiple well-being domains. In particular, the perspectives of children in terms of the places they visit (especially without supervision) might be different and their perspective should be captured. The characteristics of those places are not typically analyzed, in particular whether they are green (natural) or grey (human-made) spaces. In this way, it is possible that parents may focus on children's organized activities, whereas children (when in control) might focus more on less formal, more local destinations. Whether or not there would be differences in the characteristics of those places with respect to being formal/informal or being natural or human-made is not typically analyzed. Experts bring specialized knowledge and broader perspectives to studies on children's destinations, but it is not clear how their opinion might relate to both parents and children's. Experts might identify issues and barriers that parents and children may not mention or be aware of, offering evidence-based recommendations, and ensuring the findings are based on proven strategies. Therefore, it is crucial to engage a wide range of stakeholders. The results of focus groups can be used to identify important destinations that children would like to access or need to access, as well as areas that need specific attention.

The objective of this research is to identify the non-school destinations for children between the ages of 7-13 in a Canadian context. Through these discussions, two key questions are considered:

1)What are the most common daily destinations and informal places that children travel to?

2)How might these daily destinations relate to the different domains of children's well-being?

The focus group approach involving relevant stakeholders will explore the most relevant daily and informal places frequented by children, shedding light on previously unaddressed aspects of children's travel destinations. This study focuses on understanding how different stakeholders relate various destinations to well-being's dimensions.

This paper is organized as follows: the next section presents the methodology for conducting each focus group, followed by the results of each group. Next, a discussion section covers the overall contributions of the research, and finally, the paper concludes with our findings.

6.2 Methodology

Focus groups serve as a foundational approach to exploring participant perspectives and enriching our understanding of their needs (Adler et al., 2019). They facilitate an environment where participants are encouraged to present their viewpoints, share experiences, and actively engage in discussion (Adler et al., 2019). Therefore, using focus groups to capture real response could provide a deeper understanding of children's needs in terms of identifying their daily destinations.

Focus groups were conducted separately with the different stakeholder groups: primary stakeholders (children and parents), complemented by experts actively involved in children's independent travel and built environment impacts on children's mobility. The focus groups enhance participant interaction and discussion beyond individual interviews, providing a platform for diverse perspectives (Adler et al., 2019). Figure 6.1 summarizes the process. Details of each step are described below.

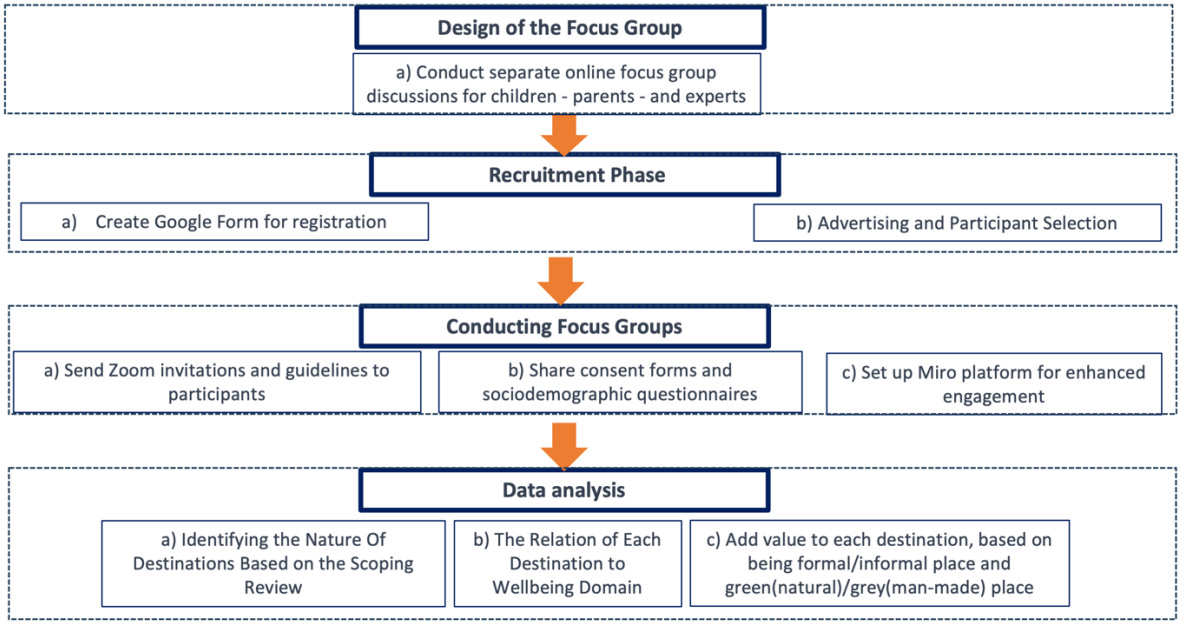


Figure 6-1 Summary of focus groups' process

6.2.1 Design of the Focus Groups

Selecting stakeholders with significant input on children's destinations was the first step in designing the focus groups (Banville et al., 1998; Marais & Abi-Zeid, 2021). Given the multiple stakeholder groups (Banville et al., 1998), both "standard" and "fiduciary" stakeholders have an important role in addressing children's travel and accessibility to their daily destinations:

"Standard stakeholders" are individuals directly affected by and influencing the problem who have substantial influence on solutions (Banville et al., 1998). We primarily involve planners, parents, and children between the ages of 8-12 because of their direct connection to the research.

"Fiduciary stakeholders," representing individuals acting on their behalf (Banville et al., 1998). While they may influence how a problem is solved, they are not personally affected. The example of this type of stakeholder could be individuals who are engaged in the decision-making process (planners or local child-safety associations) (Banville et al., 1998). Through their involvement, the findings of the study can be translated into practical, actionable strategies to improve children's access to destinations that are beneficial for their health and well-being. Often, experts are directly involved in formulating and implementing policies, which makes their participation important to understand the practical implications of research findings, as well as to develop interventions that

can be effectively integrated into existing frameworks. Also, since experts are exclusively adults, it was important to understand the differences between their perspectives and children's perspectives. Getting such feedback can improve professionals' understanding of the topic. Further, since previous research had not related destinations to well-being domains, and part of the objective of this research was to find out whether there were differences in how experts, compared to children and parents, assigned destinations to well-being.

Including both "standard" and "fiduciary" stakeholders ensured a comprehensive view, incorporating perspectives and influence of those directly affected and those advocating for them.

Five online focus groups were conducted in May-June 2023: with children (age 8-12) and parents of children (age 7-13) in English and French, and with experts from various Canadian cities in English.

6.2.2 Recruitment Steps

Participants were recruited through various social media platforms including Facebook, LinkedIn, and Twitter (now called X) in March and April 2023. Parents and children were offered a $CAD 25 certificate compensation, while experts were not offered a certificate. Two separate Google form surveys were used: one for children/parents to gather information on location and children's ages, aiming for respondents with varied experiences; and another for experts to identify their roles as professionals, academics, or involved in non-profit initiatives, advocacy, etc. It was possible to go from one form to the other. With the objective to obtain different professional perspectives, experts were asked to specify fields like engineering, urbanism, geography, psychology, sociology, politics, education, etc.

Overall, 166 responses were received from French and English parents. Parents and children were then randomly selected from different urban areas and age groups. 37 expert responses were gathered. With participants' permission, the focus groups were recorded. Doodle polls facilitated scheduling separate focus groups for children, parents, and experts, ranging from 4-10 participants each. With participants' permission, the focus groups were recorded.

An online whiteboard and presentation tool called Miro was used to facilitate active participation in the discussions along with Zoom to allow for verbal communication. For all groups, a short

demonstration on using Miro to add "sticky notes" was given, followed by a few minutes for participants to practice, ensuring everyone could provide input. When needed, alternatives such as typing in the Zoom chat were used and an assistant input the ideas on Miro.

At this point, an issue arose with the initial broad "cast the net wide" recruiting approach for parents and for children discussion groups. Despite requiring computer participation for better Miro facilitation, many individuals joined the first meeting on mobile phones, limiting their engagement. This only resulted in some limitations in the amount of information that could be gathered, and the information was valid and retained. In contrast, in the children's focus group, it became apparent that participants were actually adults on phones not the expected children. It became evident some joined just to claim the gift certificate and were not “honest” participants. Therefore, the recruitment approach changed, and the data of the children’s session is not included. Parents who had participated in a recent study on children in Montreal by researchers not involved in this research were solicited. Also, using the researchers’ networks, friends were requested to advertise to people that the researchers did not know (to limit bias).

All stakeholders were tasked with assigning the different destinations to the well-being domains to a) test whether they are understanding this categorization approach; b) examine how they see these destinations impacting children’s lives.

In all five sessions, the moderators encouraged all participants to actively contribute to the discussion. Participants were invited to use as many sticky notes as they wanted to list different destinations, and they could return to add new places if they remembered any additional ones. The approach used (an online whiteboard) allowed for parallel contributions, meaning that participants could contribute at the same time without being unduly influenced by others. The moderators then asked the participants to expand on contributions that were not evident. The moderators further made a point of directly asking participants who were not voicing their contributions as frequently (everyone contributed quite a few sticky notes in each round).

6.2.2.1 Parents’ Focus Group

Using the second approach, separate meetings took place with 10 French-speaking parents from Montreal and 4 English-speaking parents from Vancouver (1 person), Montreal (2 persons), and Saskatoon (1 person). The parents’ sessions lasted approximately 90 minutes. Table 6.1 provides the description of participants in the meeting with parents

Table 6-1 The description of participants in the meeting with parents

Parents (n=14)	**Percentage**
Location	
Montreal	85.7%
Saskatoon	7.1%
Vancouver	7.1%
Parents' Age Range*	
35-44	57%
45-54	36%
Child's age*	
7 years old	7%
8 years old	14%
9 years old	14%
10 years old	29%
11 years old	21%
12 years old	7%
Gender*	
Female	71%
Male	14%
Other	7%
Education Level*	
Certificate or diploma from a college, CEGEP, or other non-university institution	7%
Bachelor's degree	50%
Master's degree (For example M.A., M.Sc., M.Ed., M.B.A.)	29%
Doctoral degree (i.e., Ph.D.)	7%
Ethnicity*	
Other North American origins	7%
European origins	50%
Latin, Central, and South American origins	7%

Table 6-1 The description of participants in the meeting with parents (continued)

Parents (n=14)	**Percentage**
Ethnicity*	
Other North American origins	7%
European origins	50%
Latin, Central, and South American origins	7%
Work Status*	
Full time	86%
Student	7%
Total annual household income before tax*	
I prefer not to answer	7%
$30,000 to $49,999	21%
$75,000 to $99,999	21%
$100,000 to $150,000	14%
Parents' residential location in urban setting	
Center of the city	64%
Periphery	36%
Preferred language	
English	29%
French	71%

***** As a result of respondents not answering all questions, the total percentage do not equal 100% in some cases.

The first question asked about the diversity of destinations related to children's travel:

Where do your children typically go during a week (excluding vacation trips and such)? We would like to know about the diversity of the destinations!

To build on each other's ideas, the question was asked three times to collect as many responses as possible. To prevent parents from influencing one another at the start, they were given 5 minutes to enter their ideas before their notes were shown to others. The scoping review summary was then shown to parents (Desjardins et al., 2022). Parents were then asked if any new ideas had occurred to them.

Second part of the discussion explained how different destinations could support children's well-being. Four main dimensions of well-being that relate to children's travel were introduced (Waygood et al., 2020; Waygood, Olsson, et al., 2017):

Physical well-being: Anything that involves movement contributes to physical well-being, with a preference given to heart rate raising and physical health development.

Psychological well-being: Refers to individuals' emotions and feelings as well as their mental health development.

Cognitive well-being: Children's cognitive well-being includes discovering their world (formal and informal) and developing their intellectual abilities.

Social well-being: Consists of social connections with friends and the wider community.

Finally, parents were asked to categorize the destinations based on their perceptions.

6.2.2.2 Children's Focus Group

Interviews were conducted separately in two sessions with 7 French-speaking (from Montreal) and 4 (2 from Saskatoon, one from Montreal and one from Vancouver) English-speaking children. Group discussions with children designed for one hour. Table 6.2 provides the information about children who participated in the discussion.

Table 6-2 The description of participants in the meeting with children

Children (n=11)	**Percentage**
Location	
Vancouver	9.09%
Montreal	72.73%
Saskatoon	18.18.%
Child's age	
7 years old	0%
8 years old	9%
9 years old	9%
10 years old	45%
11 years old	27%
12 years old	9%
Gender	
Female	36%
Male	64%
Other	0%
Residential location in urban setting	
Center of the city	55%
Periphery	45%

Table 6-2 The description of participants in the meeting with children (continued)

Children (n=11)	**Percentage**
Preferred language	
English	36%
French	64%

Children's Focus Group sessions needed a specific methodological and ethical approach. In terms of methodology, we made sure children felt comfortable and were able to express themselves freely. To facilitate understanding and keep the children interested, we used simple language and engaging slides. Also, interactive activities (such as asking questions within the context of games) helped facilitate discussion. To meet ethical standards, it was mandatory to obtain the informed consent of the children and their parents before each session. As the focus groups were online, this likely gave parents a greater sense of safety as the child remained at their home, the parent was the one who received the link, and they could keep “one ear open” to judge the appropriateness of the discussion.

The research questions were simplified and asked through games to encourage children's participation. Two different questions were asked about places children like to go:

- It's a game! Please tell us what are your favorite places that you go to. You have 2 minutes to reply!
- Are there places you would like to go to that we didn’t mention? These need to be real options for a normal week - so nothing like "Disneyland!"

For each well-being domain, children were asked specific questions to identify how various destinations contribute to their well-being.

Social well-being:

- Other than school, where are the places you meet and hang out with your friends to have some fun, play or talk? Where are the places that you meet other people? Like neighbors or even adults that you don't really know but maybe you chat with.

Psychological well-being:

- Where are the places that you make you happy? Where are the places that you make you relaxed? Where are the places that you make you excited?

Cognitive well-being:

- Other than school, where do you learn about things? Or discover your surroundings? This can be by yourself, with friends, or learning from adults.

Physical well-being:

- Of the places we talked about, where do you move a lot? We mean, more than just walking – it can be dancing, hiking, anything that makes you breathe a little hard.

6.2.2.3 Experts' Focus Group

Six people participated in the expert meeting. The experts worked in the domains of (public transport, community engagement, active travel). They were a mix of professionals (4) and academics (2). A 90-minute discussion was held with the expert group. Using the "hidden" sticky note approach, the first question gathered diverse destination perspectives from the experts:

Where do children typically go during the week (excluding vacation trips and such)? We would like to know about the diversity of the destinations.

Experts were also asked about informal destinations for children. The objective was to focus on non-structured places that children use for play or leisure that are not (generally) identified by geographic information systems (GIS). The previous review about non-school destinations was discussed (Desjardins et al., 2022), and accordingly, experts were asked if there were additional destinations that they could remember to add.

Next, the discussion focused on how the mentioned destinations could support children's health across the four well-being domains. The experts assigned destinations to the domains and discussed any ambiguous or multi-domain ones.

6.2.2.4 Data Analysis

The qualitative focus group data analysis proceeded as follows:

1) Categorization of Destinations:

-Participants frequently mentioned specific names of places (e.g., parks, grocery stores, ice cream shops) in different discussions. Data was categorized and grouped based on the categories identified in the scoping review's typology (commercial, leisure, educational, green, social/cultural, sports, public transport). This step will ensure that the data reflected the real conditions as expressed by the stakeholders.

- Accurate categorization was ensured by multiple rounds of verification.

2) Assignment to Well-Being Domains:

- Participants assigned each destination to one or more well-being domains: physical, psychological, cognitive, and social.
- Multi-domain classification allowed to capture the diverse impacts of each destination.
- The assignments were reviewed with participants' when it was not clear.

3) Examination of Destination Characteristics:

- Destinations were assessed to determine if they were formal (structured activities) or informal (unstructured activities).
- Destinations were also classified as green (natural spaces) or grey (human-made environments).

6.3 Results

6.3.1 Identifying the Nature of Destinations Based on the Scoping Review

This step aimed to categorize the destinations by their nature, based on descriptions from parents, children, and experts. For places children identified by name - such as Crèmerie (an ice cream shop), Renaissance (a thrift store), Volcano Island (a water park) - they were asked follow-up questions about the purpose and activities there to determine the appropriate category. Figure 6.2 shows the Miro application board that parents, children, and experts wrote their ideas on.

1.a Miro board related to the question that where children go on their daily basis for parents

1.b Miro board related to the question that where children go on their daily basis for children

1.c Miro board related to the question that where children go on their daily basis for experts

Figure 6-2 Miro board related to the question about where children go on for parents(left), children(middle), and experts (right)

Next, the classification results of destinations are presented by stakeholder type.

6.3.1.1 Parents' Discussion

The destinations most frequently mentioned by parents were recreational activities, leisure places, children's sports activities, and various types of commercials. The destinations are presented by category in Figure 6-3.

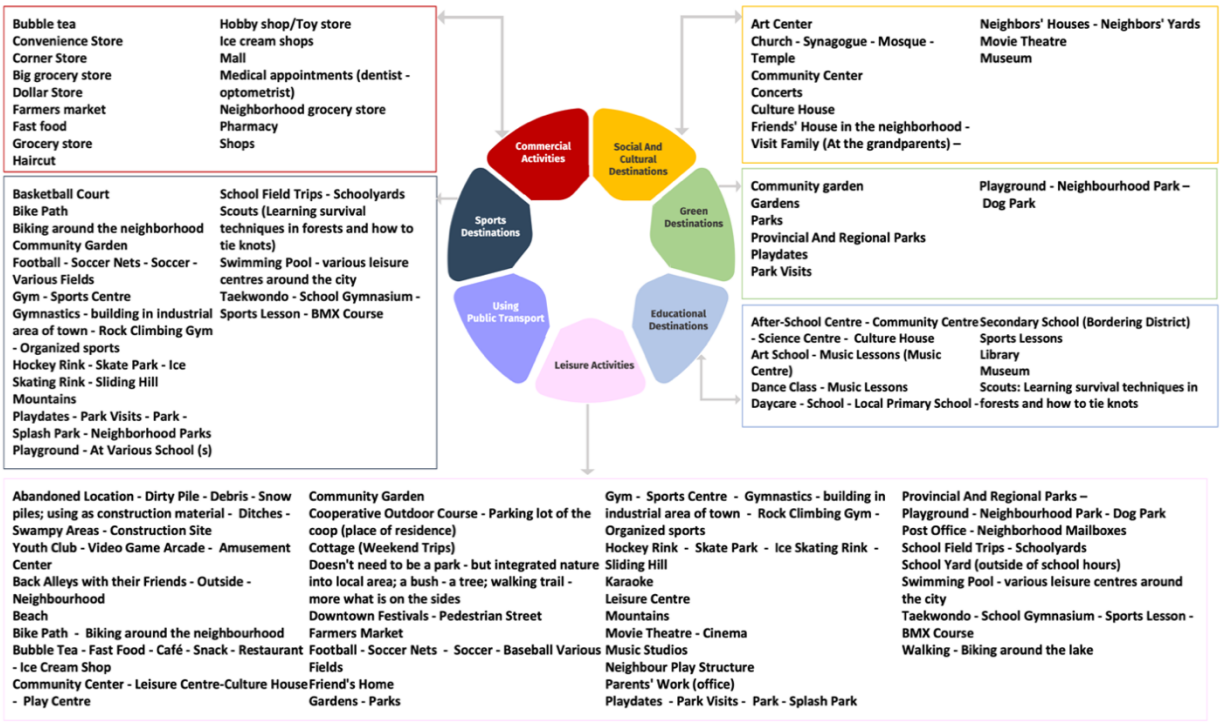


Figure 6-3 Categorizing destinations mentioned by parents

6.3.1.2 Children's Discussion

Children predominantly mentioned leisure places and green destinations like parks, playgrounds, fields, and rinks for sports activities. Figure 3.4 presents the destinations that mentioned by children.

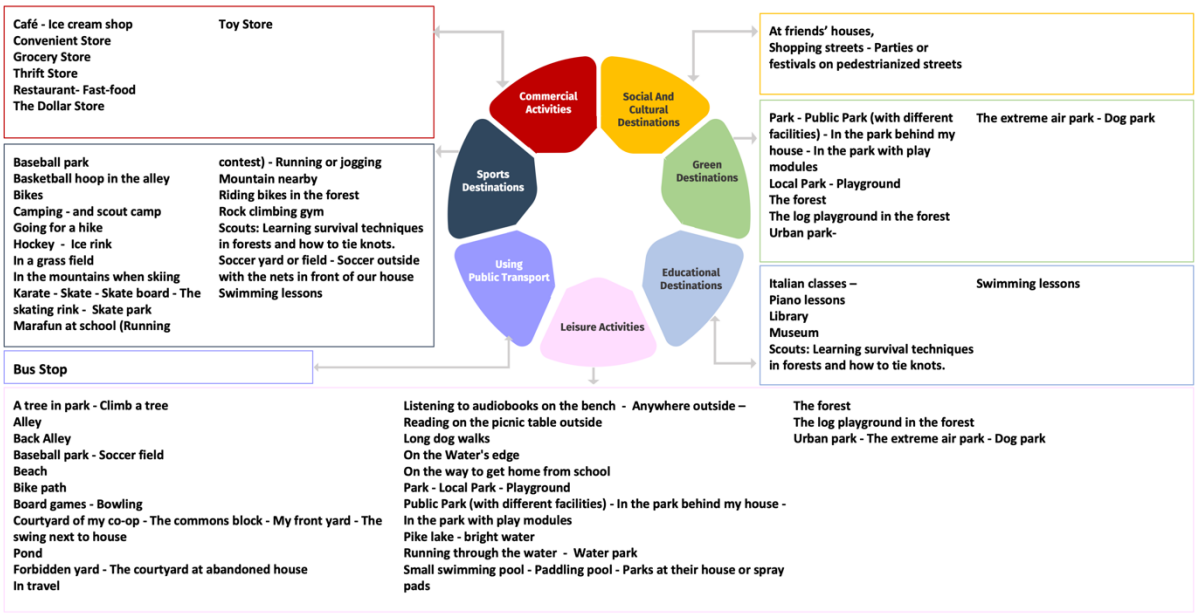


Figure 6-4 Categorizing destinations mentioned by children

6.3.1.3 Experts' Discussion

The expert discussion analyzed formal destinations children routinely visit for specific purposes (e.g. schools, grocery stores), and informal destinations children visit like empty lots, woodlots, yards, groves of trees, etc. The categorization of destinations mentioned by experts is shown in Figure 6.5.

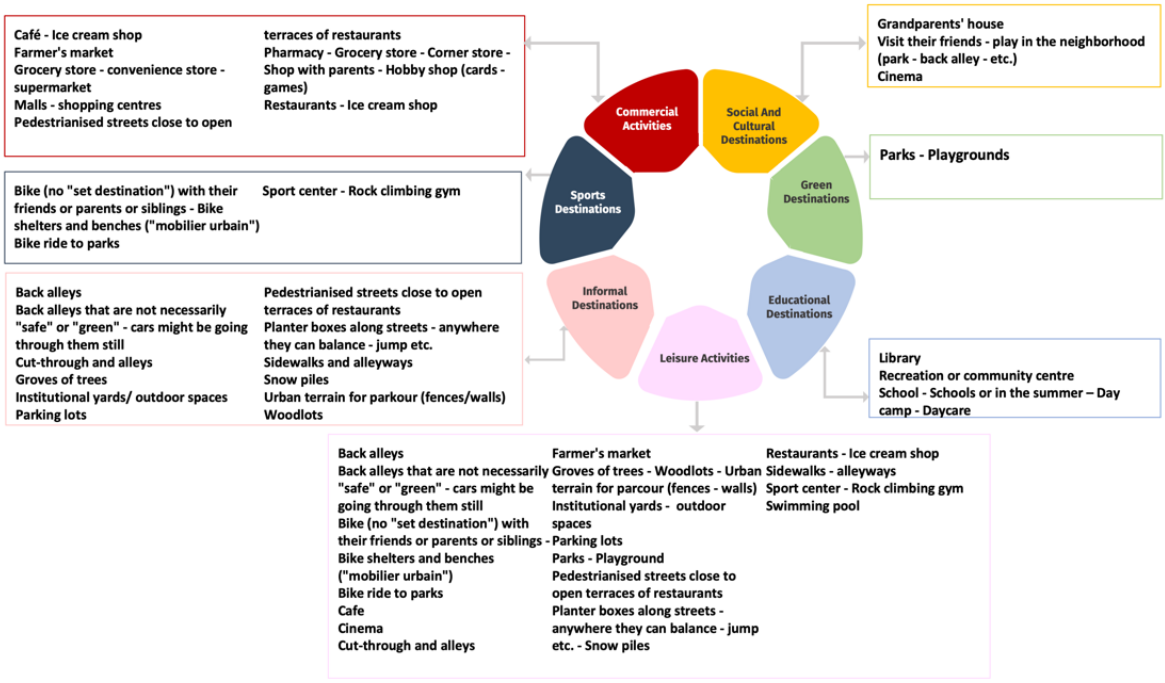


Figure 6-5 Categorizing destinations mentioned by experts

6.3.2 The Relationship of destinations to well-being domains and identifying formal/informal and green/grey destinations

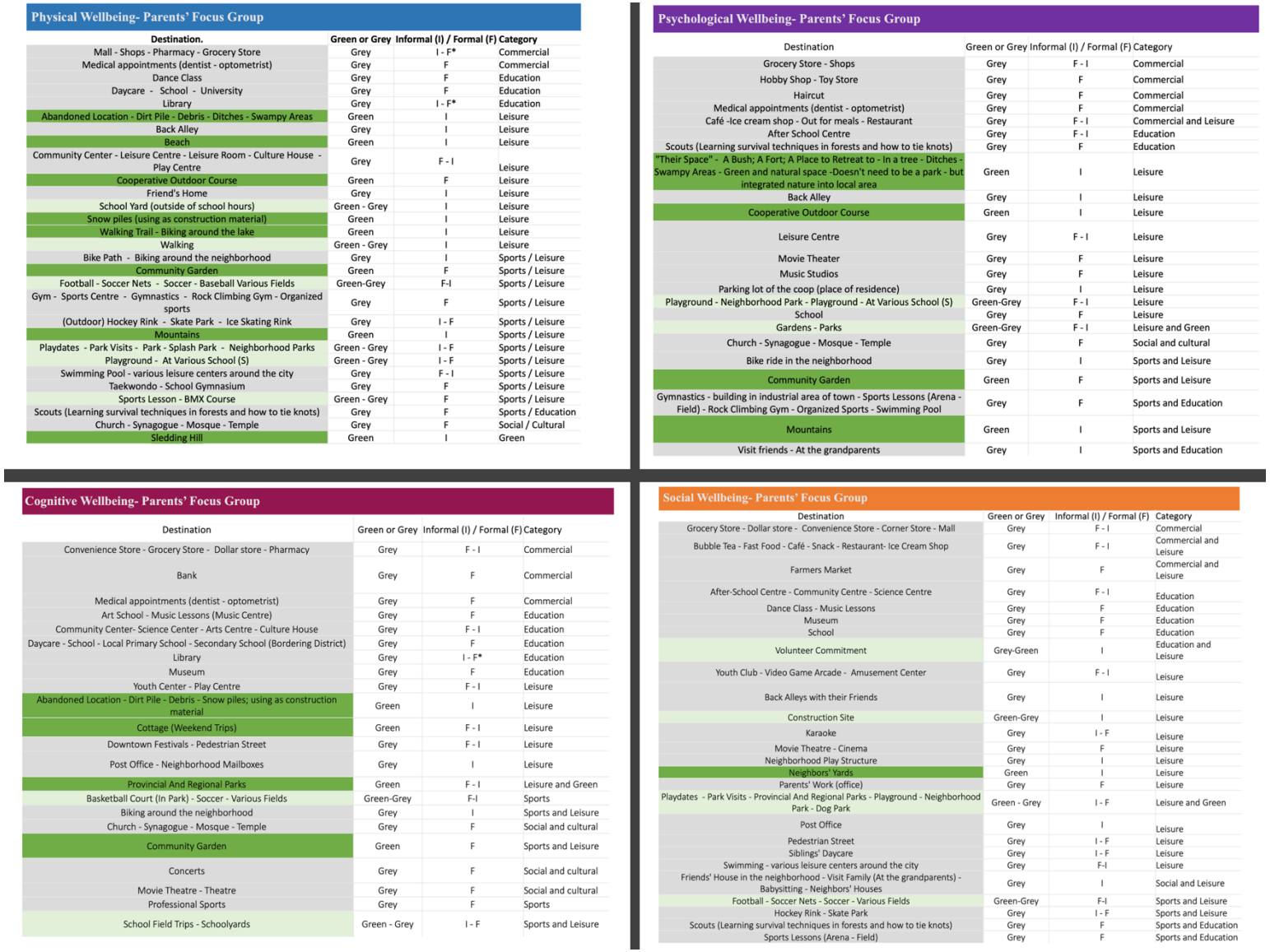
6.3.2.1 Parents' Focus Group

Parents predominantly mentioned formal locations which are primarily in grey (man-made) contexts. Across the different domains of well-being, formal destinations were consistently the most common (such as *dance class, school, daycare*), but the second most common was informal in the physical well-being domain (such as *friend's home, snow piles, mountains*), though some of those are a mix of formal and informal (e.g., *sports such as hockey rink, skate park, soccer nets* can be both).

For psychological destinations, they mentioned playing in playgrounds, back alleys, *parking lot of the residence,* or going to the places regarded as "their children's space" which were mostly associated with green and natural places.

Cognitive well-being was associated with grey and formal places like educational experiences such as school field trips, and library visits, as well as artistic pursuits such as visiting museums.

For social well-being activities, parents assigned community events at local centers, and having outdoor playdates to that section. Figure 6.6 presents the results of discussion with parents and the category of each destination that it is assigned to



Physical Wellbeing- Parents' Focus Group

Destination.	Green or Grey	Informal (I) / Formal (F)	Category
Mall - Shops - Pharmacy - Grocery Store	Grey	I - F*	Commercial
Medical appointments (dentist - optometrist)	Grey	F	Commercial
Dance Class	Grey	F	Education
Daycare - School - University	Grey	F	Education
Library	Grey	I - F*	Education
Abandoned Location - Dirt Pile - Debris - Ditches - Swampy Areas	Green	I	Leisure
Back Alley	Grey	I	Leisure
Beach	Green	I	Leisure
Community Center - Leisure Centre - Leisure Room - Culture House - Play Centre	Grey	F - I	Leisure
Cooperative Outdoor Course	Green	F	Leisure
Friend's Home	Grey	I	Leisure
School Yard (outside of school hours)	Green - Grey	I	Leisure
Snow piles (using as construction material)	Green	I	Leisure
Walking Trail - Biking around the lake	Green	I	Leisure
Walking	Green - Grey	I	Leisure
Bike Path - Biking around the neighborhood	Grey	I	Sports / Leisure
Community Garden	Green	F	Sports / Leisure
Football - Soccer Nets - Soccer - Baseball Various Fields	Green-Grey	F-I	Sports / Leisure
Gym - Sports Centre - Gymnastics - Rock Climbing Gym - Organized sports	Grey	F	Sports / Leisure
(Outdoor) Hockey Rink - Skate Park - Ice Skating Rink	Grey	I - F	Sports / Leisure
Mountains	Green	I	Sports / Leisure
Playdates - Park Visits - Park - Splash Park - Neighborhood Parks Playground - At Various School (S)	Green - Grey	I - F	Sports / Leisure
Swimming Pool - various leisure centers around the city	Green - Grey	I - F	Sports / Leisure
Taekwondo - School Gymnasium	Grey	F - I	Sports / Leisure
Sports Lesson - BMX Course	Grey	F	Sports / Leisure
Scouts (Learning survival techniques in forests and how to tie knots)	Green - Grey	F	Sports / Leisure
Church - Synagogue - Mosque - Temple	Grey	F	Sports / Education
Sledding Hill	Grey	F	Social / Cultural
	Green	I	Green

Psychological Wellbeing- Parents' Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Grocery Store - Shops	Grey	F - I	Commercial
Hobby Shop - Toy Store	Grey	F	Commercial
Haircut	Grey	F	Commercial
Medical appointments (dentist - optometrist)	Grey	F	Commercial
Café -Ice cream shop - Out for meals - Restaurant	Grey	F - I	Commercial and Leisure
After School Centre	Grey	F - I	Education
Scouts (Learning survival techniques in forests and how to tie knots)	Grey	F	Education
"Their Space" - A Bush; A Fort; A Place to Retreat to - In a tree - Ditches - Swampy Areas - Green and natural space -Doesn't need to be a park - but integrated nature into local area	Green	I	Leisure
Back Alley	Grey	I	Leisure
Cooperative Outdoor Course	Green	I	Leisure
Leisure Centre	Grey	F - I	Leisure
Movie Theater	Grey	F	Leisure
Music Studios	Grey	F	Leisure
Parking lot of the coop (place of residence)	Grey	I	Leisure
Playground - Neighborhood Park - Playground - At Various School (S)	Green-Grey	F - I	Leisure
School	Grey	F	Leisure
Gardens - Parks	Green-Grey	F - I	Leisure and Green
Church - Synagogue - Mosque - Temple	Grey	F	Social and cultural
Bike ride in the neighborhood	Grey	I	Sports and Leisure
Community Garden	Green	F	Sports and Leisure
Gymnastics - building in industrial area of town - Sports Lessons (Arena - Field) - Rock Climbing Gym - Organized Sports - Swimming Pool	Grey	F	Sports and Education
Mountains	Green	I	Sports and Leisure
Visit friends - At the grandparents	Grey	I	Sports and Education

Cognitive Wellbeing- Parents' Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Convenience Store - Grocery Store - Dollar store - Pharmacy	Grey	F - I	Commercial
Bank	Grey	F	Commercial
Medical appointments (dentist - optometrist)	Grey	F	Commercial
Art School - Music Lessons (Music Centre)	Grey	F	Education
Community Center- Science Center - Arts Centre - Culture House	Grey	F - I	Education
Daycare - School - Local Primary School - Secondary School (Bordering District)	Grey	F	Education
Library	Grey	I - F*	Education
Museum	Grey	F	Education
Youth Center - Play Centre	Grey	F - I	Leisure
Abandoned Location - Dirt Pile - Debris - Snow piles; using as construction material	Green	I	Leisure
Cottage (Weekend Trips)	Green	F - I	Leisure
Downtown Festivals - Pedestrian Street	Grey	F - I	Leisure
Post Office - Neighborhood Mailboxes	Grey	I	Leisure
Provincial And Regional Parks	Green	F - I	Leisure and Green
Basketball Court (In Park) - Soccer - Various Fields	Green-Grey	F-I	Sports
Biking around the neighborhood	Grey	I	Sports and Leisure
Church - Synagogue - Mosque - Temple	Grey	F	Social and cultural
Community Garden	Green	F	Sports and Leisure
Concerts	Grey	F	Social and cultural
Movie Theatre - Theatre	Grey	F	Social and cultural
Professional Sports	Grey	F	Sports
School Field Trips - Schoolyards	Green - Grey	I - F	Sports and Leisure

Social Wellbeing- Parents' Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Grocery Store - Dollar store - Convenience Store - Corner Store - Mall	Grey	F - I	Commercial
Bubble Tea - Fast Food - Café - Snack - Restaurant- Ice Cream Shop	Grey	F - I	Commercial and Leisure
Farmers Market	Grey	F	Commercial and Leisure
After-School Centre - Community Centre - Science Centre	Grey	F - I	Education
Dance Class - Music Lessons	Grey	F	Education
Museum	Grey	F	Education
School	Grey	F	Education
Volunteer Commitment	Grey-Green	I	Education and Leisure
Youth Club - Video Game Arcade - Amusement Center	Grey	F - I	Leisure
Back Alleys with their Friends	Grey	I	Leisure
Construction Site	Green-Grey	I	Leisure
Karaoke	Grey	I - F	Leisure
Movie Theatre - Cinema	Grey	F	Leisure
Neighborhood Play Structure	Grey	I	Leisure
Neighbors' Yards	Green	I	Leisure
Parents' Work (office)	Grey	F	Leisure
Playdates - Park Visits - Provincial And Regional Parks - Playground - Neighborhood Park - Dog Park	Green - Grey	I - F	Leisure and Green
Post Office	Grey	I	Leisure
Pedestrian Street	Grey	I - F	Leisure
Siblings' Daycare	Grey	I - F	Leisure
Swimming - various leisure centers around the city	Grey	F-I	Leisure
Friends' House in the neighborhood - Visit Family (At the grandparents) - Babysitting - Neighbors' Houses	Grey	I	Social and Leisure
Football - Soccer Nets - Soccer - Various Fields	Green-Grey	F-I	Sports and Leisure
Hockey Rink - Skate Park	Grey	I - F	Sports and Leisure
Scouts (Learning survival techniques in forests and how to tie knots)	Grey	F	Sports and Education
Sports Lessons (Arena - Field)	Grey	F	Sports and Education

Figure 6-6 The color-coded categorization of children's destinations mentioned by parents, relating to well-being domains

6.3.2.2 Children's Focus Group

For physical well-being, children associated it with informal places such as a *basketball hoop in the alley, climbing on trees (in the alley), abandoned places (called forbidden yards), bike paths, beaches, and public parks: "In the park behind my house, in the play modules, in the mountains when skiing, the bike path, the pool, the park, the skating rink, at the pool, at beach"*. In the physical domain, children primarily mentioned informal locations, followed by transport-infrastructure and "destination" type places (typically requiring parental involvement and long-distance travel), without citing formal locations.

For social well-being, children again mentioned engaging in less formalized interactions than their parents by *visiting friends' houses, parks, randomly meeting people in the neighborhood, using playgrounds, and common areas within their residences*. Destinations such as areas for shopping, food, and drink were typically found in predominantly grey locations.

As for psychological well-being, children discussed going to a *café or ice cream shop* with their parents, or meeting a friend at a park that makes them happy or lying on the ground at the park to feel relaxed. Children's associations linked to social connections (friends, family) and relaxation (alone or with friends). Nature and water type destinations such as *lake, hiking, camping, in a grass fiel*d were the most commonly associated and were dominantly green. Other destinations are places to relax (on the water's edge), and shopping (convenience store or toy store), and some more formal places (museum).

For cognitive well-being, some children named *day camps (involving learning activities in a forest), libraries, Italian classes, Karate class, skating parks to observe others and learn from them, and outdoor ice rinks*. They mentioned a mixture of formal and informal learning environments where they can observe others and learn from them. These locations were more likely to be formal and grey.

Children's responses to each question regarding activities that support their well-being and the category of each destination that it is assigned to are shown in Figure 6.7.

Physical Wellbeing- Children's Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
A tree in park - Climb a tree	Green	I	Leisure
Alley	Grey	I	Leisure
Beach	Green	I	Leisure
Forbidden yard - The courtyard at abandoned house	Green	I	Leisure
Lake - bright water	Green	I	Leisure
Long dog walks	Green - Grey	I	Leisure
Park - Public Park (with different facilities) - In the park behind my house - In the park with play modules	Green - Grey (play infrastructure)	I	Leisure and Green
Pool	Grey	I - F	Leisure
Running through the water - water park	Grey	I	Leisure
Basketball hoop in the alley	Grey	I	Sports
Going for a hike	Green	I	Sports
In the mountains when skiing	Green - Grey	I - F	Sports
Marafun at school (Running contest) - Running or jogging	Green - Grey	F	Sports and Leisure
Riding bikes in the forest	Green	I	Sports and Leisure
Skate park	Grey	I - F	Sports and Leisure
Soccer field	Green - Grey	F - I	Sports and Leisure
Soccer outside with the nets in front of our house	Green - Grey	I	Sports and Leisure
The skating rink	Grey	F - I	Sports

Psychological Wellbeing- Children's Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Café - Ice cream shop	Grey	I - F	Commercial
Convenience Store	Grey	I - F	Commercial
Toy Store	Grey	F	Commercial
Cultist lake - Pond	Green	I - F	Leisure
Hiking	Green	I	Leisure
Listening to audiobooks on the bench - anywhere outside - Reading on the picnic table outside	Green	I	Leisure
Museum	Grey	F	Education
On the Water's edge	Green	I - F	Leisure
The log play ground in the forest	Green	I - F	Leisure and Green
Urban park - The extreme air park - Dog park	Green	I - F	Leisure and Green
Camping - and scout camp	Green	I - F	Sports and Leisure
In a grass field	Green	I	Sports and Leisure
Rock climbing gym	Grey	I - F	Sports
Mountain nearby	Green	I	Sports and Leisure

Cognitive Wellbeing- Children's Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Grocery Store - Thrift Store	Grey	I - F	Commercial
Museum	Grey	F	Education
Italian classes - Piano lessons	Grey	F	Education
Library	Grey	I - F*	Education
Board games - Bowling	Grey	I - F	Leisure
Cabin - Beach on Anvil island	Green	I - F	Leisure
The forest	Green	I - F	Leisure and Green
Baseball park - Soccer field	Grey-Green	I - F	Sports and Leisure
Bike path	Grey	I	Sports and Leisure
Hockey - Ice rink	Grey	I - F	Sports
Karate - Skate/Skate board	Grey	I-F	Sports
Scouts: Learning survival techniques in forests and how to tie knots.	Grey	F	Sports and Education
Swimming lessons	Grey	F	Sports and Education

Social Wellbeing- Children's Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Convenience store	Grey	F - I	Commercial
Ice cream shop - Restaurant - Fast-food	Grey	I-F	Commercial and Leisure
Softball	Green-Grey	I	Commercial and Leisure
Back Alley	Grey	I	Leisure and Social
Courtyard of my co-op - The commons block - My front yard - The swing next to house	Green	I	Leisure and Social
On the way to get home from school	Grey	I	Leisure
Park - Local Park - Playground	Green-Grey	I	Leisure and Green
Small swimming pool - Paddling pool - parks at their house or spray pads	Grey	F - I	Leisure
At friends' houses - Parties	Grey	I	Social
Bus stop	Grey	I-F	Public Transport
In the businesses or festivals at pedestrian shopping street	Grey	I-F	Social and cultural

Figure 6-7 The color-coded categorization of children's destinations mentioned by children, relating to well-being domains

6.3.2.3 Experts' Focus Group

Responses of the experts and the category of each destination are shown in Figure 6.8. Overall, Experts highlighted more grey-type destinations than the previous two groups, but also more informal destinations than the parents group.

Physical well-being included many formal destinations where sports or athletics can be learned and practiced, but this was nearly balanced by informal destinations, often occupying transport infrastructure such as *alleyways, parking lots, and sidewalks*. Places where children's affordance might be different than adults also came up such as using urban shapes to run and do "parkour". The destinations in this group are greyer than the previous two.

Cognitive well-being was a major topic in the experts' group. They discussed how children's cognitive well-being is enhanced through exploration at various destinations, mainly transport-related *(bus stops, bike rides to parks)* and a few shopping ones *(grocery store, corner store)*. Like other groups, these destinations were grey locations, though experts were more likely to mention informal places.

The other two domains of well-being were more mixed. Social well-being included multiple types of destinations *(ice cream shops, back alleys),* with only a few classified as formal *(school).* Only one destination that could be termed formal was assigned to the psychological well-being domain *(schools or day camps)*. Experts discussed psychological and social aspects of different destinations, including how an "ice cream place" can be associated with tradition, emotions, and reconnection with friends. Similar to the other two groups, most destinations here were grey.

Physical Wellbeing- Experts' Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Grocery store - convenience store - supermarket	Grey	I-F	Commercial
Cafe	Grey	I-F	Commercial and Leisure
Pedestrianized streets close to open terraces of restaurants	Grey	I-F	Commercial and Leisure
Library	Grey	I - F*	Education
Recreation or community center	Grey	F - I	Education
School	Grey	F	Education
Back alleys that are not necessarily "safe" or "green" - cars might be going through them still	Grey	I	Leisure
Institutional yards - outdoor spaces	Grey-Green	I	Leisure
Parking lots	Grey	I	Leisure
Planter boxes along streets - anywhere they can balance - jump etc.	Grey-Green	I	Leisure
Sidewalks	Grey	I	Leisure
Snow piles	Green	I	Leisure
Swimming pool	Grey	F - I	Leisure
Urban terrain for parkour (fences - walls)	Grey	F - I	Leisure
Parks - Playground	Green- Grey	I - F	Leisure and Green
Grandparents' house	Grey	I	Social
Bike (no "set destination") with their friends or parents or siblings - Bike shelters and benches ("mobilier urbain")	Grey	I-F	Sports and Leisure
Sport center - Rock climbing gym	Grey	F - I	Sports and Leisure

Psychological Wellbeing- Experts' Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Malls - shopping centers	Grey	I - F	Commercial
Café - Ice cream shop	Grey	I-F	Commercial and Leisure
Schools or in the summer - Day camp	Grey-Green	F	Education
Back alleys	Grey	I	Leisure
Groves of trees - Woodlots	Green	I	Leisure
Urban terrain for parkour (fences - walls)	Grey	I	Leisure
Parks	Grey - Green	I - F	Leisure and Green
Grandparents' house	Grey	I	Social

Cognitive Wellbeing- Experts' Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Pharmacy - Grocery store - Corner store - Shop with parents - Hobby shop (cards - games)	Grey	I-F	Commercial
Farmer's market	Grey	I-F	Commercial and Leisure
Restaurants	Grey	I-F	Commercial and Leisure
Library	Grey	I - F*	Education
School	Grey	F	Education
Cinema	Grey	F	Leisure
Cut-through and alleys	Grey	I	Leisure
Play in the neighborhood (park - back alley - etc.)	Grey-Green	I	Leisure
Sidewalks - Alleyways	Grey	I	Leisure
Urban terrain for parkour (fences - walls)	Grey	I-F	Leisure
Bus stop	Grey	I-F	Public Transport
Visit their friends	Grey	I	Social
Bike ride to parks	Grey -Green	I	Sports and Leisure

Social Wellbeing- Experts' Focus Group

Destination	Green or Grey	Informal (I) / Formal (F)	Category
Malls - shopping centers	Grey	I - F	Commercial
Restaurants - Ice cream shop	Grey	I-F	Commercial and Leisure
Library	Grey	I - F*	Education
School - Schools or in the summer - Day camp - Daycare	Grey-Green	F	Education
Back alleys	Grey	I	Leisure
Cinema	Grey	F	Leisure
Play in the neighborhood (park - back alley - etc.)	Grey-Green	I	Leisure
Urban terrain for parkour (fences - walls)	Grey	I-F	Leisure
Woodlots	Green	I	Leisure
Visit their friends	Grey	I - F	Social

Figure 6-8 The color-coded categorization of children's destinations mentioned by experts, relating to well-being domain

6.4 Discussion

The paper presents the outcome of focus group discussions on non-school destinations involving children, parents, and experts. The results demonstrated that the diversity is much larger than captured by a systematic review of literature on such destinations (Desjardins et al., 2022). Further, the destinations were classified as informal or formal and natural (green) or human-made (grey) which highlights differences in the perspectives of those three stakeholders. Then, it discussed how those destinations might be related to physical, psychological, cognitive, and social well-being from the perspectives of children, parents, and experts. The conceptualization and categorization of destinations by their relationship to well-being domains is a significant theoretical contribution as it directly links the objective of improving children's lives with the potential impact of specific destinations. The combination of these layers (different stakeholders), characteristics, and relationship to wellbeing provides unique contributions that showcase the differences in perspectives. Using this approach, planners can better understand how built environments affect children beyond simple categories like educational, leisure, and commercial.

Focus group discussions highlighted the importance of leisure destinations in children's daily travel. Children prefer common spaces over backyards for social interactions with friends and the wider community which confirms previous research with children (Furneaux & Manaugh, 2019). They mentioned visiting neighbors when shopping or returning from school and going to ice cream shops or dollar stores for social activities. In less urban areas, parents mentioned children collecting mail with friends from centralized mailboxes as a social activity. This aligns with research showing neighborhood involvement promotes children's social skills and frequent socialization (Prezza et al., 2010; Waygood et al., 2020). Back alleys, biking around the neighborhood, and playgrounds were frequently mentioned in leisure activities in all groups. Experts noted shared spaces like alleys and common blocks promote intergenerational connections and enhance the sense of community.

The results show while parents may view a certain destination as offering opportunities from a structured perspective, children will perceive a particular destination based on their enjoyment, social influences, and their interactions and experiences (Loebach & Gilliland, 2014; Veitch et al., 2006). Children's responses were mostly towards informal destinations such as alleys, abandoned areas, beaches, and public parks for physical well-being activities like climbing trees, or playing

basketball. In most cases, these informal destinations were grey or man-made environments such as alleys or in front of their houses. While not necessarily designed for play, grey spaces provide opportunities for independent mobility, exploration, and creative use of the urban landscape for children which as also highlighted by (Villanueva, Giles-Corti, Bulsara, Timperio, et al., 2012). As the informal spaces provide opportunities for meeting friends, and engaging in unstructured play, the spaces also contribute to the development of social connections and psychological well-being which is also argued by (Summers et al., 2019). These informal destinations are mainly within their territorial range, and they are socially, emotionally, and functionally important for children (Broberg et al., 2013). These results align with the concept of affordance — that meaningful places for children are assessed according to the functional quality of the environment that may enable or impede their actions (Desjardins et al., 2022). In contrast to children, parents mostly mentioned formal destinations like libraries, classes, and structured learning environments were more commonly associated with cognitive well-being which is aligned with prior study (Gemmell et al., 2023). Experts also highlighted informal destinations, but they were more likely to mention grey destinations. This contrast between children's preferences for informal, grey and green spaces with adults' responses highlights how it is important to get children's input. The results point to the importance of considering both green and grey along with informal places to support the diversity of destinations that link with child well-being.

This study provides a more holistic view of well-being than previous studies, which focused more on physical health (Gong et al., 2024), physical and social (Christensen et al., 2015) and psychological development (Summers et al., 2019). According to our findings, various destinations simultaneously contribute to a variety of aspects of well-being in a complementary approach. Children's activities often involve socializing with friends or visiting neighbors (social well-being), walking or playing with other kids (physical and social well-being), and exploring the neighborhood (physical and cognitive well-being). This result aligned with a prior study's findings that recreational spots could contribute to children's social and physical health (Gong et al., 2024). Parents and children mentioned sports facilities like hockey rinks and soccer fields provide opportunities for physical activities such as identified in previous research (Egli et al., 2020). This study also highlighted that they are associated with cognitive and social well-being through learning and social interactions. Parents identified parks, nature walks, alleys, and areas near swamps as key locations for children's psychological well-being, noting that these places provide

solitude in distressing times, rest after school, and opportunities for quiet play (Janssen & Rosu, 2015; Loebach & Gilliland, 2014). Through increased walking and movement, these destinations can encourage children to explore, have adventures, and engage in unstructured play, contributing to their physical well-being as these destinations may provide children with a sense of adventure, exploration, and opportunities for unstructured play, which could contribute to their physical well-being through increased walking and movement (Loebach & Gilliland, 2014; Veitch et al., 2006). This aligns with research on the positive impact of natural environments on children's psychological development (Summers et al., 2019). Also, according to a prior study, these "local places" have a direct impact on children's physical well-being due to their affordability and the fact that they are near places that children are familiar (Christensen et al., 2015). Experts and parents agree that destinations such as toy stores, dollar stores, commercial streets, and grocery stores support cognitive well-being by providing opportunities for exploration and learning through new adventures (for example they need to do calculations) and problem-solving. The multifaceted approach aligns with recent calls for better assessments of children's well-being in urban areas (Brown et al., 2019).

Informal destinations and their relevance to well-being domains are further supported by Lynch with four key aspects (Lynch, 1981): *Presence* (access to local public/semi-public areas); *Use and Action* (possibility to play there freely); *Appropriation* (perception of possessing that street with a group of others by frequently using/modifying spaces); and *Disposition* (possibility for new children to join). Our research demonstrates this through the wide variety of local destinations children use (Presence). The use of informal locations that do not have rules and thus allow them to freely play how they want (Use and Action). Destinations where children frequently visit and manipulate objects to make it "their place" (Appropriation), such as building snow structures or exploring abandoned spaces. Inclusive play in communal areas like streets, alley ways, and courtyards (Disposition) that can be seen in previous research on social well-being (Waygood et al., 2021). The parents' perspectives were often related to Lynch's (1981) concept of appropriation, where children feel ownership over unstructured places with no set rules, contributing to cognitive (creating their own games), social (playing with friends in yards/alleys), or psychological well-being (peaceful alone spaces). Playing in open spaces such as empty parking lots allow for creative games (cognitive well-being) or places that are special for children to be alone and feel more peaceful (psychological well-being) like a little corner of the back yard. Experts, children, and

parents discussed unstructured destinations like trees, construction sites, swamps, common spaces, and abandoned areas that allow for Use and Action. This is consistent with the findings of a prior study that found children preferred green spaces for emotional experiences and action activities (Desjardins et al., 2022). According to experts, children can also make play spaces out of transitory places, like sidewalks, benches, or even a bus stop. These destinations allow children to discover surroundings through play (Rissotto & Tonucci, 2002; Villanueva, Giles-Corti, Bulsara, McCormack, et al., 2012), learn about risks (Bento & Dias, 2017), interact with peers (Waygood et al., 2020), and encourage social connections within their community (Waygood et al., 2020).

This research identified child-relevant formal and informal destinations from the perspectives of parents, children, and experts. The findings show that it is crucial for urban design and placemaking to ensure children have access to safe and engaging spaces that are not always already structured for them (Derr & Tarantini, 2016). Children can interact with their peers in the child-friendly neighborhood through a variety of structured and unstructured activities that support their well-being (Prezza et al., 2010; Waygood et al., 2020). From spatial analysis perspective, while informal places are important to children, it is difficult to directly measure accessibility to important destinations as such places are often not documented in GIS data.

This research further showed that important formal and informal destinations are both green (nature) and grey (human-made). Children's inputs differed from parents, often being much more about the informal than formal locations. Therefore, this research demonstrates the importance of children's involvement in shaping child-friendly public spaces that support their well-being. It is important for decision makers to prioritize both formal and informal spaces that respond to children's needs. Additionally, innovative methods for documenting informal spaces in GIS data should be explored to improve children's walking accessibility measurement (Kyttä et al., 2012). As a result of involving children and the main stakeholders in the planning process, urban design can be more effective and inclusive, creating environments that promote children's physical, social, cognitive, and psychological development.

6.5 Limitations

This study focused on differences between children, parents, and experts, not differences within these groups caused by socio-economic or cultural factors. Although children were asked whether there were destinations that they did not go to, but they would like to, the diversity of destinations

will be influenced by their lived context, physical capacity, economic situation, and social expectations. As such, there is an opportunity in the future to develop a more exhaustive list of all destinations nor an analysis of how participation might differ within a group (i.e., the heterogeneity of children and parents). In other cultures, different destinations would probably exist, and future research could employ our methodology of identifying the characteristics (informal/formal and green/grey) to study how they might differ. As a result of recruitment challenges, participants may have been less diverse and representative. Moreover, when humans respond to other humans in person, there may be a possibility of socially desirable response bias, which results in participants responding in an expected manner (socially acceptable) rather than providing their true opinion. As a result, places not considered appropriate or socially desirable may not have been mentioned. However, the children and parents in our study mentioned places that may not have been legal, such as abandoned lots. Results may also be affected by cultural factors. The types of destinations that children might mention if they are closely supervised and discouraged from exploring unfamiliar places on their own would likely be limited to those they are escorted to.

6.6 Conclusion

This paper reports on focus groups that explored the diversity of children's destinations and their potential impact on children's well-being. The focus groups were held with children (aged 8-12), parents (with the children aged 7-13), and experts. This is the first such approach to categorize children's destinations with respect to the different well-being's domains.

The results highlighted the significance of leisure destinations as places with high level of affordance (Chaudhury et al., 2017) in children's daily travels, encouraging their social interactions, play, and community connections. Among the different categories of destinations, parents mentioned mostly formal places like libraries for cognitive development while children mostly referred to informal destinations like alleys and parks for physical play, social connections, and psychological well-being. According to a prior study, educational and recreational destinations support children's social and physical development (Gong et al., 2024). Experts discussed the importance of a wide variety of destinations for supporting children's cognitive development through active learning. Unstructured destinations were described as allowing children to explore and interact with their surroundings while developing cognitive, social, and physical skills. This contrast underscores considering both green natural areas and grey urban spaces, including

informal places, to support children's diverse well-being needs through independent mobility, exploration, and unstructured play opportunities. Unstructured destinations were described as allowing children to explore and interact with their surroundings while developing cognitive, social, and physical skills.

The study makes several contributions: First, it identifies a diverse range of child-friendly destinations, both formal and informal, from the perspective of children, parents, and experts as key stakeholders. Children's insights about the places they travel daily were essential since their unique experience as the main actors may differ from adults'. Furthermore, the study assessed how various destinations may affect children's health. These results may aid future studies in developing tools to measure children's mobility and accessibility. It demonstrated how both green and grey destinations are important for children’s diverse needs. The findings also emphasize the need for inclusive urban planning that takes children's perspectives into account. This systematic approach can be applied to different contexts to integrate formal and informal spaces into urban design, promoting holistic child development. The study clearly highlighted how a diversity in destinations beyond simply schools and parks be related to various aspects of health. As the use of destinations might vary culturally, future studies in diverse locations are recommended to better understand what is stable and what might be culturally anecdotal.

CHAPTER 7 ARTICLE 3: EVALUATING CHILDREN'S ACCESSIBILITY TO DESTINATIONS BY WELL-BEING ASSOCIATIONS

Zahra Tavakoli, Owen Waygood, Geneviève Boisjoly

Submitted on July 30, 2024, in the:

Transportation Research Board, Annual Meeting 2025

7.1 Introduction

Transportation planning has traditionally focused on adults' mobility patterns and prioritized vehicular traffic flow (Curl et al., 2018). Even public health and built environment professionals who focus on place-based health initiatives frequently neglect children in public policy (Brown et al., 2019). However, children's ability to access daily destinations through active and independent modes is crucial for their development (Christian et al., 2015; Villanueva, Giles-Corti, Bulsara, Timperio, et al., 2012) and for their well-being (Waygood, Friman, et al., 2017).

Children's travel patterns are different compared to adults. Elementary school aged children's destinations are typically more local. Much research on them focuses on school trips, but children's destinations are more diverse than that (Buliung et al., 2014; Mitra, 2013; Westman et al., 2017). The distances they walk are typically shorter (whether that is because of the local nature of their destinations or other) as it was shown in another study in Montreal that used the 80th percentile of walking distance to demonstrate how distances vary by age groups (Morency et al., 2020). Children are frequently not given permission to travel independently or to cross certain roads because of traffic danger (Buliung et al., 2014; Mitra, 2013; Westman et al., 2017); adults may also fear traffic danger, but evidence of all of their travel freedoms being revoked is not evident.

Understanding how various destinations and activities contribute to children's well-being in multiple domains is important. (Waygood, Friman, et al., 2017) highlighted links between the domains of wellbeing with children's travel: physical wellbeing such as walking or cycling (Smith et al., 2017); psychological wellbeing such as happiness or feeling excited (Rissotto & Tonucci, 2002); cognitive wellbeing such as intellectual or school-related activities (Waygood, Friman, et al., 2017); and social wellbeing such as social interactions between their peers or adults (Prezza et

al., 2010). To support overall wellbeing it is necessary to consider accessibility to multiple locations that are beneficial to those diverse domains of children's well-being.

In the current state of research, there is no accessibility measure that reflects the relation of all the well-being domains on child-relevant destinations. Various previous research has considered different destinations that could be related to some of the wellbeing domains. Prior studies focused on measuring accessibility to limited destinations such as primarily schools (e.g., (Schlossberg et al., 2006) or parks (e.g., (El Murr et al., 2022; Reyes et al., 2014). One exception to that approach is a study conducted in Australia that measured accessibility to numerous destinations (Badland et al., 2015), but the limiting impact of traffic danger was not considered. Furthermore, the focus of these studies (Badland et al., 2015; Egli et al., 2020) was on destination diversity rather than the destination's impact on well-being domains. In recent studies, physical (Yang et al., 2023) and social well-being (Gong et al., 2024) were discussed, but they analyzed parents' perceptions rather than children's (Christian et al., 2015). As children are the principal actors, it is important to consider not only parents' perspectives of the importance, but also children's as their opinions and experiences might differ (Tavakoli et al., 2024)

Another important consideration is how danger can limit children's accessibility (Amiour et al., 2022a). In related work, the impact of dangerous streets was taken into account for children's accessibility to diverse destinations (Tavakoli et al., 2024) . That research demonstrated that traffic danger could potentially significantly reduce accessibility and should be taken into account. One final key point is that previous accessibility research typically considers all destinations of equal value (Tavakoli et al., 2024). However, not all destinations are of equal importance to children or the different domains of well-being. Not only might they support different facets (e.g., supporting relaxation versus being excited), children might appreciate or frequent some places over others.

The objective of this study is to provide a methodology to assess children's accessibility to destinations that are associated to diverse domains of well-being. This assessment incorporates the relative importance of these destinations from the perspectives of both parents and children. The measure of accessibility is calculated with and without considering traffic danger to examine how this limiting factor might impact children's accessibility. The development of a tool that incorporates children's unique needs and perspectives into planning and policy will contribute to developing environments that support their overall well-being.

7.2 Literature Review

Previous transport related research on children's health and well-being has often focused on physical activity during travel (Davison & Lawson, 2006) or access to destinations that are related to physical activity such as parks or recreational centres (Desjardins et al., 2022). In a review of the built environment's impacts on children's health (Abdollahi, Waygood, et al., 2023), externalities from traffic were highlighted as a major problem, and healthy behaviours were dominated by physical activity with some research on links to social activities. For this research, the focus is on reviewing children's walking accessibility indicators and their relationship to destinations that might be related to various activities associated with well-being domains.

7.2.1 Children's walking accessibility indicators

To understand children's walking accessibility, it is crucial to define the term of "accessibility" for this research. Land use and transportation planning refer to accessibility as a means of assisting individuals to access a wide range of opportunities and destinations within a region (Levinson & Wu, 2020). Accessibility has been defined as a method for illustrating how land use and transportation systems can facilitate the ability of people to travel by one or more modes of transportation (Geurs & van Wee, 2004). For a better understanding of accessibility's impact on children's mobility, it is essential to review its key components (Geurs & van Wee, 2004): the ability to cover a distance using a specific mode of transportation based on cost, time, and effort; the availability, distribution, and quality of opportunities and destinations; and consideration of time barriers, as well as people's capabilities, needs, and opportunities.

Taking Geurs and Wee's points into consideration for this study, children's active and independent travel is predominantly on foot with consideration given to the limiting factor of traffic danger on children's independent and active travel. The quality of the opportunities will be related to associations with well-being. The availability of those opportunities or destinations will be measured by the cumulative opportunities measure. Prior studies examined accessibility to a diversity of destinations' types (Badland et al., 2015; Egli et al., 2020) or specific destination such as parks (Robillard et al., 2023), or schools (Zhao et al., 2022). As for the barriers, one key factor is that these destinations must be located within a reasonable distance, which can vary with the child's age (Babb et al., 2017; Cervesato & Waygood, 2019; Morency et al., 2020; Timperio et al., 2006). Another important barrier is traffic safety measures which significantly influence children's

ability to access desired destinations safely and independently (Amiour et al., 2022a; Tavakoli et al., Under Revision). Therefore, in reviewing children's accessibility indicators, it is crucial to consider the diversity of destinations, a reasonable travel distance, and the traffic safety measures that could influence their mobility.

7.2.2 Children's health and well-being

The definition of the term "well-being" is highly dependent on different factors (Dodge et al., 2012; Pollard & Lee, 2003). Dodge et al. (2021) outline a framework for defining well-being which balances resources and challenges across psychological, physical, and social domains (Dodge et al., 2012). Based on Pollard and Lee's discussion of the term, well-being can mean happiness, self-esteem, a high standard of living, or lack of depression (Pollard & Lee, 2003). They define well-being as "a multidimensional construct incorporating mental/psychological, physical, and social dimensions" (Pollard & Lee, 2003). As children are in a state of learning and development, Pollard and Lee (2003) also proposed a cognitive domain relating to intellectual pursuits such as school, which was distinct from the psychological domain that related to emotions and mental health. A fifth domain, economic, was proposed by Pollard and Lee but as it pertains generally to the household's economic circumstances, it is not relevant for this analysis though later applications could consider how accessibility to diverse well-being destinations relate to average household incomes. The four domains of the well-being used in this research are discussed next.

7.2.2.1 Physical well-being

The physical domain focuses primarily on physical activity, physical health, and physical harm. In this research, the focus is primarily on where physical activity occurs as a contributor to physical health. In previous research, much attention has been given to access to parks (Robillard et al., 2023), green spaces (Teeuwen et al., 2023), or leisure (Badland et al., 2015) assuming that such destinations facilitate physical activity. Previous work asked children and parents in focus groups to associate children's destinations to the different well-being domains (Tavakoli et al., Under Revision). Examples of destinations where children are physically active are informal places such as back alleys, sidewalks, or climbing a tree, but also formal ones like public parks/playgrounds, indoor sports activities (sports centers, skate parks or hockey rink) and outdoor destinations that

support organized sports.

7.2.2.2 Psychological well-being

The indicators related to this domain are associated with mental health, mental illness, and emotions (Pollard & Lee, 2003). As such, different destinations that relate to stress management and happiness would be relevant. An example would be that lower stress might be related to destinations related to the nature that could relieve stress and anxiety (Barbayannis et al., 2022) . In our focus group research (Tavakoli et al., Under Revision), children related many natural spaces to feeling happy or relaxed such as urban parks or informal places such as playing in groves of trees or woods. Parents also mention going to playgrounds or on hikes as activities that support this domain of well-being.

7.2.2.3 Cognitive well-being

The cognitive domain's indicators are mainly school-related and they are about intellectual aspects (Pollard & Lee, 2003). Although many people might focus on formal learning destinations such as school, there are many locations that children can intellectually develop. In our focus group discussions (Tavakoli et al., Under Revision), playing on basketball courts, various fields, back alleys, abandoned locations, playing with dirt or snow piles (using as construction materials) were examples of destinations that our participants associated with this domain.

7.2.2.4 Social well-being

This domain relates to sociological perspectives such as relationships with friends, family, and the wider community including the development of social skills (Pollard & Lee, 2003). Although many studies examine children's access to destinations associated with physical activity, social relationships play an important role in children's well-being (Helliwell & Putnam, 2004). Our focus group study identified many destinations that relate to social interactions with friends and the wider community such as neighbor's yards, local parks, friends or families' house, or play in the neighborhood (back alleys) (Tavakoli et al., Under Revision).

7.2.3 Children's destinations

Children's destinations vary from those of adults due to their different interests and their needs (Desjardins et al., 2022). While many studies have focused on children's independent travel to school (Ewing et al., 2004; Mitra, Buliung, & Roorda, 2010), research has identified a wide range of other important destinations for children, including multi-use parks, supermarkets, fast-food restaurants, convenience stores, public transportation access points, cultural activities, and sports facilities (Babb et al., 2017; Egli et al., 2020; Fyhri et al., 2011). These destinations can be classified into categories such as education, consumer (financial), general food services, public transport, recreation, and social and cultural places (Badland et al., 2015). Such destinations must be found at a local level due to children's limited autonomy (Badland et al., 2015; Kyttä, 2004) and their tendency to travel independently on foot (Williams et al., 2018). However, another way of considering these destinations is how they relate to children's well-being. A child might have access to many destinations, but perhaps they are primarily focused on cognitive well-being with limited physical and/or social well-being potential. As such, knowing how destinations might relate to different well-being advantages can highlight where a city is succeeding and where it is failing to support such development.

7.2.4 Traffic safety measures

Along with having diverse destinations locally, children need to be able to get there safely. The built environment and traffic conditions have been found to influence objective traffic safety for child pedestrians (Hwang et al., 2017; Jamshidi et al., 2017; Rothman, To, et al., 2014). Research has identified high vehicle speeds and high traffic volume as the main determinants of collisions and injuries for children (Amiour et al., 2022a). Traffic-related danger can negatively impact children's walking accessibility (Rothman, To, et al., 2014), potentially limiting their independence and autonomy. Factors such as speed limits (Oliver et al., 2015), traffic volumes (Amiour et al., 2022a; Cloutier et al., 2021), pedestrian infrastructure (Cloutier et al., 2017; Rothman, Buliung, et al., 2014), and road characteristics (Rothman et al., 2015; Rothman et al., 2021) have been shown to influence children's travel patterns (Rothman, Buliung, et al., 2014), real traffic safety (e.g., collisions and injuries) (Nevelsteen et al., 2012), and perceived traffic safety (Alonso et al., 2018; Amiour et al., 2022a).

7.3 Summary

In studies of transportation and well-being among children, physical activity during travel (Davison & Lawson, 2006) and access to locations that are related to physical activity have mostly been the focus (Christensen et al., 2015). In recent research, the built environment has been studied in relation to children's health, with traffic externalities being highlighted as a significant concern (Abdollahi, Waygood, et al., 2023). The objective of this study is to calculate children's walking accessibility to their daily destinations based on their proposed relationship to the different domains of well-being (physical, psychological, cognitive, and social well-being). It is applying traffic danger penalties and examining the relative importance of children's destinations in measuring children's accessibility. Ultimately, this comprehensive approach provides a deeper understanding of the importance of children's destinations and their relation to children's well-being, which can be used to develop more child-friendly urban environments.

7.4 Methodology

This study has five key steps that build upon each other to measure children's walking accessibility to destinations that relate to the four main well-being domains (divided by 7 distinct subtypes): (i) identifying the relative importance of child-relevant destinations, (ii) determining which destinations contribute to each health and well-being domain, (iii) determining destinations weight, for each wellbeing subdomain, (iv) applying traffic danger penalties to street segments, and (v) measuring walking accessibility to destinations that are associated to well-being domains.

The proposed methodology integrates the relative importance of destinations and their contribution to well-being domains from the perspective of Canadian parents and children within the age of 8 to 12. Based on these results, it generates accessibility measures for the City of Montreal, Canada, considering traffic danger. All data processing and analysis was performed using PostGIS (DBeaver Enterprise 23.0.0), RStudio (Version 2023.12.1+402) and QGIS (version 3.24).

We start with a description of the study area and the available spatial data, followed by the detailed methods for each of the five steps.

The analysis was limited to the City of Montreal due to the lack of data available for other municipalities on the Island of Montreal. The Dissemination Area (DA) was chosen as the spatial unit of analysis. DAs are the smallest geographic areas for which complete population census data

are disseminated by Statistics Canada. There are 400 to 700 individuals in each DA (StatisticsCanada, 2021).

The City of Montreal is characterized by a mix of land uses and transportation infrastructures across its 19 boroughs. The central boroughs, historically a hub of urban growth, are full of densely packed residential, commercial, and public spaces, and they are well-served by public transportation. The peripheral boroughs, characterized by predominantly residential neighborhoods and many families with children, have arterial roads and major east-west roads that provide suburban connectivity.

The spatial data for the City of Montreal is obtained from open data sources. Shapefiles were obtained from Open Data Montreal, an online data portal managed by the City of Montreal, to geolocate multiple child-relevant destinations (OpenDataMontreal, 2023). Data related to traffic safety measures and road segments were also sourced from the open data repositories of the City of Montreal.

7.4.1 Identifying the relative importance of child-relevant destinations

Not all destinations are of equal importance. To examine the importance of different destinations, two surveys were designed: one with parents and one with children aged 8 to 12 years old. Both surveys were composed of a detailed list of destinations to enquire about the frequency of going to different destinations.

The list was developed using three sources. First, a systematic review of children's non-school destinations was conducted, and the destinations were identified (Desjardins et al., 2022). Additionally, an extensive list of destinations provided by the city of Montreal was used. These two data sources considered exclusively formal destinations. However, a previous study based on focus groups with children and parents demonstrated the predominance of informal destinations in children's daily trips (Tavakoli et al., Under Revision). Accordingly, informal destinations such as sidewalks, or different seasonal destinations (such as back alleys, street in front of the house) were included in the list. At the end, the surveys included 72 destinations, categorized as follows: *Education, Green spaces, Visiting a doctor, Social and cultural, Winter activities, Summer activities, Public transportation,* and *Commercial establishments*.

The recruitment for these surveys was through done through a panel (LEO - Leger company). However, due to the limitation of panels for children within our target age group with Leger, we also ran the survey for children through Canadian Viewpoint. These two companies are firms specialized in large-scale surveys. The surveys were administered in October 2023. For the survey with parents, two control factors were included with respect to participants. As income has been found to influence access, we set a limit for the number of responses by income quintile based on population distributions in the different regions of Canada. To do so, the total number of responses for each province was assigned based on the number of households with children in each income quintile. We used data from the 2020 Canadian Census. 587 responses were gathered from parents. As the survey was fairly long and repetitive, two trap questions were included to ensure that the respondents were paying attention. After data cleaning, there were 422 valid responses from parents. For the children's survey, additional tests were added along with trap questions, to verify whether or not the respondents were likely children. One was related to a high-pitch frequency at 15 kHz that adults are not able to hear. Another was a set of questions related to modern playground games that are common across Canada but were not played by previous generations. We collected 871 responses, and after data cleaning, there were 583 valid responses from children. Tables with general descriptive data of the two – parents and children – surveys are provided in Appendix C and Appendix D.

The first section of the survey asked about the frequency of visiting various destinations. However, a child might go to a destination frequently, but not desire to do so. Vice-versa, a child might never or infrequently go to another type of destination but wish to visit such a place more often. Children might not go to a destination because of various reasons, but critical ones are likely availability and safety. As such, a second section asked respondents (children and parents) whether they would increase or decrease their frequency if the destination was at the end of their block and they did not have to cross a road to reach it. That information was used to determine the importance of each destination (referred to in this study as the frequency score) from the perspective of parents and

children. Figure 7.1 shows a sample of questions in the described sections:

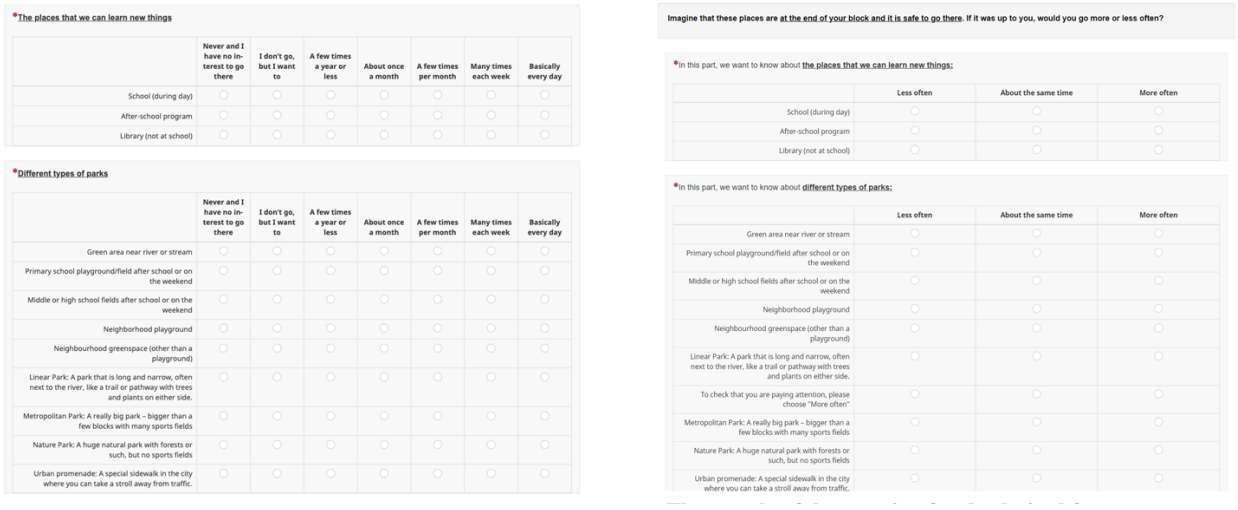


Figure 7-1 The sample of the question for the frequency of the destinations (left) and the sample of the question for the desired frequency (right)

The frequency responses were classified as follows:

- High Frequency = ("Basically every day", "Many times each week")
- Medium Frequency = ("About once a month", "A few times per month")
- Low Frequency = ("A few times a year or less", "Never and he/she has no interest to go there", "My child doesn't go, but he/she wants to")

For the desired frequency question, the answer options were as follow:

- More often,
- About the same time, and
- Less often.

A frequency score was then calculated for each destination according to the results from the survey with parents and the results from the survey with children (Table 7-1). The frequency score was based on two coupled parameters: the actual frequency of visits and the child's desired frequency of visits. The base logic is that on a scale of 1 to 5, 3 is the neutral condition based on Medium Frequency and no desired change. A desire to go more often adds one point, a desire to go less often takes away a point. One exception is that a high frequency destination with a desire to go

less often was scored at 2 to show that its attraction should be less than "*neutral*". We did not assign a score of 4, because it did not align with the same value as high frequency with about the same time. We did not assign a score of 3 because this situation could not be considered "neutral." Therefore, to show the real situation, we assigned a score of 2 to indicate that destinations with lower desirability have a lower value. Further analysis was conducted to compare the scenario where we applied a score of 3. However, the difference between the scenario with a score of 2 and a score of 3 was less than 2% for almost all destinations.

The average frequency score from the perspective of parents and children was then used as a proxy for the importance of the destination and used to calculate the weight assigned to each destination in the accessibility measures.

Table 7-1 The frequency scores based on the frequency and the desired frequency

Frequency of Visit	Desired Frequency of Visit	Frequency Score
High Frequency	More often	5
High Frequency	About the same time	4
High Frequency	Less often	2
Medium Frequency	More often	4
Medium Frequency	About the same time	3
Medium Frequency	Less often	2
Low Frequency	More often	3
Low Frequency	About the same time	2
Low Frequency	Less often	1

In addition to the frequency score, to explore the differences in perception between children and parents, the 72 destinations were ranked from the most important to the least important (from 1 to 72) for both children and parents, based on the average frequency scores calculated above. The

difference between the ranking was then analyzed to explore how children's and parents' perceptions vary.

7.4.2 Linking destinations with health and well-being domains

Two additional surveys (one for children and one for parents) were designed to explore the relationship between child-relevant destinations and domains of well-being. The destinations presented in the surveys were essentially the same. The language used for the children's survey was simplified and tested with children of the appropriate age. These two surveys were launched in December 2023 through LEO (Leger Opinion). Considering that Canadian Viewpoint had a smaller children's pool than Leger, we decided to only continue with Leger. As explained earlier, to ensure that the respondents were real children, several filters had been implemented. Therefore, we proceeded only with Leger and only with IDs that we could confidently verify children as the real respondents. After data cleaning, there were 438 (from 500) responses from parents and 215 (from 300) responses from children. Tables with general descriptive data of the two – parents and children are provided in Appendix E and Appendix F.

Seven measures related to the four well-being domains (see below) were used based on the prior literature (Waygood, Friman, et al., 2017). Each measure was defined for the respondents:

-Physical well-being relates to activities that involve varying levels of movement intensity. Two types of physical well-being were included:

- The medium/high intensity activities increase the heart rate and breathing, which is made possible by destinations such as playgrounds and sports facilities that promote vigorous play or exercise.
- Low-intensity activities involve less exertion, such as walking to neighborhood or commercial destinations.

-Psychological well-being covers two types of feelings:

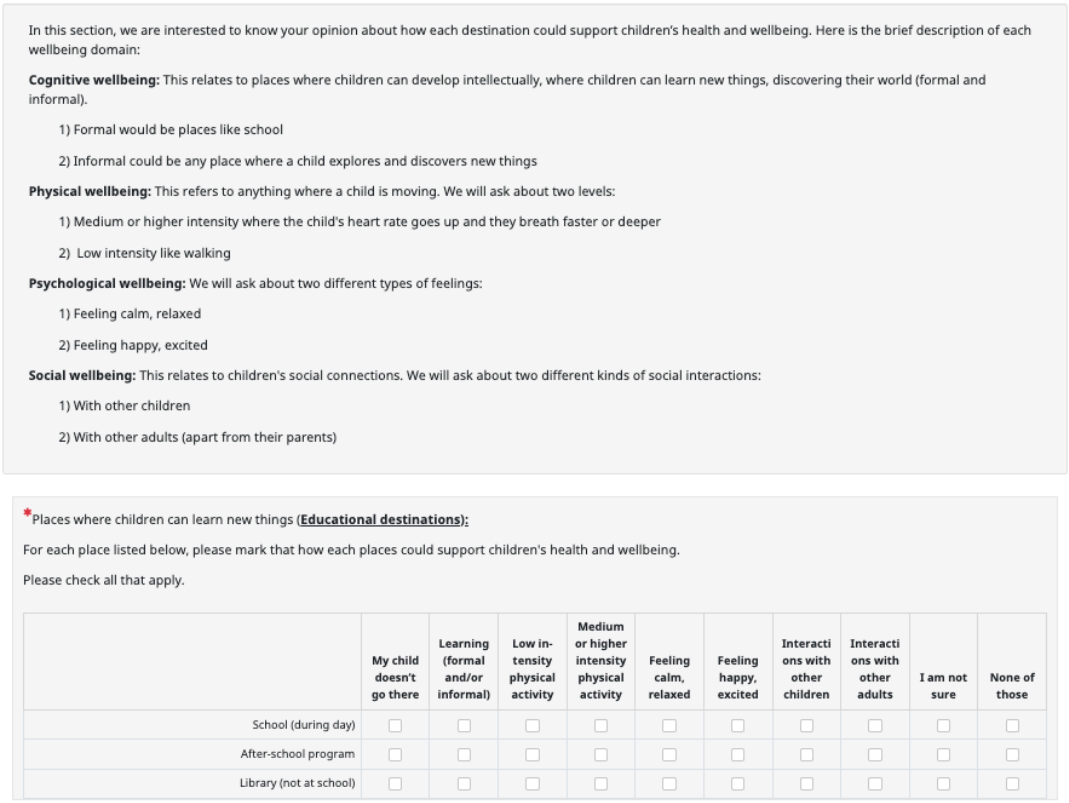
- Feeling calm and relaxed, which could be supported by destinations like green spaces or quiet areas.
- Feeling happy and excited, potentially experienced at entertaining or stimulating destinations like amusement parks.

-Social well-being relates to children's social interactions, separated into:

- Interactions with their peers at destinations enabling social play.
- Interactions with adults.

-Cognitive well-being relates to places where children can develop intellectually, learn new things, and discover their world.

The respondents were then asked to check off, for each destination, every 7 subtypes of the well-being domain it is associated to (Figure 7.2)



In this section, we are interested to know your opinion about how each destination could support children's health and wellbeing. Here is the brief description of each wellbeing domain:

Cognitive wellbeing: This relates to places where children can develop intellectually, where children can learn new things, discovering their world (formal and informal).

1) Formal would be places like school

2) Informal could be any place where a child explores and discovers new things

Physical wellbeing: This refers to anything where a child is moving. We will ask about two levels:

1) Medium or higher intensity where the child's heart rate goes up and they breath faster or deeper

2) Low intensity like walking

Psychological wellbeing: We will ask about two different types of feelings:

1) Feeling calm, relaxed

2) Feeling happy, excited

Social wellbeing: This relates to children's social connections. We will ask about two different kinds of social interactions:

1) With other children

2) With other adults (apart from their parents)

*Places where children can learn new things (**Educational destinations):**

For each place listed below, please mark that how each places could support children's health and wellbeing.

Please check all that apply.

	My child doesn't go there	Learning (formal and/or informal)	Low intensity physical activity	Medium or higher intensity physical activity	Feeling calm, relaxed	Feeling happy, excited	Interactions with other children	Interactions with other adults	I am not sure	None of those
School (during day)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
After-school program	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Library (not at school)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Figure 7-2 Sample of the question where respondents asked to associated well-being dimensions to each destination

First, the average response for each destination for each 7 subtypes of well-being domain was calculated (0 if not checked, 1 if checked), indicating the proportion of respondents reporting that the destination contributes to the corresponding well-being domain. All destinations with an average above 49% (i.e. 50% or more), for either the parents or the children, were selected to be included in the accessibility measure for the respective subtype of well-being domain.

Second, the agreement between parents' and children's perceptions was explored. Strong agreement was established when both parents and children's average score was above 49%, indicating that essentially half the respondents believe that the destination relates to that well-being domain. Low agreement was noted when one group's average score exceeded 49% indicating a favorable impact, while the other group's score fell below, suggesting a less positive impact. The disagreement was if both groups had an average less than 49%.

Table 7.2 present the number of destinations in each agreement level within each subtype of well-being domain. These numbers capture the extent of the agreement between the two groups regarding the impacts of various destinations on children's health and well-being. For example, for cognitive well-being only three destinations – *schools*, *museums*, and *library* – (out of 69) had an average above 49% for both groups of parents and children.

Table 7-2 The number of the destinations in each agreement level within different well-being domains

Well-being Domain	Number of Destinations in each Level of Agreement (Total Destinations =72)		
	Strong Agreement (The average is more than 49% for both groups)	**Low Agreement(One group reply more than 49%)**	**Disagreement Both groups replied under 49%**
Medium to High Intensity Physical Well-being	17	7	48
Low Intensity Physical Well-being	7	8	57
Psychological Health (feeling calm and relaxed)	5	6	61
Psychological Health (feeling happy and excited)	24	15	33
Social Health (Having social interaction with children)	11	16	45
Social Health (Having social interaction with adults)	0	6	66
Cognitive Well-being	3	0	69

7.4.3 Determining destinations weight (for each destination related to each well-being domain)

This step built on the previous two steps, using the calculated frequency scores and the destinations' contribution to well-being domains (section 10.4.1 and 10.4.2). Based on the responses from parents and children, we obtained a frequency score from both groups for all 72 destinations (section 10.4.1). We then calculated the average frequency score from both groups for each destination and assigned this average score to the respective destinations. Then, we selected which destinations related to each of the seven subtypes as follow: we included all destinations with a score above 49% for either the parents or children (section 10.4.2), we assigned each destination to the respective well-being domains.

7.4.4 Applying traffic danger penalty on each segment

Given that traffic danger likely limits the freedom of many children to travel independently to destinations (Tavakoli et al., Under Revision), a traffic danger score is used for each street segment, as previously developed by (Abdollahi, Tavakoli, et al., 2023).

In short, a combination of danger rating and relative weight of different road factors is used to assign penalties to the road segments. Speed limit, road classification, and traffic regulation tools (here stop signs, traffic lights) are considered. Each factor has a relative weight with speed being the most important factor (Abdollahi, Tavakoli, et al., 2023). The traffic danger of each segment is then estimated using a "weighted cost" function, as proposed by Al Shammas and Escobar (2019).

7.4.5 Measuring walking accessibility to destinations that are associated to well-being domain

Based on Geurs and Wee's cumulative accessibility measure (location-based method) (Geurs & van Wee, 2004), accessibility was calculated based on the number of child-relevant destinations within a 1 km walking distance from the centroid of each DA, for each well-being domain. Regarding reasonable walking distances for children, in accordance with previous research on children's walking accessibility (Tavakoli et al., Under Revision), 1- km was determined.

Walking accessibility was calculated with and without the traffic danger penalty, which excludes streets that are categorized as too dangerous for children. Further discussion on the application of

the traffic danger measure to accessibility can be found in (Tavakoli et al., Under Revision). Following this methodology, two service areas were generated using the centroid of the DA to assess the impact of traffic danger on child accessibility. Based on a general accessibility scenario, the first service area included all segments within a 1-km walking distance (Tavakoli et al., Under Revision). Using the traffic danger penalty, the second service area simulated a restricted accessibility scenario for children. In short, road segments with a traffic danger score above a specific threshold were excluded.

The last step was that each DA was assigned an accessibility score based on the sum of the frequency score of the destinations associated to the different children's health and well-being measures within a 1-km walking distance (obtained from section 10.4.3).

7.5 Results

7.5.1 Frequency score of destinations for children and parents

In general, the results of frequency scores from both parents and children indicate that among all destinations, *school* (with an average frequency score of 4.09), *neighborhood playground* (with an average frequency score of 3.42), *the street in front of the house during summer* (with an average frequency score of 3.30), and *primary school playground field after school or on weekends* (with an average frequency score of 3.30) were rated the highest. Conversely, the destinations *doctor appointments, flower shops, and cemeteries* received the lowest frequency scores from both groups. The complete results are provided in Appendix G.

For each destination, we conducted a Welch Two Sample t-test analysis comparing parents' and children's rankings, since we had unequal sample sizes. Appendix H shows the complete t-test result.

Within all the destinations, school (related to the education category) was the top destination. The average frequency score of (4.25) by parents and (3.95) by children are statistically different.

For green destinations, the two highest ranked destinations (using the average of the parents' and children's scores) were *Neighborhood playground* and then *Primary school playground field after school or on the weekend*. Parents' and children's frequency scores indicate that the differences in rankings for *Neighborhood playground* (3.31 vs 3.54) and for *school playground field after school or on the weekend* (3.22 vs 3.38) are statistically significant. The lowest score was for *Green near*

river (avg. 2.91 vs 3.16). This is reflecting a meaningful difference in how parents and children score these destinations, highlighting the distinct preferences of each group.

For healthcare related destinations, all scores were between 1.8 and 2. Although parents' frequency score is significantly higher for all these destinations, these results overall show that parents and children perceive visiting these healthcare providers as less important (in terms of frequency) compared to other destinations, highlighting a lower priority placed on these medical visits within the scope of desirable locations (as opposed to the importance they likely have for health problems).

For social and cultural destinations, the top two destinations were *Restaurants, fast-food* (avg. 3.1, 2.95 vs 3.22) and then *Community organization recreation centre* (2.7). The average frequency score of *Restaurants, fast-food* was significantly higher for children, indicating a stronger preference by children for this destination. The lowest score was for *Cemetery* (avg. 1.8 vs 1.64). Differences in preferences were also seen for *Cinema* (2.4 vs 2.6) and *Café* (2.4 vs 2.5).

For public spaces, the average frequency for the *street in front of the house in summer* was significantly higher for children (3.45) compared to parents (3.15). In general, the *street in front of the house in summer* has a higher frequency score than *the street in front of the house in winter* with a score of (3.45 vs 3.17) for children and (3.15 vs 2.99 for parents). The statistically higher score for both destinations shows the greater importance of these destinations for children. The lowest score was for *Sidewalk* where parents' score (3.06) was significantly higher than children's score (2.82).

For commercial establishment, the top two destinations were *Convenience stores* (avg. 2.93 vs 3.08) and then *small grocery* (2.68 vs 2.89). The average frequency score of *Convenience stores* was significantly higher for children, indicating a stronger preference by children for this destination. The lowest scores were for *video game rental* (avg. 2.14, vs 2.23) and *clothing stores* (2.56 vs 2.74).

7.5.1.1 Frequency score hierarchical rank – differences

For both parents and children, destinations were ranked from 1 to 72 based on their average frequency scores, offering a clear hierarchy of daily destinations as perceived by each group. To capture the differences between two groups, we calculated the differences in ranking between

parents and children. A detailed table of parents' and children's score and ranking is provided in Appendix G.

The scatter plot of the differences in ranking between the two groups is shown in Figure 7-3. To increase the readability, we categorized the differences in ranking from both groups into three levels ("Greater than 5", "Less than -5", and "Within ±5"). The inverted scales place the lowest rankings (72) in bottom-left corner, and the highest ranking (1) in the top-right corner.

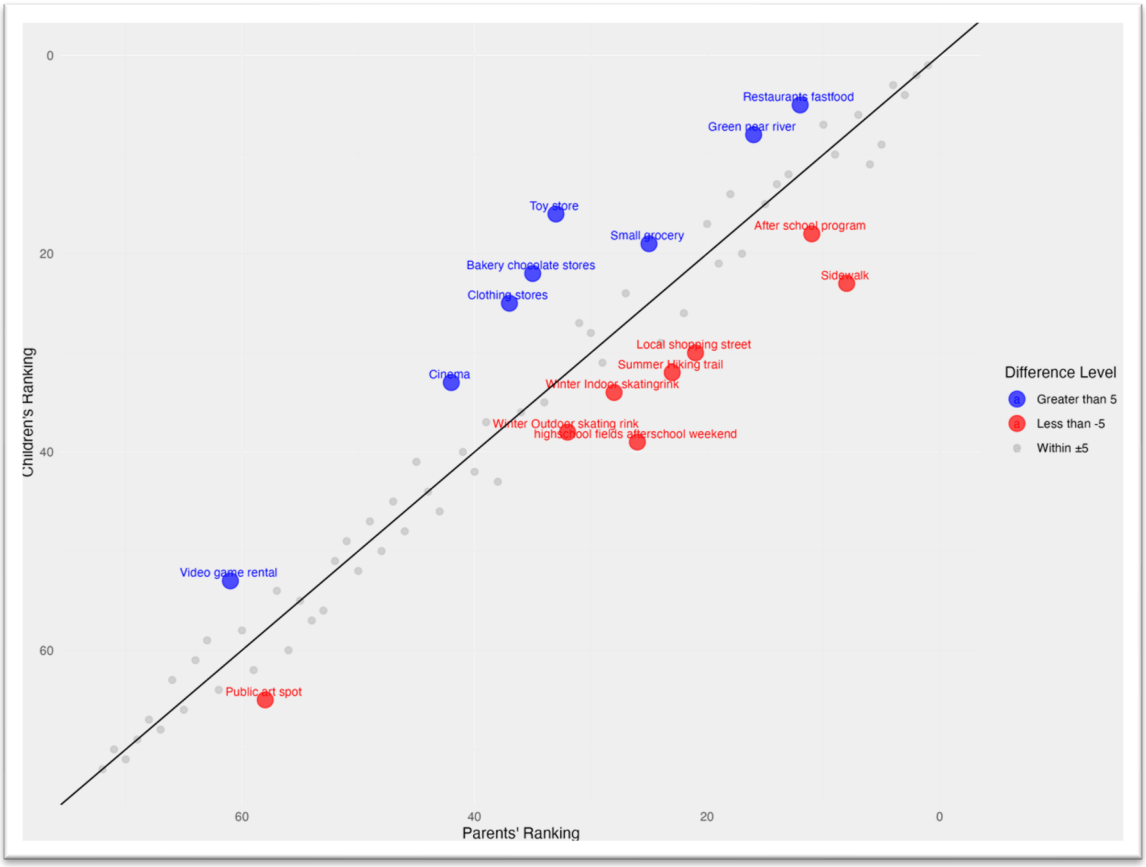


Figure 7-3 Hierarchical rank of destinations for children and parents (*With the scale inverted to have the highest ranking in the top-right corner)

Blue dots represent destinations ranked higher by children, whereas red dots are destinations ranked higher by parents. *Toy stores* show the most significant difference, being preferred much more by children (16th place) than parents (33rd place). *Fast-food restaurants* also rank much higher for children (5th place) than parents (12th place), as do *bakery and chocolate stores* (22 and 25th respectively). Conversely, *sidewalks, nature parks,* and *local shopping streets* are ranked

higher by parents than children, with *sidewalks* showing a particularly large gap, preferred by parents (8th place) much more than children (23rd place).

7.5.2 Result of agreements on health and well-being domains

In this section, we observe which destinations are associated to each of the well-being domains by children and parents. All destinations with an agreement of more than 49% by either parents or children or both are included in the domain for the accessibility measure. In each figure, grey dots are excluded from the domain.

7.5.2.1 Physical well-being: Low intensity activities

Fifteen destinations were associated with low-intensity physical well-being by either parents or children or both groups (Figure 7-4). Parents and children agreed on seven different destinations with respect to low physical intensity activities: *linear parks, neighborhood playgrounds, summer swimming pools, summer street fronts, winter street fronts, nature parks, and urban parks*. Seven destinations were associated with low physical intensity activities by parents, but not by children (bottom-right quadrant). Children associated *back alley (in summer)* with low physical intensity activities, while parents did not. These results show differences between perceptions among these two groups.

The details of parents' and children's agreements and their ranking for destinations are provided in Appendix I.

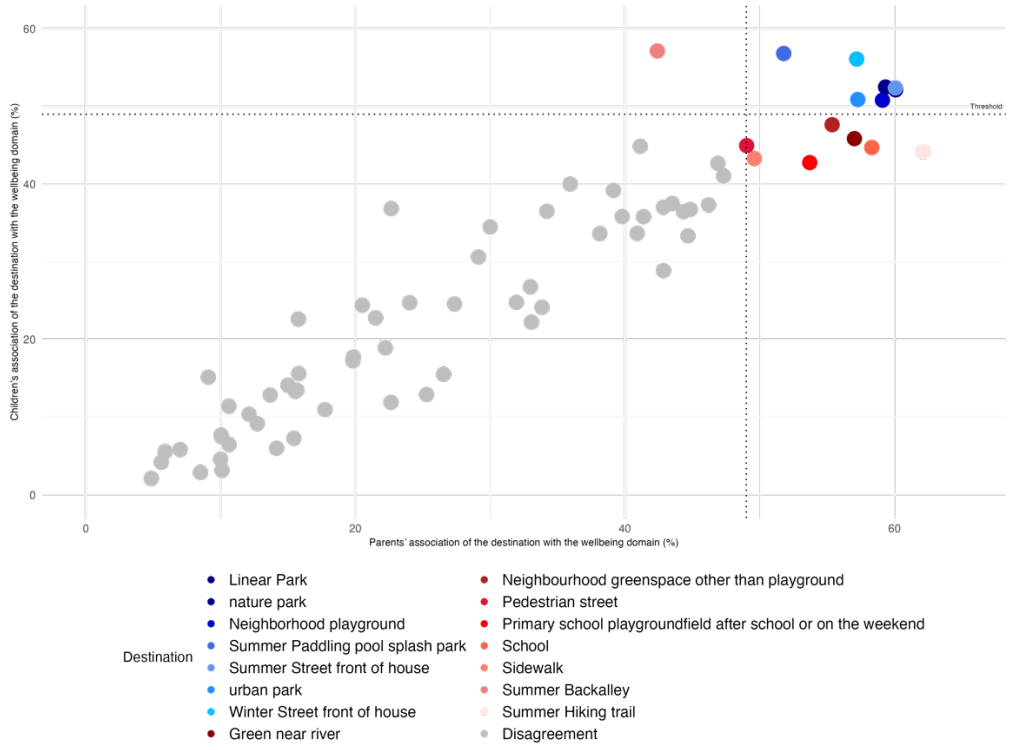


Figure 7-4 Agreement for destinations that support low intensity physical health

7.5.2.2 Physical well-being: Medium to high intensity physical activities

Twenty-four different locations were associated with medium to high intensity physical activities by either one or both groups (Figure 7-5). Eight of those were associated by at least 60 % of either type of respondent: *Outdoor sports – no team*, *Bike path (in summer), Outdoor sports – team, Indoor pool (in winter), Toboggan hill, Other indoor sports (in winter), Indoor skating rink,* and *Outdoor skating rink.* There were six associated by parents that were not by children. The greatest discrepancy was for *Outdoor tennis* (54.3 parents vs 26.5 children). One destination, *Street in front of house (in summer)*, was associated by children, but not by adults. However, it should be noted that the scores in this case were 49.4 for children and 48.4, which suggests similar perceptions. The details of parents' and children's agreements and their ranking for destinations are provided in Appendix J.

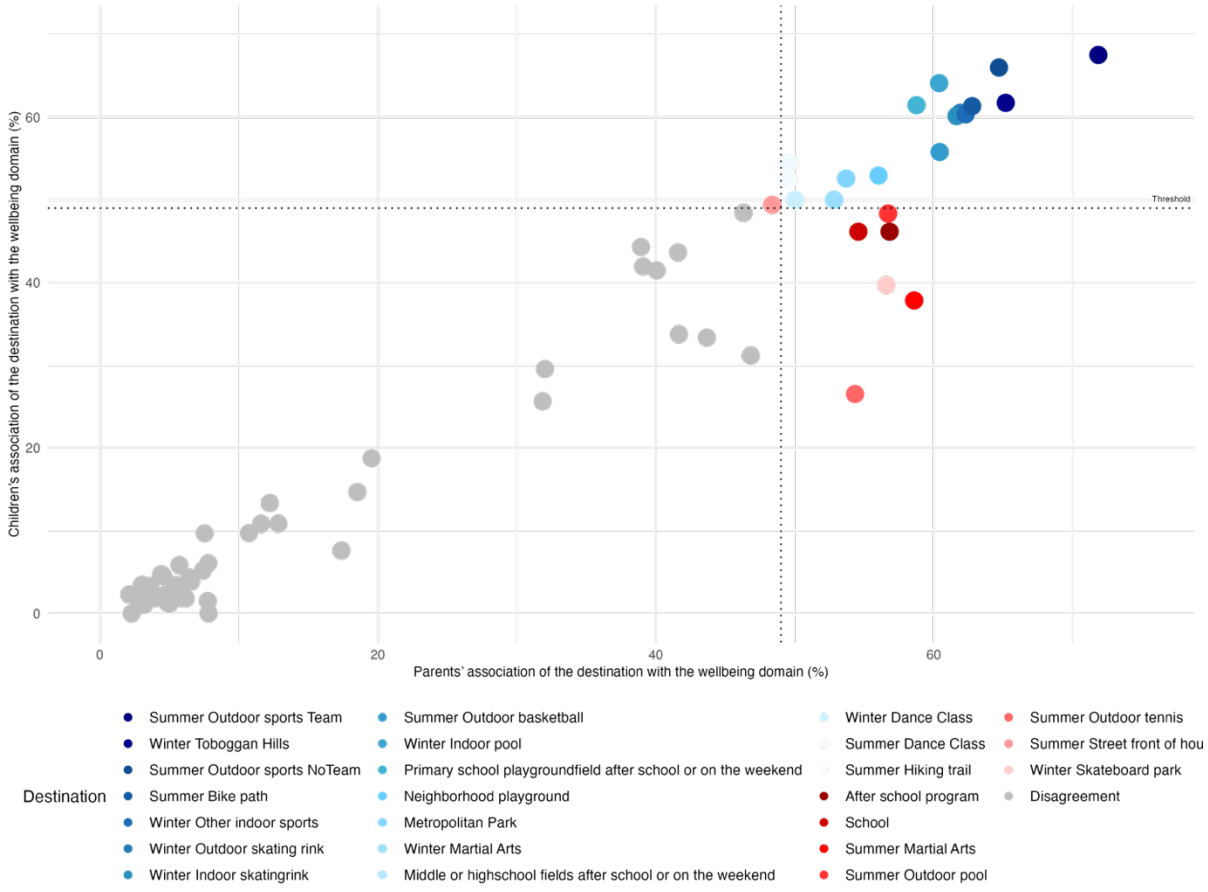


Figure 7-5 The agreement for destinations that support medium to high intensity physical health

7.5.2.3 Psychological well-being: Feeling calm and relaxed

Eleven destinations were associated by either parents and children or both to feelings of being calm and relaxed (Figure 7-6): *Library, Picnic area (in summer)*, *Nature park*, *Linear park,* and *Church or religious centre*. Parents associated another six destinations with these feelings that were not associated by children. Three destinations had a difference of roughly 20 points: *Neighborhood greenspace other than playground, Green near river, Hair salon,* and *Art galleries*. There were no destinations that children associated these feelings that parents did not also. Figure 11 reflects the scatter plot for the agreement between parents and children, and the detailed table is provided in the Appendix K.

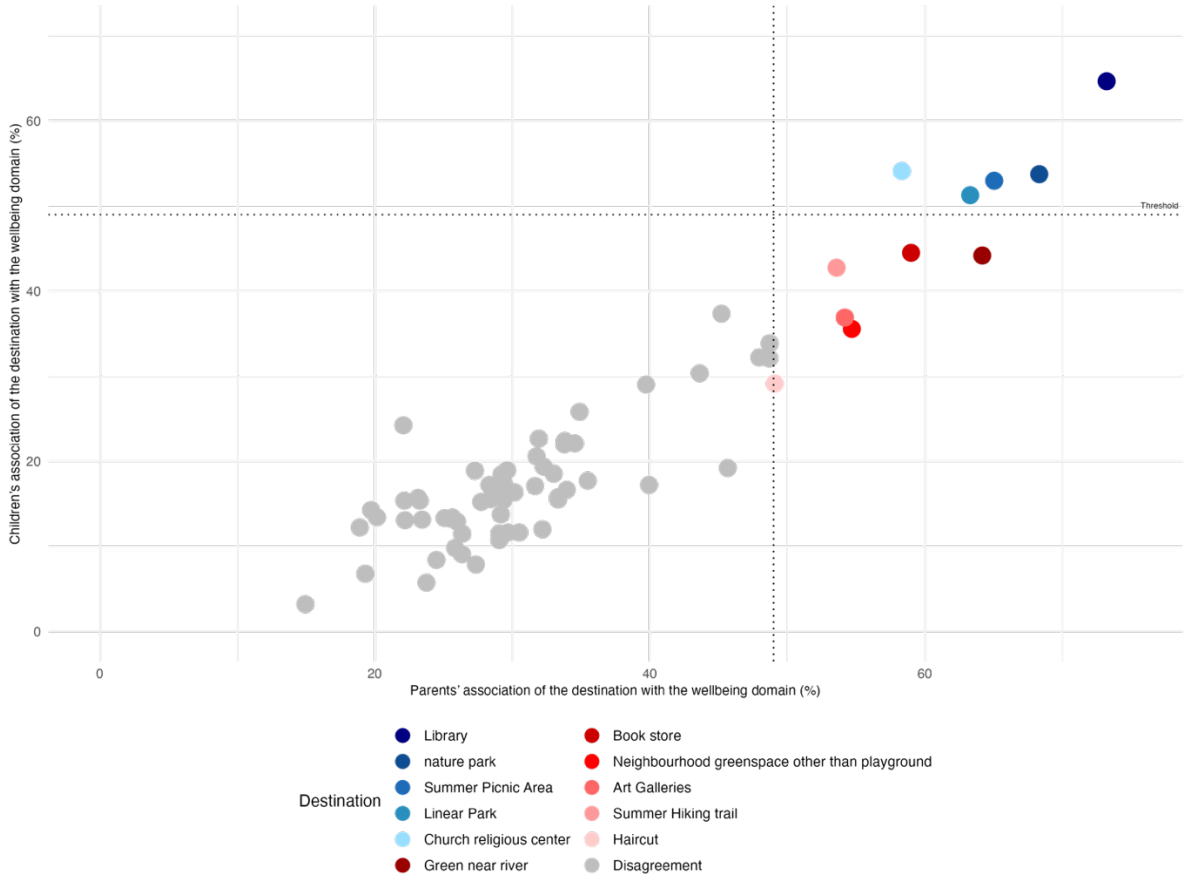


Figure 7-6 The agreement for destinations that support psychological well-being, feeling calm and relaxed

7.5.2.4 Psychological well-being: Feeling happy and excited

Thirty-nine destinations were associated with feelings of being happy and/or excited (Figure 7-7). Seven of those destinations had strong associations overall (at least 2/3rds of respondents): Neighborhood playground, Outdoor pool, Fast-food restaurants, Toy store, Bakery and/or chocolate stores, Toboggan hills, and Cinema. Fifteen destinations were associated by parents that were not by children. The two largest differences (of nearly 20 points) were: Other indoor sports (in winter) and Café. The detailed table is provided in the Appendix L.

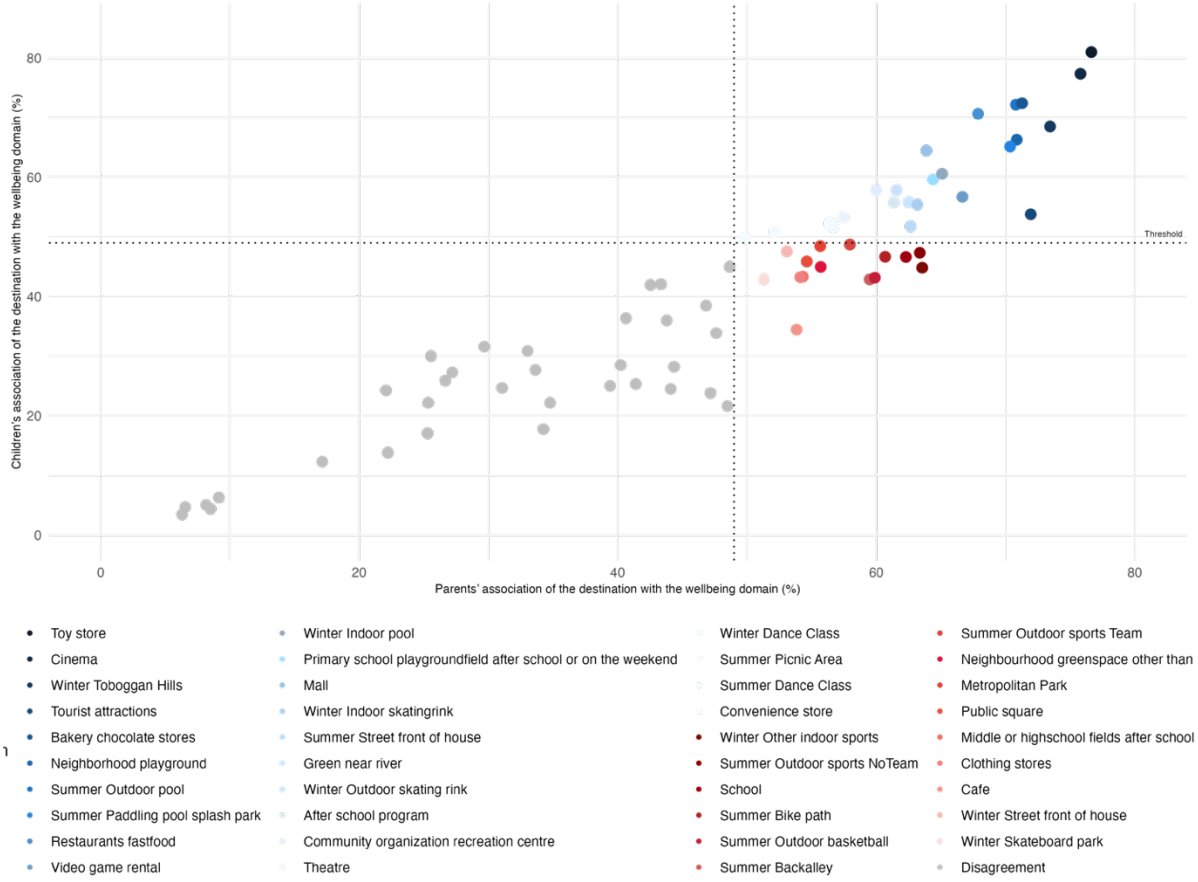


Figure 7-7 The agreement for destinations that support psychological well-being, feeling happy and excited

7.5.2.5 Social well-being: Interacting with other children

Twenty-seven destinations were associated by parents and children or both to places where children interact with other children (Figure 7-8). Four of those had at least a 60 % association by both groups: *School, Neighborhood playground, Primary school playground – after school or on the weekend,* and *After school program*. Sixteen destinations were associated with this type of social interaction that were not associated by children. Some had at least a twenty-point discrepancy: *Outdoor sports – team, Other indoor sports (in winter), Dance class (in summer)*. The averages for destinations associated to interacting with other children are provided in Appendix M.

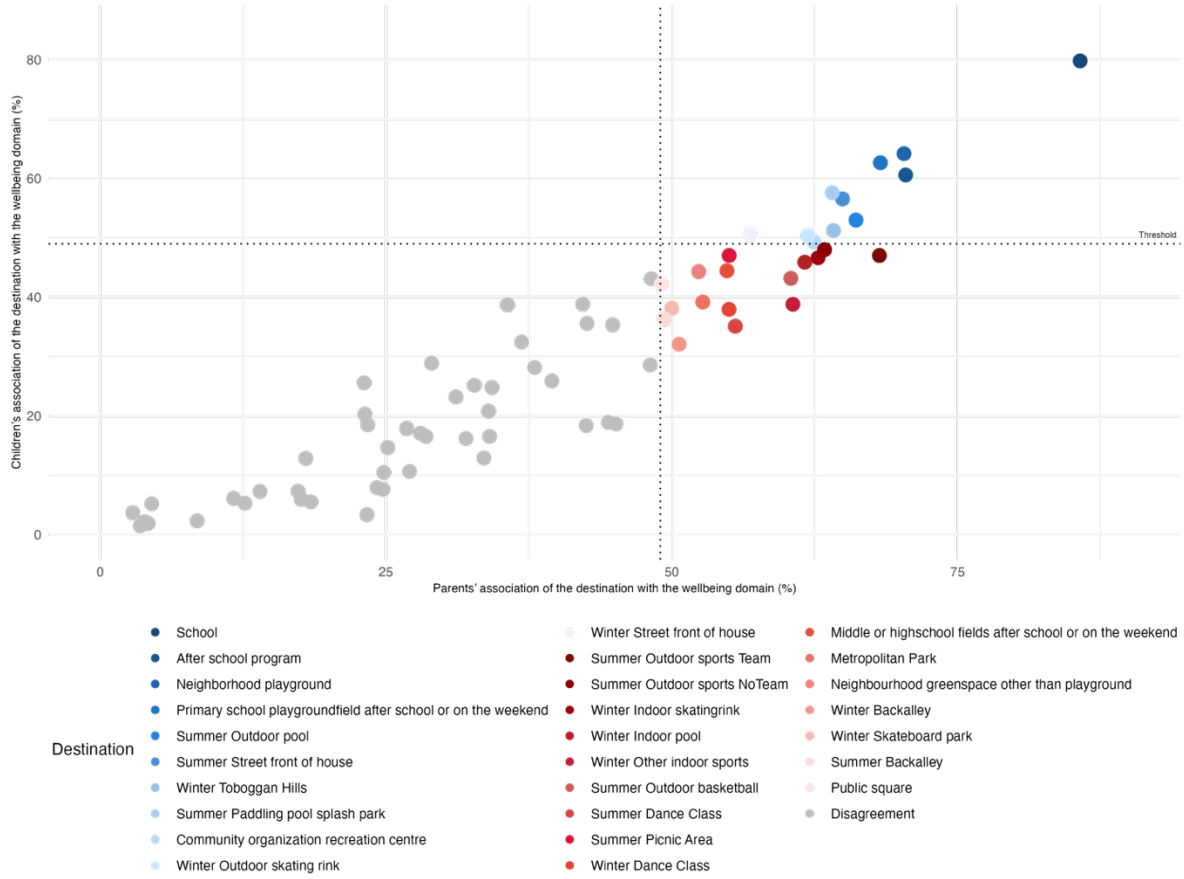


Figure 7-8 The agreement for destinations that support social well-being, having interaction with children

7.5.2.6 Social well-being: Interacting with adults

This measure was the least associated with six destinations having at least 49 % of children and parents agreeing (Figure 7-9). Six destinations were associated by parents however*: School, After school program, Doctor, Dentist, Optometrist,* and *Medical specialist.* Nearly all of these have a difference of 20 points or more. The largest differences are observed for *School* (67.2 vs 33.2) and for *After school program* (50.5 vs 20.2). The details of parents' and children's agreements and their average associations for destinations are provided in Appendix N.

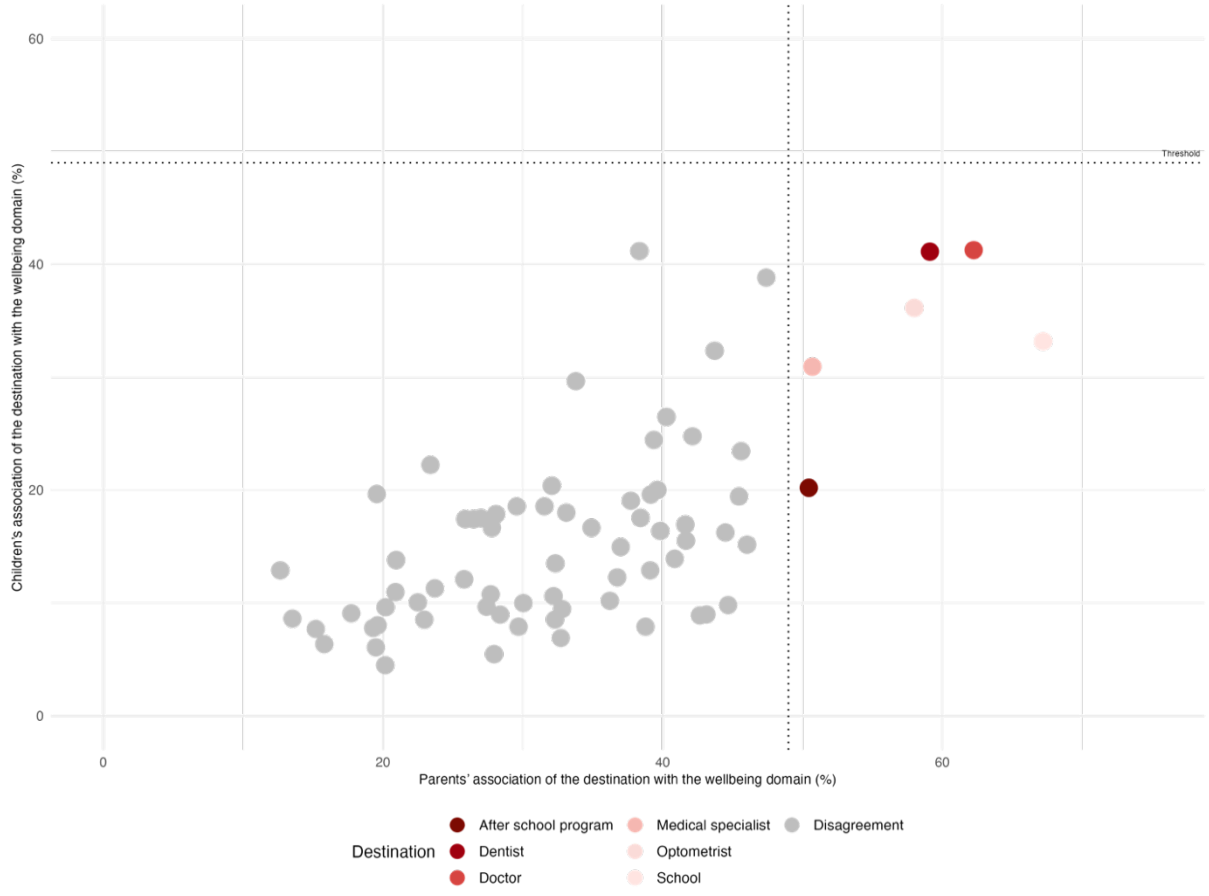


Figure 7-9 The agreement for destinations that support social well-being, having interaction with adults

7.5.2.7 Cognitive well-being

Three places were recognized as places that children can learn things (Figure 7-10): *School, Library,* and *Museum.* All three were associated by more than 60 % or respondents except for Museum by parents (59.3). The details of parents' and children's agreements and their ranking for destinations are provided in Appendix O.

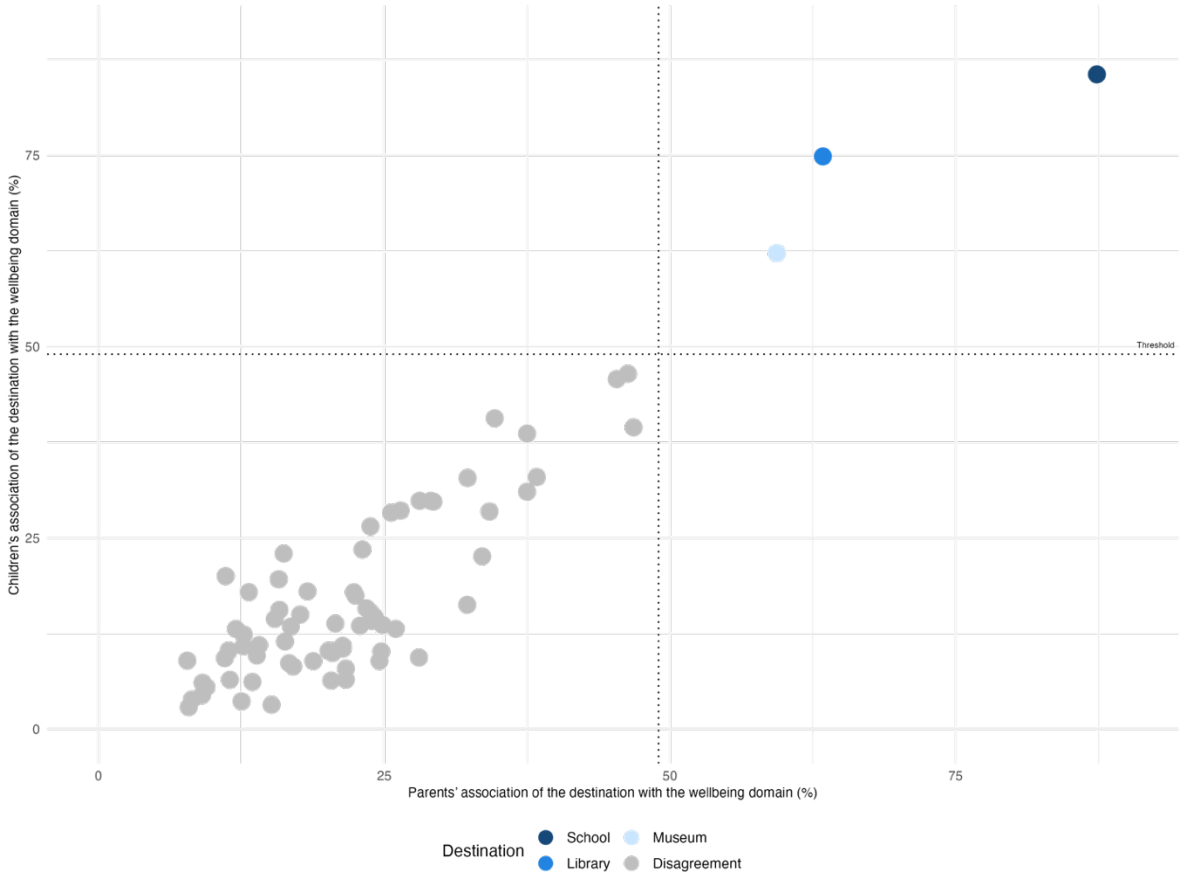


Figure 7-10 The agreement for destinations that support cognitive well-being

7.5.3 Weighted accessibility with and without considering traffic danger

The results of the weighted accessibility for each well-being domain can be seen in Table 7. 4. The median value for destinations that respondents associated with *feeling happy and/or excited* has by far the highest median value with 280 before traffic danger is applied. This is a result of many destinations being associated with this well-being domain and many of those destinations existing in Montreal. The second highest median accessibility score is for destinations that were associated *with social interaction with children*, which has a median score of 153.1. This is followed by *Low intensity physical activity* (119.4), *High intensity physical activity* (115.3), *Social interaction with adults* (68.8), and *Cognitive* (61.4). The well-being domain with the lowest association is *feeling calm or relaxed* (42.4).

Weighted accessibility decreases significantly across all categories after traffic danger penalties are applied. This suggests that traffic conditions greatly hinder the accessibility of children to destinations that support their health and well-being. Across all health domains, traffic danger

penalties reduce accessibility by roughly 80 %. The order of highest to lowest score does not change, suggesting that all of the types of destinations are affected in a similar manner by traffic danger.

Table 7-3 The weighted accessibility to each well-being domain before and after applying traffic danger (TD) penalties

	Low-PA*	Low-PA + TD*	High-PA	High-PA + TD	Calm / Relaxed	Calm / Relaxed + TD	Happy / Excited	Happy / Excited + TD	Cogn.*	Cogn. + TD	SI*-Child	SI-Child + TD	SI-Adult	SI-Adult + TD
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Max	402.88	115.78	334.59	109.87	300.29	89.57	1879.50	548.89	268.54	69.18	500.94	131.20	279.35	76.26
SD	69.61	18.66	63.83	16.72	42.04	10.03	336.24	70.87	45.65	11.55	83.77	21.89	50.52	12.62
Mean	132.05	22.96	123.37	21.05	53.63	9.09	384.13	66.00	69.30	12.07	165.49	28.18	77.45	13.46
Median	119.38	19.32	115.33	18.03	42.36	6.54	279.99	45.10	61.35	8.18	153.11	24.05	68.84	10.12
Difference in mean with and without traffic penalties	109.09		102.32		44.54		318.13		57.23		137.31		63.98	
Percent. Difference with Mean	82.61%		82.93%		83.04%		82.81%		82.57%		82.96%		82.61%	
Difference in median with and without traffic penalties	100.06		97.3		35.82		234.89		53.17		129.06		58.72	
Percent. Difference with Median	83.82%		84.37%		84.56%		83.89%		86.67%		84.29%		85.30%	

*TD: when traffic danger is considered; PA = Physical activity; Cogn. = cognitive; SI = social interaction

Figure 11.10 shows the accessibility for each well-being domain before applying traffic danger and after applying traffic danger, highlighting the most significant patterns by using natural breaks classification. In this Figure, we also provided the percentage of destinations that remain accessible after applying traffic danger, which will be discussed in section 11.5.3.1.

Following are the spatial patterns for each domain of well-being, along with E-Sankey diagrams to describe the pattern before and after applying traffic danger. The E-Sankey diagrams in this analysis show the changes in Dissemination Area (DA) proportions across different accessibility ranges within each well-being category before and after applying traffic danger.

Physical Well-being Accessibility

Figure 7-11 presents the E-Sankey diagrams for Physical Health. The diagram shows a significant reduction in the proportion of DAs with the highest accessibility class for *high intensity physical activities*, decreasing from 88.48% before applying traffic danger to 5% after applying traffic danger. Moreover, the diagram shows that the majority of DAs in the highest class drop to lower categories, with only about 5% remaining in the highest class. Examining the map before traffic danger penalties, central regions have high accessibility for *high intensity physical activities*, ranging from 53.1 to 335, indicating that central areas are well-equipped for different physical activities with the higher average ranking such as school, neighborhood playground, primary school playground.

Accessibility to the destinations that support *low intensity physical activities* was more evenly distributed before the penalty, with such destinations available in both central and peripheral areas. As a result of traffic danger penalties, accessibility scores drop significantly, particularly in peripheral areas, with scores between 0 and 10 becoming common. The E-Sankey diagram for this dimension also shows nearly a 9.41% increase in the proportion of DAs with zero accessibility. After applying traffic danger, only around 4.49% of the proportion of DAs with the highest class of accessibility remain accessible for children.

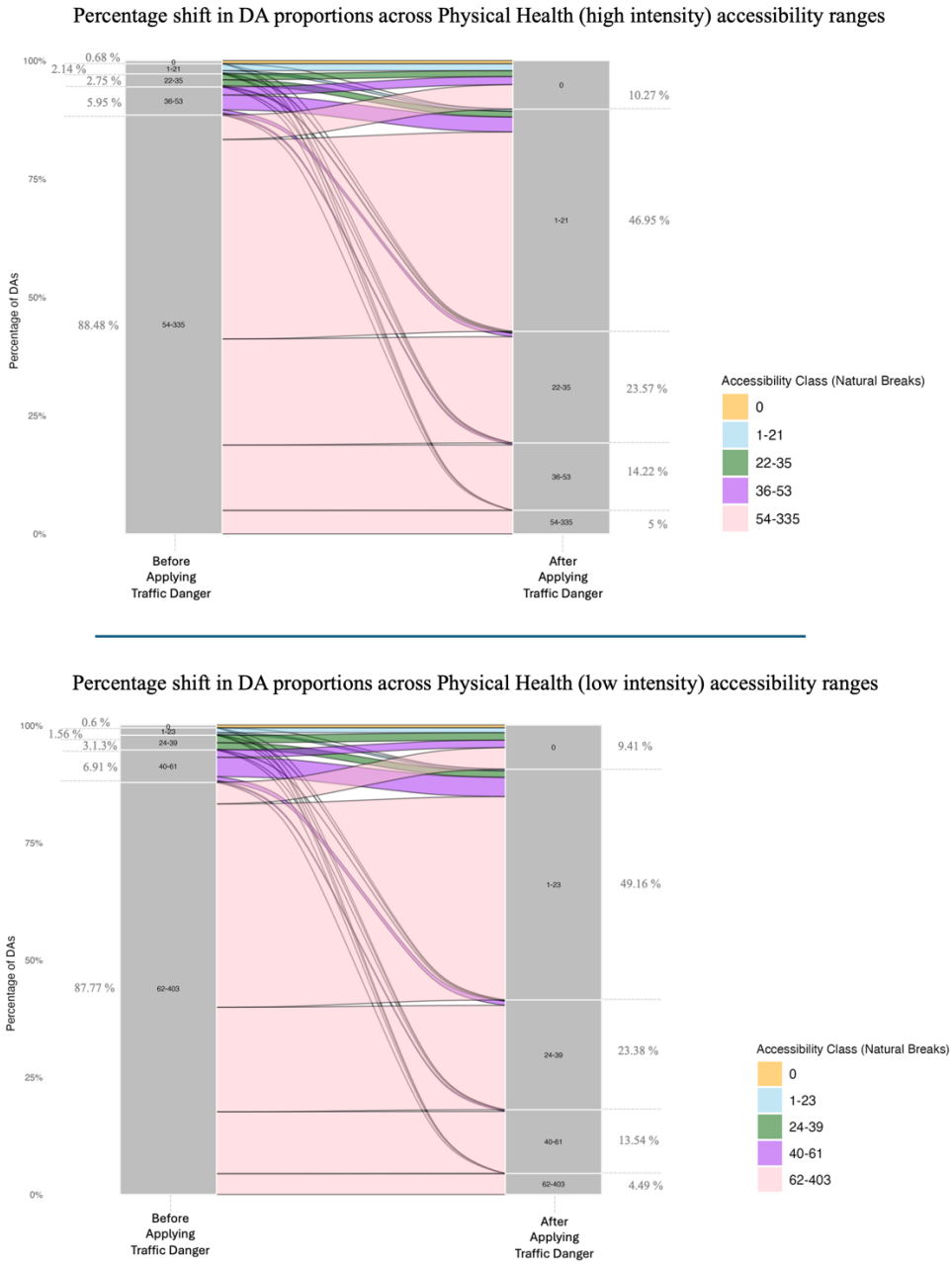


Figure 7-11 Percentage shift in DAs' proportions for High-Intensity Physical Well-being (Up) and for Low-Intensity Physical Well-being (Down)

Psychological Well-being Accessibility

The E-Sankey diagrams for psychological health are shown in Figure 7-12. The E-Sankey diagram illustrates a significant change in accessibility when considering the *feeling of calm and relaxed*. The proportion of DAs with zero accessibility increases from 1.43% before applying traffic danger to 25.24% afterward, while the proportion of DAs in the highest accessibility class decreases from

44.69% to 0.78%. This demonstrates that applying traffic danger significantly reduces children's access to opportunities in this dimension of well-being.

Destinations that contribute to *feeling calm and relaxed* appear to have a wide range of accessibility before traffic penalties are applied, with scores ranging from 0 to 300. The top category is predominantly found in the more central urban areas. The scores decrease significantly after traffic danger penalties are implemented with very few destinations having the top two categories of access suggesting that traffic risks may limit children's ability to enjoy environments that promote feeling calm and relaxed. Areas in the lowest category are evident in most of the peripheral regions.

For accessibility to destinations that support *feeling happy and excited*, the values for the categories are much larger, ranging from 0 to 1880. Although the top categories are concentrated in the main core of the city, the coverage is larger than for destinations associated with *feeling calm or relaxed*. The E-Sankey diagram indicates that after applying traffic danger, the proportion of DAs with zero opportunities increases from 0.35% to 4.91%, while the proportion in the highest accessibility class decreases from 49.98% to 2.39%. This reflects the significant impact of traffic danger on children's walking accessibility to destinations that support this well-being domain.

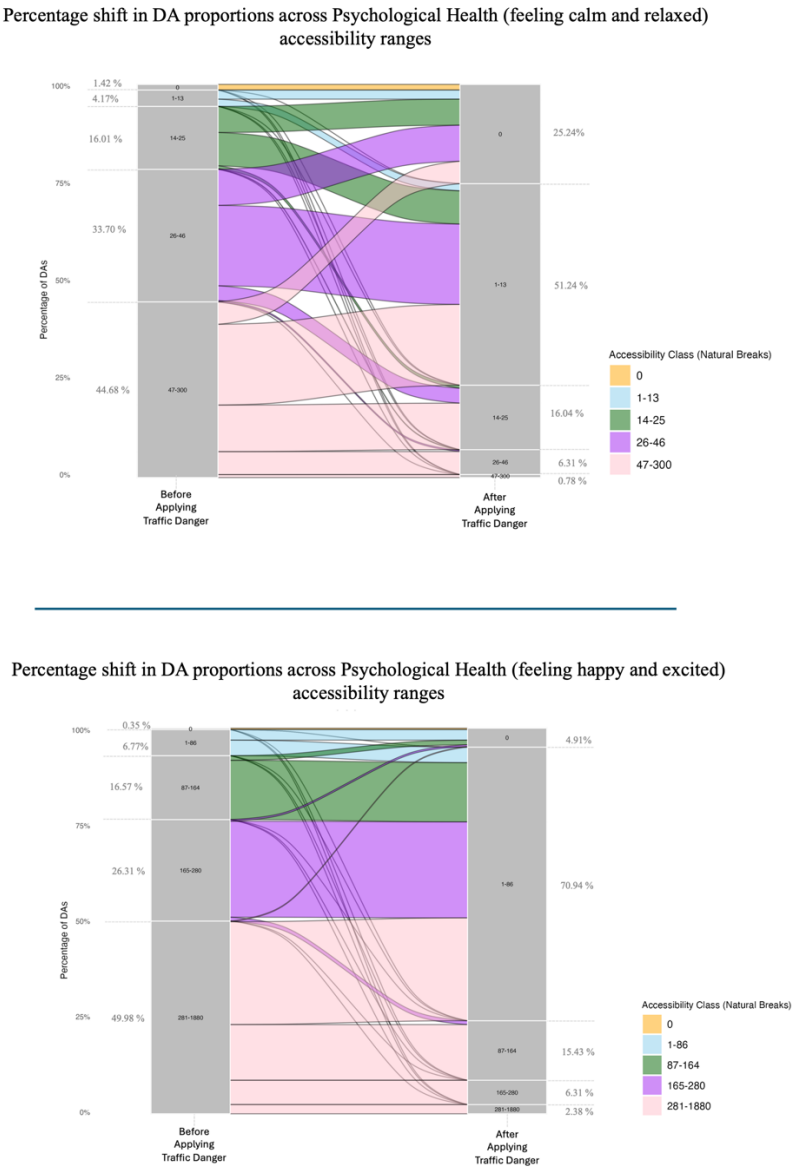


Figure 7-12 Percentage shift in DAs' proportions for Feeling and Calm and Relaxed (Up) and Happy and Excited (Down) for Psychological Well-being

Social Well-being Accessibility

Figure 7-13 presents the E-Sankey diagrams for Social Health. Before accounting for traffic danger, 89.93% of the Dissemination Areas (DAs) were classified in the highest accessibility category for *social interactions with other children*. The diagram shows that the number of DAs with zero accessibility increases dramatically, from 0.57 % before applying traffic danger to 7.20 % after applying traffic danger. As illustrated on the map, which highlights the abundance of

accessible destinations prior to applying traffic danger penalties. The results reveals a significant reduction in accessibility when traffic danger is introduced, particularly in peripheral regions, where scores drop to the 0-15 range. The central neighborhoods are again the destinations more likely to have better access.

In terms of *social interactions with adults*, which (following the results of the survey) is mainly related to school- or healthcare-related destinations, the pre-penalty accessibility scores show that much of the main core of the city are in the top category. The E-Sankey diagram illustrates that when traffic danger penalties are applied, the impact is quite noticeable, with accessibility scores dropping sharply. Only around 3.13% percentage of DAs proportion remain accessible from the highest class after applying traffic danger. The proportion of DAs with zero accessibility increases from 1.53% to 19.07 %. Also, the proportion of DAs with scores between 1 and 15 rises from 5.16% to 43.85 %. Based on the map, this reduction is more obvious in peripheral boroughs where they reach 0 to 6. Only a very few central locations remain in the highest category.

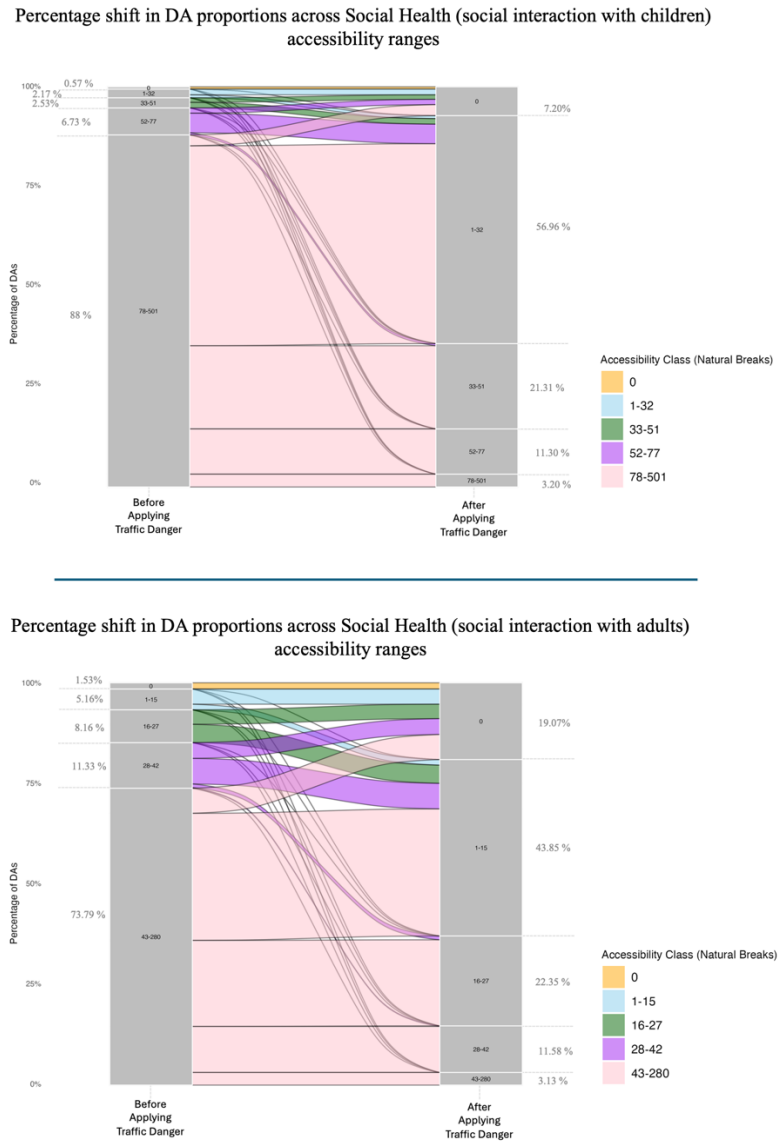


Figure 7-13 Percentage shift in DAs' proportions for Having Social Interaction with Children (Up) and Having Social Interaction with Adults (Down) for Social Well-being

Cognitive Well-being Accessibility

Figure 7-14 presents the E-Sankey diagram showing the percentage shift in DA proportions across Cognitive Health accessibility ranges. The diagram highlights a considerable increase in the proportion of DAs with zero accessibility, rising from 1.78% to 22.06% after applying traffic danger. Additionally, there is a considerable drop in the proportion of DAs in the highest accessibility category, dropping from 69.30% before applying traffic danger to 1.74% after applying traffic danger.

The map also shows a high level of accessibility to cognitive health destinations across much of the City of Montreal before traffic danger penalties. Upon application of traffic danger penalties, accessibility scores in peripheral areas are greatly reduced, with many belonging to the lowest category. Few dissemination areas remain in the top category. The findings suggest that traffic danger significantly hinders children's access to key cognitive destinations.

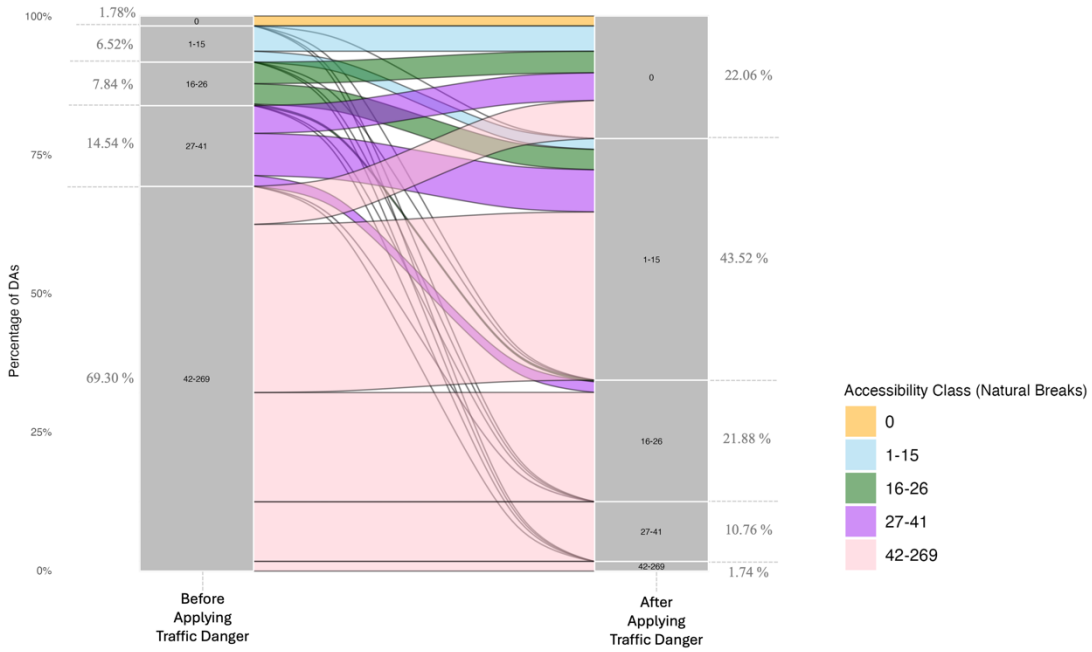


Figure 7-14 Percentage shift in DAs' proportions across Cognitive Health accessibility ranges

7.5.3.1 Percentage of accessibility after applying traffic danger penalties

Although the accessibility might remain highest in many cases for a few central DAs and the accessibility at peripheral areas is very low, it can be difficult to see the percentage loss in accessibility. In Figure 11.10 the percentage of destinations that remain accessible after applying traffic danger are presented in right line of each well-being domain.

We used a uniform quintile-based classification to simplify the interpretation of results. For instance, a higher concentration of areas in the 80-100 quintile indicates regions with low reductions in accessibility due to applying traffic danger. The detailed breakdown in the higher ranges (70-80, 80-90, 90-100) enables us to understand variations within areas experiencing less accessibility changes. Using the extremes (0-40 and 90-100) allows us to assess the impact of traffic danger at critical points.

The results suggest that after traffic danger has potentially larger affects in the peripheral boroughs where the 0-40 categories are more evident. This might be a result of such areas more arterial roads. On the other hand, in central boroughs, the percentage retention in accessibility in DAs mostly falls within the 70-90 range. Since central areas have a greater density of land use, and Montreal has been actively reducing traffic danger in such areas, the result is a less noticeable change in accessibility compared to peripheral boroughs. Among all well-being domains, accessibility to destinations associated with cognitive health and having interaction with adults are most affected, with the most observations within the percentage difference range of 0-40. This shows that by applying traffic danger penalties, destinations such as schools, libraries, museums, or after school programs which are related to these feelings, are mostly affected.

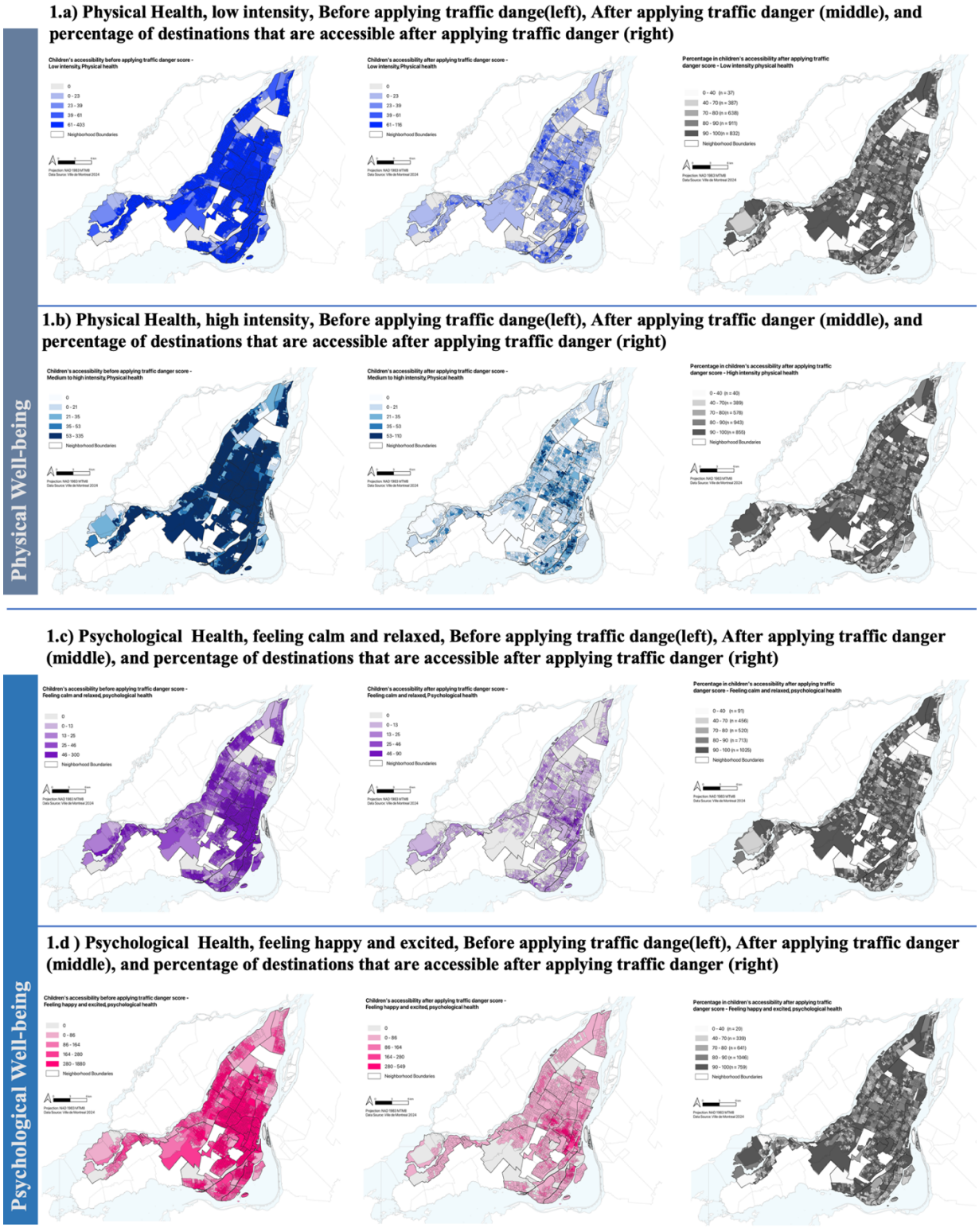


Figure 7-15 Accessibility for each well-being domain (physical and psychological) before applying traffic danger, after applying traffic danger, and the percentage of destinations that are accessible after applying traffic danger

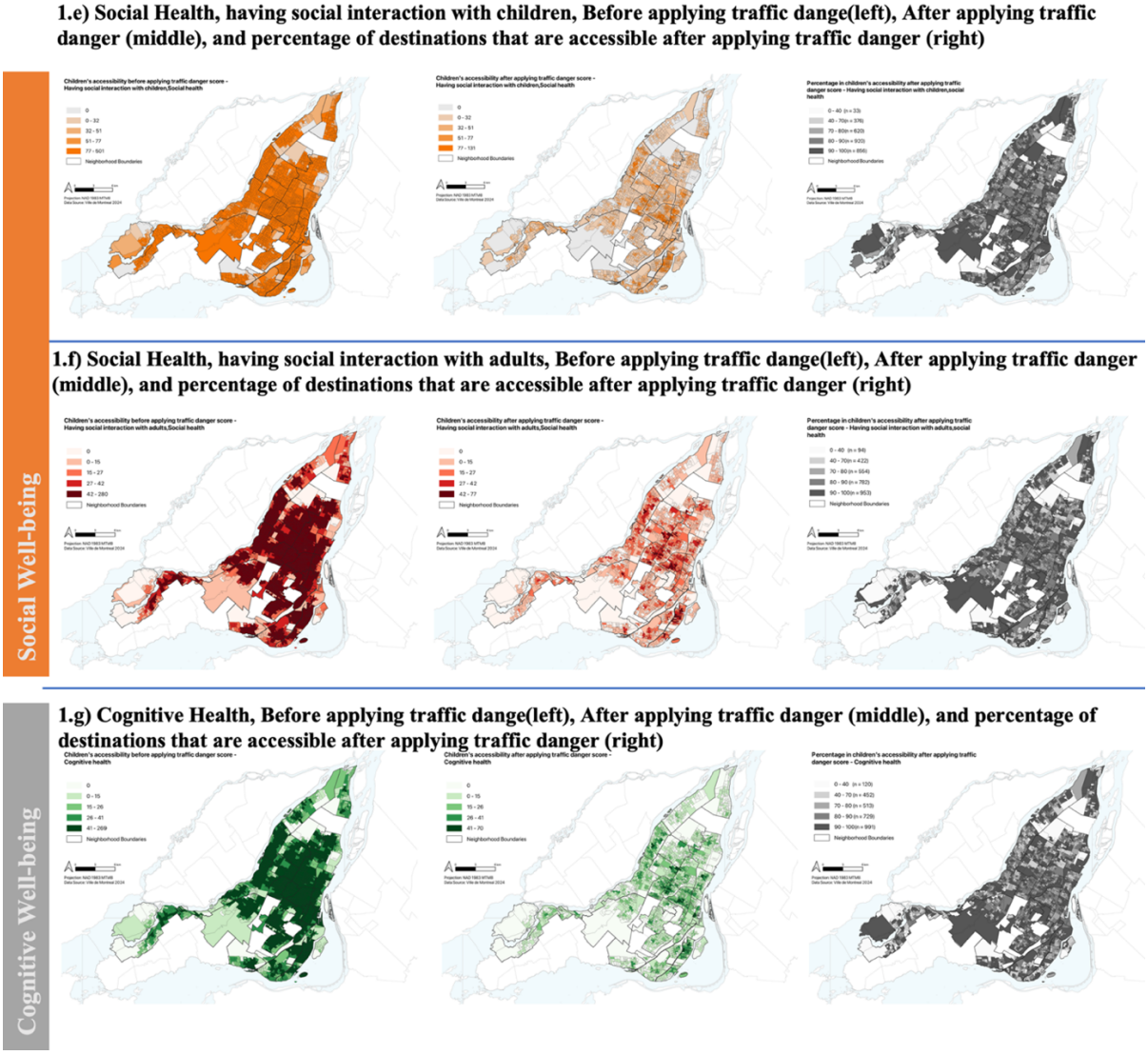


Figure 7-16 Accessibility for each well-being domain (social and cognitive) before applying traffic danger, after applying traffic danger, and the percentage of destinations that are accessible after applying traffic danger

7.6 Discussion

Results highlighted several commonalities and several differences in the importance of destinations between parents and children. The top four destinations were the same (*school, neighbourhood playground, primary school playground after school or on the weekends, street in front of house – during the summer*), with some other common destinations in the top ten (*neighborhood greenspaces other than playground, outdoor pool, bike path, and street in front of house – winter*). Such results emphasize the importance of opening publicly funded destinations such as school playgrounds outside of school hours to the children of the neighborhood, having more than just playgrounds, and taming traffic on streets to allow for play. Other public destinations like pools could follow the example of Montreal where the pools are free. If a cost is associated, this could be an additional reduction in accessibility to many children.

In terms of differences, children exhibit a stronger preference than parents for destinations like *fast-food restaurants*, *green near rivers*, *toy stores*, and *bakery and/or chocolate stores* that are predominantly associated with *being happy or excited*. In contrast, parents' average ranking of destinations showed higher importance given to places like *sidewalks*, *after school programs*, *local shopping streets*, *hiking trails*, and *fields at middle or high schools* that are mostly related to physical well-being or social well-being from the perception of parents.

Seasonal variations in activity preferences are also evident, with outdoor activities like sports, swimming, and biking being favored by both groups during the summer months. Children's average ranking for the street in front of their house was more than adults, suggesting a stronger connection to children's immediate surroundings and a preference for familiar outdoor spaces. This shows the importance of streets as they were historically a place where children would always go to play (Waygood et al., 2021). This finding aligns with the results from focus group discussions, where children identified back alleys as highly valued informal destinations that offer different opportunities for leisure activities (Tavakoli et al., Under Revision). These findings highlight distinct priorities between parents and children about children's daily destinations, emphasizing the importance of considering children's preferences and engaging them in planning and research that impacts them (Smeds et al., 2023).

The findings also show the need to consider both parent and child perspectives when evaluating the impact of different destinations on children's physical health, particularly for medium- and

high-intensity activities. Parents may have a more structured view of how certain destinations can offer opportunities, whereas children's perceptions may be influenced by their own experiences, enjoyment, and social factors (Loebach & Gilliland, 2014; Veitch et al., 2006). In related work using focus groups (Tavakoli et al., Under Revision), children primarily identified informal destinations rather than the formal ones that parents mentioned. Prior studies find that spending time outdoors with peers is crucial to engaging in healthy physical activity (Pearce et al., 2014), and this research identified many potential destinations that could support that. Previous research has highlighted recreational facilities, team sports, and outdoor place spaces to promote physical activity (Janssen & Rosu, 2015; Veitch et al., 2006). Sorting by weight (frequency to go to those destinations and desire to attend more/less), the top five destinations are: *Neighborhood playground, the school playground after school or on the weekend, outdoor sports without a team, bike paths*, and finally *outdoor sports with a team*. This would suggest that facilitating children to meet up when they have time (not being dependent on when a parents could escort them) might be a better approach. A key challenge remains on how best to incorporate this into spatial analysis that is dependent on destinations that have been given value by adults and are thus available in the data.

There is a consensus between parents and children about low-intensity physical well-being destinations such as *linear parks, neighborhood playgrounds, and seasonal recreational areas*. A pedestrian-friendly environment, accessible green spaces, and natural settings are all crucial factors when it comes to enhancing children's physical activity and overall well-being (Janssen & Rosu, 2015; Loebach & Gilliland, 2014; Robillard et al., 2023). Children were more likely to associate *summer back alleys and summer hiking trails* with low physical activity than parents, potentially reflecting their unique perspectives as these destinations may provide children with a sense of adventure, exploration, and opportunities for unstructured play, which could contribute to their physical well-being through increased walking and movement (Loebach & Gilliland, 2014; Veitch et al., 2006).

Natural destinations support children’s well-being by reducing stress and promoting calmness in children (Jimenez et al., 2021). Our findings reflect several green destinations such as *Picnic areas, Nature parks, and Linear parks* were identified by both parents and children as being places where children can be calm and relaxed, likely relating to the concept of restoration (Gobster, 2007; Jimenez et al., 2021). Although not seen here, in the focus group work (Tavakoli et al., Under

Revision), children were more likely to identify green (and informal) destinations as being associated with such benefits than parents. Other destinations were also identified including libraries and religious centers by both groups which suggests that quiet “grey” infrastructure can also promote such feelings (Tavakoli et al., Under Revision).

Leisure activities and entertainment promote positive emotions and psychological health in children including improved cognition (Holder et al., 2009) and stress reduction (Iwasaki, 2001). The findings related to the psychological well-being aspect of feeling happy and excited reveal a strong alignment between parents' and children's perceptions of the positive impact of leisure-oriented destinations. In our result, there is a high degree of agreement regarding the role of destinations such as cinemas, toy stores, and bakeries/chocolate shops in enhancing feelings of happiness and excitement. For feeling calm and relaxed, there was an agreement in the wide range of destinations mainly related to the green spaces such as green near river, picnic areas in summer, nature or linear parks, which were all highly ranked for their importance in children’s daily travels.

In terms of social well-being, some studies highlighted how school environments can shape children's social development and improve their peer networks (Tavakoli et al., Under Revision; Warner & Zhang, 2020). Also, being able to walk to meet friends is associated with higher frequency of meeting with them outside of school (Waygood et al., 2022). This highlights why examining access from the perspective of active and independent travel is important as considerable peer interactions can occur outside of school without an adult supervising or controlling interactions. Our results identify many non-school settings that are associated with interactions with other children. Although school-related destinations are identified, there are informal destinations such as the *street in front of the house and toboggan hills.* Such destinations are important as these environments provide opportunities for social play, peer interaction, and continued social engagement beyond school hours (Burdette & Whitaker, 2005; Veitch et al., 2006). This is in agreement with prior findings that schools are not enough to meet the needs of children, and the public realm can play a positive role in improving their health and well-being (Brown et al., 2019). Play, exploration, and socialization should be possible for all children in all parts of the city (Kyttä, 2004). In our previous focus group research, similar destinations were mentioned such as pools, local shops, but also friends’ homes and simply walking home from school. These later two are not captured in the approach applied here, but future work could

examine how they might be accounted for through methods that identify the potential for children to meet based on the ability to travel independently and the density of children.

Social interactions with adults were associated with very formal situations such as schools, after-school programs, and medical facilities like doctors, dentists, and optometrists. This perhaps highlights some cultural tendencies for children where they are taught not to interact with adults, especially if they do not know them. Children need to know how to interact with adults in the public realm whether it be to seek help when needed or simply to get into destinations such as swimming pools, cinemas, etc. (Milne, 2009).

Destinations like schools, libraries, and museums were frequently associated by both parents and children to cognitive well-being. *Libraries and museums* were previously recognized for their contribution to learning, exploration, and cognitive stimulation (Tavakoli et al., Under Revision). These institutions are valued not only for their educational content but also for offering cultural experiences and environments that promote curiosity and intellectual development (Livingston, 2022). However, in this research, less obvious places where children learn such as stores and community centers or more informal locations that were identified in the focus groups (Tavakoli et al., Under Revision) were not associated frequently enough with this measure of well-being to be considered in the accessibility measure. Future work could examine whether different approaches or wording might better capture such places.

For children, their daily travels depend on the accessibility, traffic safety, and comfort of their built environment (Brown et al., 2019). Therefore, parents and children's perspectives are essential to understanding which destinations are critical to their daily activities and how traffic danger may affect their access to them. From children's perspectives, we can identify critical places where traffic danger may impede children's access to destinations that are important for their health and well-being. The safety and equitable access of children to these places is therefore dependent on addressing traffic danger. When we assessed the impact of traffic danger penalties on accessibility to destinations related to children's well-being, we observed significant differences before and after applying the traffic danger scores.

Traffic danger has a significant negative impact on children's independent accessibility (e.g., Mitra, 2013) and our estimation is that it might reduce accessibility to destinations across almost all well-being domains by over 80%. According to our results, peripheral areas are especially affected,

where arterial roads and higher speeds reduce accessibility because of higher traffic danger scores. The results show that peripheral boroughs have fewer opportunities for children to reach their destinations than central boroughs. On the other hand, in central boroughs with a higher density of destinations and safer travel segments, the number of accessible destinations is less affected. Although accessibility to destinations that enhance children's psychological well-being decreased, particularly in peripheral regions, children's accessibility to destinations that make them feel happy and excited was the highest. Conversely, after applying traffic danger penalties, destinations supporting cognitive well-being showed the lowest accessibility, however only three destinations were associated with this measure of well-being. Following previous research on the importance of an accessible, safe environment in fostering active and healthy lifestyles in children, strategic approaches using transparent and objective measures such as this one are crucial for enhancing active and healthy lifestyles among children.

Traffic danger was previously discussed or examined for children's ability to independently reach important destinations such as parks (Robillard et al., 2023; Tavakoli et al., Under Revision), having a detrimental impact on their physical (Carver et al., 2008) and psychological development (Wang et al., 2021). To implement targeted interventions in areas affected by traffic danger, policymakers and planners can use spatial analysis and expert input to map it. This approach enhances the urban infrastructure while ensuring future planning prioritizes the mobility and well-being of the youngest residents. New resources exist to improve the design of infrastructure to better provide for children such as NACTO's Designing Streets for Kids (NACTO, 2020). As a result of this strategic approach, children's mobility and access to key destinations are enhanced, ensuring their safety, and promoting their overall well-being (Abdollahi, Tavakoli, et al., 2023; Tavakoli et al., Under Revision).

This study has significant implications for transport policy, emphasizing the importance of actively involving children and parents in identifying not only the most important destinations, but also recognizing the ones that might be related to children's health and well-being. In accordance with the United Nations Convention on the Rights of the Child (UNCRC, 1988), children must be consulted on matters that affect their quality of life. As a result of this inclusive approach, cumulative walking accessibility with and without applying traffic danger was measured for different aspects of well-being. These results highlight the importance of creating safer, more

supportive environments for children's independent mobility by incorporating insight from children and parents about their daily destinations.

7.7 Limitations

The study has several limitations. There is no defined benchmark for what defines an acceptable level of accessibility for well-being domains. To compare accessibility and assess its adequacy, further analysis is needed that could consult children and parents on thresholds. Furthermore, the threshold of danger that limits children's access has not been validated with parents as to where they would restrict children and how that might change with age or experience. Children should also be consulted to know if there are roads deemed to be too dangerous by them. To refine this measure and accurately reflect the danger levels for children's travel, more studies involving these stakeholders and practitioners are needed. Furthermore, some outcomes may be influenced by cultural factors, such as children being instructed not to interact with strangers. Children who are rarely independent in their travel may not be aware of such interactions because they do not have experience with them.

7.8 Conclusion

Through a structured four-step approach, this study examined how traffic danger impacts children's (ages 8 to 12) accessibility to destinations that were associated by parents and children to relate to different domains of well-being. From the perspective of children and parents, this study measured the importance of child-relevant destinations. It also demonstrated how accessibility to destinations that could be related to different domains of well-being (based on an agreement between parents and children) varies spatially. It further demonstrates how traffic danger can significantly reduce children's accessibility to such important destinations. By identifying key destinations from the perspective of children and parents, understanding the relationship between these destinations and children's well-being, and incorporating these insights into accessibility analyses, we highlighted where accessibility to well-being domains exists and that potentially if traffic danger is limited, accessibility would be roughly 5 times greater (traffic danger was estimated to reduce accessibility by over 80 %).

When traffic penalty scores are applied, destinations that enhance children's psychological well-being (to feel happy and excited) retain the highest accessibility score, while those that enhance

cognitive well-being have the lowest score. Using the outcomes of this approach, targeted interventions based on these insights could help inform cities on conditions and where they might want to intervene – whether that be to reduce traffic danger or increase certain types of destinations. Furthermore, this approach provides a roadmap for urban planners and policymakers to create environments that are both safer and more supportive for children by focusing on destinations that contribute to their well-being.

The key contributions of this study include several critical insights: it recognized the relative importance of child-relevant destinations from the input of parents and children. It also identified from the perspective of parents and children which destinations are related to different domains of well-being. As seen through the lens of children and parents, the results of this study provide valuable insight into the understanding of the relative importance of child-relevant destinations and how traffic danger affects children's accessibility to places that might be related to their well-being. Urban planners and policymakers can use these strategies to target interventions to reduce traffic danger and increase accessibility to health-promoting destinations, thus creating healthier and more child-friendly cities.

CHAPTER 8 GENERAL DISCUSSION

The purpose of this chapter is to discuss how this PhD project as whole responded to the overall research objective. It will first review the general objectives, followed by explaining the general contributions and the main limitations of this research.

8.1 General Objectives

The general objective of this research was to measure children's accessibility and further, to understand how child-relevant destinations could relate to multiple domains of health and well-being.

The first objective of this study is to define accessibility indicators that were relevant to children's specific needs and demands by focusing on the differences between their travel behaviors and those of adults. Although different accessibility tools and methodologies are used to measure accessibility, these measures do not apply the difference in children's travel behavior with adults in their approach. Children's destinations extend beyond schools and parks (Desjardins et al., 2022), their walking patterns are often more local and shorter distances (Morency et al., 2020), and they may be at greater risk when it comes to environmental barriers such as traffic danger (Rothman, 2019). Therefore, the focus of this study is to highlight those measures tailored to children should be used in assessing the accessibility of their environments.

Another purpose of this study is to highlight how different types of destinations could be related to multiple domains of well-being. The concept of well-being has multiple dimensions including physical, social, psychological, and cognitive (Waygood et al., 2020). These diverse aspects, however, are not adequately recognized or incorporated into current urban planning and accessibility measures. As a consequence, child-relevant destinations that are not included in these measures could result in incomplete and inaccurate assessments of a neighborhood's walking accessibility for children.

8.2 Discussions of the results

Several studies have examined children's accessibility; however, two issues have been identified: either they have been focused on a specific destination, such as school (Schlossberg et al., 2006) or parks and playgrounds (Robillard et al., 2023), or they have measured children's mobility to multiple destinations without addressing environmental barriers that might hinder their mobility

(Badland et al., 2015; Carver et al., 2014). It is evident that even in neighborhoods with high accessibility, unsafe roads can prevent children from reaching their destinations safely. This highlights the unsuitability of standard measures to address this population group's needs. Therefore, it is more accurate to measure accessibility when suitable infrastructure, such as traffic calming measures, is present, in addition to identifying destinations for children. In the absence of such a tool, cities cannot provide a safe and accessible environment for children's mobility.

To address the lack of an accessibility measure tool for children, the **first contribution** of this research is to *evaluate children's accessibility to various daily destinations based on existing knowledge*. Children's destinations can be classified into various categories based on the findings from the scoping review on non-school destinations (Desjardins et al., 2022). Using available GIS data, we calculated cumulative walking accessibility for each multiple destination categories within a 1 km network distance to capture children's walking accessibility. The intent of this analysis was to shed light on the extent to which each neighborhood facilitates access to various types of destinations, such as recreational facilities, educational destinations, leisure places, and other essential locations. This contribution also provided a solid foundation for further exploration and analysis by classifying destinations and quantifying children's walking accessibility. By providing a comprehensive overview of destinations, policy makers can identify areas that lack access to certain types of destinations, influencing future urban planning and policy decisions to improve the mobility and accessibility of children.

The **second contribution** relates to *the impact of traffic danger on children's accessibility*. Accessibility assessments are valuable in providing insights for urban planners and decision makers, but they may not fully capture children's real-life challenges and limitations in terms of reaching to their meaningful places or their daily destinations. This contribution provides a more comprehensive understanding of children's accessibility indicators by integrating traffic danger penalties, which shows the reality of children's travel experiences and account for potential barriers posed by traffic-related risks. I compared accessibility in two scenarios both with and without considering traffic danger. Despite the fact that children may appear to have accessibility when not considering traffic danger, applying traffic danger results in a more realistic assessment. This measure reflects a more true condition of children's walking accessibility, as it incorporates the traffic danger risks they face that can result in restrictions from parents and also avoidance by

children, giving a more accurate picture of children's actual walking accessibility in the real world. By calculating traffic danger scores, we evaluated how different destinations are accessible across regions when street safety is applied. This step provides decision makers with a comprehensive framework for measuring children's accessibility and relevant indicators. It also illustrates the interplay between child-relevant destinations and traffic safety to measure children's accessibility. It also allows them to identify areas of intervention that can enhance children's mobility and make urban environments safer and more child-friendly for them. A secondary contribution of this methodological contribution lies in its flexibility; the methodology can be adapted to any other environmental barriers (applied to each street segment) to this tool. This flexibility makes it a comprehensive and adaptable approach to assessing children's walking accessibility in different contexts.

The **third key contribution** of this research was *demonstrating how perspectives of children, parents, and experts differ with respect to children's destinations and how they relate to the children's well-being*. In other words, children, parents, and experts did not make identical lists of destinations, and these destinations had different characteristics from their perspectives. Also, although some similarities were observed in how these groups categorized destinations in terms of well-being domains, notable differences were notified as well. A child-friendly environment requires an inclusive approach that allows all relevant stakeholders' voices to be heard and incorporated. Focus groups was an option that could provide a more interactive method for testing children's and adults' ability to assign destinations to different well-being domains instead of solely relying on survey results. It is also possible to gain a more comprehensive understanding of children's accessibility needs by incorporating the perspectives of experts in child development and urban planning alongside those of children and parents.

In my PhD, the research captures the preferences and values that multiple groups assigned to various child-relevant destinations. To better align accessibility assessments and future surveys with children's experiences and priorities, we directly discussed with multiple groups of stakeholders to gain a deeper understanding of how they perceive different child-relevant destinations. Prior studies focused on primarily one aspect of well-being such as physical (Gong et al., 2024) or social well-being (Christian et al., 2015), but focus group results show that various destinations contribute simultaneously to a variety of well-being aspects. This contribution offers a holistic and child-centered perspective on mobility patterns and preferences by identifying

structured and unstructured destinations and understanding the relative relations of these destinations to well-being domains. Socializing with friends and visiting neighbors (social well-being), walking or playing with friends (physical and social well-being), and exploring the neighborhood (physical and cognitive well-being) are common activities for children. Among the locations identified by parents as having a positive effect on their children's psychological well-being (parks, nature walks, alleys, swamps, etc.) are places that provide solitude in distressing times, rest after school, and opportunities for quiet play. Knowledge of child-friendly environments will facilitate the development of more effective urban planning strategies and policies that address their specific needs, aspirations, and perceptions about what makes a destination child-friendly. Therefore, by including multiple types of stakeholders that could influence children's travel such as children, parents, and experts in comprehensive focus groups, the **third contribution** emphasizes that: 1) *different destinations (structured and unstructured destinations) could have different levels of importance for children and for parents; and 2)* that *different destinations that children interact with and how those destinations affect their well-being*. The result of this qualitative approach helped me to design more targeted surveys for the final phase.

The final step of this research was to link accessibility of various destinations to their potential impact on children's well-being. Although a few studies have looked at the multiple aspects of children's well-being when it comes to transport without consulting with children or parents (Waygood, 2018) or only with parents' participation (Gong et al., 2024), there is a gap in understanding the diverse range of destinations that could be related to children's well-being by including both groups of parents and children. A diverse range of destinations contributes to children's well-being, and cities may fail to provide such resources and spaces if they do not recognize this importance. In the absence of this knowledge, planning efforts remain inadequate, and children remain unable to access essential destinations.

As part of addressing this issue, the **final contribution** to this study focused on *establishing an accessibility measure that explicitly considers the diverse range of destinations along with integrating their relative importance that are associated to the well-being of children*. By understanding and integrating children's specific needs into urban planning, cities can create more inclusive and supportive environments that enhance children's overall quality of life. Through surveys with children and parents, this contribution established links between a large and diverse

number of child-relevant destinations to the four domains of well-being (including physical, psychological, social, and cognitive development). Using traffic danger penalty scores, we have also assessed the extent to which children's mobility to destinations that support their health and well-being is restricted.

Taking a holistic approach to evaluating child well-being in urban environments makes this contribution unique. By conducting separate surveys of parents and children, our study differs from previous studies that primarily examined physical and social attributes from the perspective of parents. A comprehensive review of all domains of well-being was conducted in this contribution, taking into account physical, psychological, social, and cognitive aspects. The findings of this part have significant implications for urban planning, transportation policy, and public health initiatives. By considering both children's and parents' perspectives about the importance of different destinations, this contribution identifies the diverse needs of children. It has also measured the relation of those destinations to children's well-being. Considering both children's and parents' priorities, this comprehensive and multidimensional evaluation offers valuable insights to policymakers and practitioners seeking to enhance child well-being in urban settings.

8.3 Limitations

The research demonstrated the potentially significant impact of traffic danger on children’s accessibility. However, we utilized traffic danger levels gathered during the initial stages of another complementary study (Abdollahi, Tavakoli, et al., 2023). For this study, traffic danger scores were not intended to be perfect measures but rather indicative ones. Due to the simultaneous deadlines for this project and the complementary project, it was not feasible to refine the traffic danger measure at this time, but it might be possible in the future. As well, we used the upper categories of traffic danger, but it is possible that different, even lower categories, might limit children’s independence, especially younger ones. A validation is needed with parents and children to determine at what point these limitations start. Finally, data limitations exist that impact the ability to measure traffic danger as some areas were missing some data, but also more precise data such as street width, lane number, and traffic volume were not available for all streets.

This study examined traffic danger penalty scores on segments, but we acknowledge that the level of danger at intersections was not available at the time of the study and would be valuable to include

in future studies. Therefore, future versions of the tool should consider intersection danger as a critical component.

A limitation of the current accessibility analysis is that it relies on the number of opportunities without taking into account their quality and size. The approach does not consider the differences between the user experience for example at small and large parks, which can greatly affect both accessibility and children's satisfaction. In this study, no quality-based measures were used due to a lack of coherent spatial data and difficulties integrating these factors. To fill this gap, future research should incorporate measures to assess the quality and attributes of accessibility opportunities.

We had multiple challenges conducting online focus groups as well. The first challenge was finding reliable parents and children. Likely due to the incentive offered in the advertisements, we had a large number of participants who were not "honest" participants in the sense that they were not actively participating and were clearly not paying attention. We then recruited parents in Montreal who had actively participated in a project with a professor from another university. As a result, participants may have been less diverse and representative due to recruitment challenges. Also, time constraints limited the number of questions participants could answer. This was particularly the case during the focus group with children that was limited to one hour.

Cultural factors may influence some outcomes or responses. Children in some cultures may not interact with strangers, which could limit the places that they would associate as places they interact with adults. It seems that children possibly conceptualized this differently as well as they did not even identify schools, yet presumably their teachers are adults. To develop more effective and inclusive urban planning strategies for children, it is necessary to understand these cultural aspects.

Also, GIS data was not available for many informal places mentioned by children in focus groups, which was a significant limitation. The identification of these informal spaces during the focus groups added valuable information to that found in the background literature, but they could not be incorporated into our accessibility measurement tool as such destinations are not present in the available GIS data.

At present, no benchmark has been established what defines acceptable accessibility levels for most destinations, never mind those now associated to well-being domains. The absence of a standard makes it difficult to compare accessibility across different regions and evaluate its adequacy. The

development of comprehensive benchmarks requires further analysis. The benchmarks would allow for a clear assessment of whether various well-being domains have sufficient accessible destinations for children.

The results could also be strengthened by gathering further input from individuals (possibly through more in-depth discussions), including parents, children, experts in multiple fields, and members of the community about places that support different aspects of well-being for children. Through this approach, we would be able to gain a more comprehensive understanding of the destinations that contribute to children's physical, social, cognitive, and psychological wellbeing.

CHAPTER 9 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE STUDIES

9.1 Conclusions

This PhD project aimed to provide a diagnostic tool to measure children's accessibility to their daily destinations, considering how those destinations relate to multiple domains of health and well-being. The study was successful by: 1) assessing children's accessibility to a variety of daily destinations based on existing knowledge; 2) developing a methodology for incorporating environmental barriers (traffic danger as an impedance function) into the cumulative accessibility measure; 3) enriching the literature on non-school destinations that children might travel to by identifying structured and unstructured destinations; and 4) using a methodology that integrates children's and parents' perceptions to measure accessibility to diverse destinations by their perceived relationship with four well-being domains.

Four methodological contributions provided a better understanding of the main question, “How to measure children’s accessibility and how do those destinations relate to children’s health and well-being?”

A tool to measure children's accessibility was proposed, focusing on identifying indicators of child-relevant walking accessibility and tailoring this tool to children's needs. The study involved a detailed analysis of the factors that influence children's access to non-school destinations. A comprehensive accessibility assessment is provided by the tool by incorporating the objective measures (such as different walking distances and environmental barriers) and stakeholders’ perceptions (children, parents, experts). The tool evaluated access to children's destinations in detail and highlighted the perceptions of children and parents about how these destinations relate to well-being, in addition to improving the previous methodological approach to measuring children's accessibility. Also, I considered not only physical or social factors, but also psychological and cognitive factors in examining the relationship between children's daily destinations and their well-being domains. Children's quality of life can likely be improved by understanding how destinations relate to these dimensions and what their accessibility is with respect to children’s independent travel.

Children's walking accessibility highlights the importance of not only considering an appropriate walking distance to diverse destinations, but also integrating environmental barriers. The study assessed children's access to relevant destinations within a 1-kilometer walking distance under two conditions: with and without applying traffic danger. This analysis revealed to what extent traffic danger potentially limits children's access to their daily destinations. A key function of this tool is to assess the ability of different neighborhoods to support children's independent mobility (CIM), i.e., enabling children to reach destinations on their own without adult supervision. As a result of traffic danger, the service area and number of accessible destinations are reduced by over 75%. As a result of applying this methodology, urban planners can identify priority areas and understanding whether it is a problem of a lack of particular types of destinations, traffic danger or a combination of the two. Addressing those problems can help to improve children's quality of life. Further research could exam how to best adapt the methodology for other contexts (or ages of children) which might require adjusting for different traffic measures, destination types, and reasonable walking distances.

In light of the fact that children's daily experiences and preferences may differ from adults', the insights of children were crucial. Therefore, various stakeholder perspectives needed to be captured, including those of children, parents, and experts, regarding the destinations children go to in their daily lives and the impact of those destinations on their well-being. While parents provided valuable insight into formal locations that support cognitive development, experts emphasized the importance of a varied selection of destinations for active learning and cognitive development. Involving these groups helped the study understand the importance of both formal and informal destinations, revealing how diverse environments impact children's physical, social, psychological, and cognitive well-being. The holistic approach ensures that the findings are based on actual experiences and should thus be more reliable and applicable to developing mobility and accessibility measurement tools for children.

Finally, this study highlights the differences in perceptions of children’s destinations between children and parents, highlighting their views on the importance of these destinations and their relationship to well-being. The importance of destinations for physical and psychological well-being is prioritized by children, while a distinguishing feature for parents was the importance of mostly formal destinations. In this holistic measure, we explore different domains of well-being, providing a comprehensive understanding of the relation of diverse destinations to multiple aspects

of well-being domains. Incorporating children's and parents' perspectives into the design of safer, more accessible environments can help urban planners and policymakers create more supportive environments for children.

9.2 Recommendations for future studies

Traffic danger thresholds need to be validated through more comprehensive research. To determine at what levels the perceived danger occurs, additional focus groups will need to be conducted to gather insights from principally children and parents as they are the decision makers in this context. Additionally, the traffic danger assessment outputs from the Multi-Criteria Decision Analysis (MCDA) project, which was happening concurrently with this project, can be integrated into this tool, enhancing its accuracy. An approach such as this would help better understand the point at which traffic conditions turn from safe to dangerous.

The future work may also examine intersection danger, since intersections also have an impact on children's travel. A more accurate assessment could be achieved by integrating the data from another comprehensive study measuring traffic dangers at intersections into the tool.

In this tool, a few attempts have been made to explore different walking distance thresholds in relation to different ages. I would recommend detailed analyses, as the distance children are willing to travel to certain destinations might vary.

Gravity accessibility measures could provide a more detailed understanding of accessibility by accounting not just for distance, but also for the attractiveness of various destinations. Planners and policymakers would be better able to design child-friendly urban environments if they examined the effects of distance and destination attractiveness on children's walking accessibility. This advanced information will help future versions of the tool better capture the complexities of children's mobility and improve planning efforts designed to improve their access to essential services.

Despite measuring access to well-being domains, this study has no benchmark to explore and compare results to determine the extent to which those levels are meaningful. I would recommend that comprehensive benchmarks be developed to define acceptable accessibility levels for well-being domains. The aim is to facilitate clear evaluations of whether various domains of well-being have sufficient accessible destinations for children. These standards would enable policymakers to

identify areas of improvement by comparing different regions. Creating these benchmarks could also help explore if children have sufficient access to destinations that benefit their physical, social, psychological, and cognitive well-being, ultimately improving children's accessibility and mobility.

The children's walking accessibility analysis is based on counting the number of opportunities, but it is important to understand that not all opportunities are equal - a small park and a large park may not offer the same level of accessibility or experience. A recent study in Montreal has developed measures that evaluate the quality of access to parks, taking into account factors such as size and quality (El Murr et al., 2022). Due to inconsistencies and challenges in integrating the spatial units and data availability, my research did not incorporate these parks quality measures into the spatial analysis. In the future, researchers should explore ways to incorporate these quality-based measures to provide more accurate assessments of differences between locations. A prior study have found that the satisfaction with park access is less strongly correlated with park size and number than with park attributes and activities (El Murr et al., 2022). Therefore, future analyses should take both quantity and quality into account to better reflect the children's walking accessibility and their satisfaction levels in urban areas.

Equity considerations are essential for targeting accessibility interventions to target the areas and populations that need them most in future analysis. To further support decision-making by using accessibility analysis, it would be highly relevant to consider additional factors, such as the number of children living in each zone or near key destinations, and those living below the poverty line.

A few attempts were made during this project to improve accessibility results by including population size and traffic danger within each Distribution Area (DA). Expanding this tool to incorporate the number of children in economically disadvantaged situations would provide a more comprehensive understanding of accessibility. The current study did not include this analysis due to time constraints, but it is an important area for future studies. A decision-making framework that incorporates these factors ensures that resources are allocated where they can make the biggest difference by guiding interventions to high-risk areas.

Future studies could conduct further focus groups with children to gain a deeper understanding of the relationship between children's destinations and multiple aspect of the well-being domain. These focus groups can help to explore the relation between well-being domains and multiple daily

destinations more in depth. Also, it could be beneficial to examine further in the literature to identify any links or correlations with the findings of the current study. A detailed survey might be needed to gather comprehensive responses and measure well-being impacts directly.

It will be important to identify and integrate informal spaces, such as street corners or empty lots into GIS data in a comprehensive manner in future studies. These informal spaces are often essential to children's daily activities and significantly contribute to multiple aspects of their well-being. Therefore, adding these spaces to GIS data can improve the tool for measuring children's accessibility and can help understand how children's environments could be related to various domains of well-being.

The tool results could also be examined in future studies to determine whether they are related to children's independent travel and whether they accurately reflect children's perceptions of their neighborhood. This will help ensure the tool is effective and aligns with children's real-world experiences and perceptions.

REFERENCES

Abdollahi, S., Tavakoli, Z., Waygood, O., Cloutier, M., & Boisjoly, G. (2023, July 17 to 21). *Identifying the Influence of Dangerous Intersections in Measuring Accessibility for Children's Independent Mobility, A Case Study in Montreal, Canada* 16th World Conference on Transport Research, Montreal, Canada.

Abdollahi, S., Waygood, E. O. D., Aliyas, Z., & Cloutier, M. S. (2023). An Overview of How the Built Environment Relates to Children's Health. *Curr Environ Health Rep*, *10*(3), 264-277. https://doi.org/10.1007/s40572-023-00405-8

Adler, K., Salanterä, S., & Zumstein-Shaha, M. (2019). Focus Group Interviews in Child, Youth, and Parent Research: An Integrative Literature Review. *International Journal of Qualitative Methods*, *18*. https://doi.org/Artn 1609406919887274

10.1177/1609406919887274

Al Shammas, T., & Escobar, F. (2019). Comfort and Time-Based Walkability Index Design: A GIS-Based Proposal. *International Journal of Environmental Research and Public Health*, *16*(16), 2850. https://doi.org/10.3390/ijerph16162850

Aliyas, Z. (2022). The role of subjective and objective indicators of neighbourhood safety on children's physical activity level. *Security Journal*, *35*(2), 297-316. https://doi.org/10.1057/s41284-020-00278-8

Alonso, F., Esteban, C., Useche, S., & Colomer, N. (2018). Effect of Road Safety Education on Road Risky Behaviors of Spanish Children and Adolescents: Findings from a National Study. *International Journal of Environmental Research and Public Health*, *15*(12). https://doi.org/ARTN 2828

10.3390/ijerph15122828

Amiour, Y., Waygood, E. O. D., & van den Berg, P. E. W. (2022a). Objective and Perceived Traffic Safety for Children: A Systematic Literature Review of Traffic and Built Environment Characteristics Related to Safe Travel. *International Journal of Environmental Research and Public Health*, *19*(5). https://doi.org/ARTN 2641

10.3390/ijerph19052641

Amiour, Y., Waygood, O., & van den Berg, P. (2022b). The Relationship between Built Environment Characteristics and Parents' Perceptions of Children's Traffic Safety on the Trip to School. *Journal of Transport & Health*, *25*. <Go to ISI>://WOS:000828751300007

Arribas-Bel, D., Green, M., Rowe, F., & Singleton, A. (2021). Open data products-A framework for creating valuable analysis ready data. *Journal of Geographical Systems*, *23*(4), 497-514. https://doi.org/10.1007/s10109-021-00363-5

Babb, C., Olaru, D., Curtis, C., & Robertson, D. (2017). Children's active travel, local activity spaces and wellbeing: A case study in Perth, WA. *Travel Behaviour and Society*, *9*, 81-94. https://doi.org/https://doi.org/10.1016/j.tbs.2017.06.002

Badland, H., Donovan, P., Mavoa, S., Oliver, M., Chaudhury, M., & Witten, K. (2015). Assessing neighbourhood destination access for children: development of the NDAI-C audit tool.

Environment and Planning B: Planning and Design, *42*(6), 1148-1160. https://doi.org/10.1068/b140009p

Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy*, *15*(2), 73-80. https://doi.org/https://doi.org/10.1016/j.tranpol.2007.10.005

Banville, C., Landry, M., Martel, J.-M., & Boulaire, C. (1998). A stakeholder approach to MCDA [https://doi.org/10.1002/(SICI)1099-1743(199801/02)15:1<15::AID-SRES179>3.0.CO;2-B]. *Systems Research and Behavioral Science*, *15*(1), 15-32. https://doi.org/https://doi.org/10.1002/(SICI)1099-1743(199801/02)15:1<15::AID-SRES179>3.0.CO;2-B

Barbayannis, G., Bandari, M., Zheng, X., Baquerizo, H., Pecor, K. W., & Ming, X. (2022). Academic Stress and Mental Well-Being in College Students: Correlations, Affected Groups, and COVID-19 [Original Research]. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.886344

Bell, C. A. (2009). All Choices Created Equal? The Role of Choice Sets in the Selection of Schools. *Peabody Journal of Education*, *84*(2), 191-208. https://doi.org/10.1080/01619560902810146

Bennet, S. A., Yiannakoulias, N. J. A. A., & Prevention. (2015). Motor-vehicle collisions involving child pedestrians at intersection and mid-block locations. *78*, 94-103.

Bento, G., & Dias, G. (2017). The importance of outdoor play for young children's healthy development. *Porto biomedical journal*, *2 5*, 157-160.

Berg, P., Kemperman, A., & Waygood, E. (2021). The Social Dimensions of Children's Travel. In (Vol. 8). https://doi.org/10.1016/bs.atpp.2021.06.002

Blazquez, C. A., Celis, M. S. J. A. A., & Prevention. (2013). A spatial and temporal analysis of child pedestrian crashes in Santiago, Chile. *50*, 304-311.

Boarnet, M. G., Cl., A., K., D., T., M., & Alfonzo, M. (2005). Evaluation of the California Safe Routes to School legislation: urban form changes and children's active transportation to school. (0749-3797 (Print)).

Boisjoly, G., & El-Geneidy, A. (2017a). How to get there? A critical assessment of accessibility objectives and indicators in metropolitan transportation plans. *Transport Policy*, *55*, 38-50. https://doi.org/10.1016/j.tranpol.2016.12.011

Boisjoly, G., & El-Geneidy, A. M. (2017b). The insider: A planners' perspective on accessibility. *Journal of Transport Geography*, *64*, 33-43. https://doi.org/https://doi.org/10.1016/j.jtrangeo.2017.08.006

Braza, M., Shoemaker, W., & Seeley, A. (2004). Neighborhood Design and Rates of Walking and Biking to Elementary School in 34 California Communities. *American Journal of Health Promotion*, *19*(2), 128-136. https://doi.org/10.4278/0890-1171-19.2.128

Broberg, A., Salminen, S., & Kyttä, M. (2013). Physical environmental characteristics promoting independent and active transport to children's meaningful places. *Applied Geography*, *38*, 43–52. https://doi.org/10.1016/j.apgeog.2012.11.014

Brown, B., Mackett, R., Gong, Y., Kitazawa, K., & Paskins, J. (2008). Gender differences in children's pathways to independent mobility. *Children's Geographies*, *6*(4), 385-401. https://doi.org/10.1080/14733280802338080

Brown, C., de Lannoy, A., McCracken, D., Gill, T., Grant, M., Wright, H., & Williams, S. (2019). Special issue: child-friendly cities. *Cities & Health*, *3*(1-2), 1-7. https://doi.org/10.1080/23748834.2019.1682836

Buliung, R., Larsen, K., Hess, P., Faulkner, G., Fusco, C., & Rothman, L. (2014). Driven to school: Social fears and traffic environments. *The urban political economy and ecology of automobility: Driving cities, driving inequality, driving politics*, 81-100.

Burdette, H. L., & Whitaker, R. C. (2005). Resurrecting free play in young children: looking beyond fitness and fatness to attention, affiliation, and affect. *Arch Pediatr Adolesc Med*, *159*(1), 46-50. https://doi.org/10.1001/archpedi.159.1.46

Butschi, C., & Hedderich, I. (2021). How to Involve Young Children in a Photovoice Project. Experiences and Results. *Forum Qualitative Sozialforschung Forum: Qualitative Social Research*, *22*. https://doi.org/https://doi.org/10.17169/fqs-22.1.3457

Carver, A., Timperio, A., & Crawford, D. (2008). Playing it safe: The influence of neighbourhood safety on children's physical activity - A review. *Health & Place*, *14*(2), 217-227. https://doi.org/10.1016/j.healthplace.2007.06.004

Carver, A., Veitch, J., Sahlqvist, S., Crawford, D., & Hume, C. (2014). Active transport, independent mobility and territorial range among children residing in disadvantaged areas. *Journal of Transport & Health*, *1*(4), 267-273. https://doi.org/https://doi.org/10.1016/j.jth.2014.01.004

Carver, A., Watson, B., Shaw, B., & Hillman, M. (2013). A comparison study of children's independent mobility in England and Australia. *Children's Geographies*, *11*(4), 461-475. https://doi.org/10.1080/14733285.2013.812303

Cervesato, A., & Waygood, E. O. D. (2019). Children's Independent Trips on Weekdays and Weekends: Case Study of Québec City. *Transportation Research Record*, *2673*(4), 907-916. https://doi.org/10.1177/0361198119837225

Chang, H. S., & Liao, C. H. (2011). Exploring an integrated method for measuring the relative spatial equity in public facilities in the context of urban parks. *Cities*, *28*(5), 361-371. https://doi.org/10.1016/j.cities.2011.04.002

Chaudhury, M., Hinckson, E., Badland, H., & Oliver, M. (2019). Children's independence and affordances experienced in the context of public open spaces: a study of diverse inner-city and suburban neighbourhoods in Auckland, New Zealand. *Children's Geographies*, *17*(1), 49-63. https://doi.org/10.1080/14733285.2017.1390546

Chaudhury, M., Oliver, M., Badland, H., Garrett, N., & Witten, K. (2017). Using the Public Open Space Attributable Index tool to assess children's public open space use and access by independent mobility. *Children's Geographies*, *15*(2), 193-206. https://doi.org/10.1080/14733285.2016.1214684

Chin, H. C., & Foong, K. W. (2006). Influence of school accessibility on housing values. *Journal of Urban Planning and Development*, *132*(3), 120-129. https://doi.org/10.1061/(Asce)0733-9488(2006)132:3(120)

Christensen, J. H., Mygind, L., & Bentsen, P. (2015). Conceptions of place: approaching space, children and physical activity. *Children's Geographies*, *13*(5), 589-603. https://doi.org/10.1080/14733285.2014.927052

Christian, H. E., Klinker, C. D., Villanueva, K., Knuiman, M. W., Foster, S. A., Zubrick, S. R., Divitini, M., Wood, L., & Giles-Corti, B. (2015). The Effect of the Social and Physical Environment on Children's Independent Mobility to Neighborhood Destinations. *J Phys Act Health*, *12 Suppl 1*, S84-93. https://doi.org/10.1123/jpah.2014-0271

Cloutier, M.-S., Beaulieu, E., Fridman, L., Macpherson, A. K., Hagel, B. E., Howard, A. W., Churchill, T., Fuselli, P., Macarthur, C., & Rothman, L. J. I. p. (2021). State-of-the-art review: preventing child and youth pedestrian motor vehicle collisions: critical issues and future directions. *27*(1), 77-84.

Cloutier, M.-S., Lachapelle, U., d'Amours-Ouellet, A.-A., Bergeron, J., Lord, S., & Torres, J. (2017). "Outta my way!" Individual and environmental correlates of interactions between pedestrians and vehicles during street crossings. *Accident Analysis & Prevention*, *104*, 36-45.

Cloutier, S. G. M.-S. (2018). *On the way to school: perceptions of parents and elementary school children facing road risk during the implementation of a Trottibus in Quebec*.

Comber, A., Brunsdon, C., & Green, E. (2008). Using a GIS-based network analysis to determine urban greenspace accessibility for different ethnic and religious groups. *Landscape and Urban Planning*, *86*(1), 103-114. https://doi.org/10.1016/j.landurbplan.2008.01.002

Cordovil, R., Lopes, F., & Neto, C. (2015). Children's (in)dependent mobility in Portugal. *J Sci Med Sport*, *18*(3), 299-303. https://doi.org/10.1016/j.jsams.2014.04.013

Curl, A., Clark, J., & Kearns, A. (2018). Household car adoption and financial distress in deprived urban communities: A case of forced car ownership? *Transport Policy*, *65*, 61-71. https://doi.org/https://doi.org/10.1016/j.tranpol.2017.01.002

Curtis, C., Babb, C., & Olaru, D. (2015). Built environment and children's travel to school. *Transport Policy*, *42*, 21-33. https://doi.org/https://doi.org/10.1016/j.tranpol.2015.04.003

Davison, K. K., & Lawson, C. T. (2006). Do attributes in the physical environment influence children's physical activity? A review of the literature. *The international journal of behavioral nutrition and physical activity*, *3*, 19-19. https://doi.org/10.1186/1479-5868-3-19

Deakin, E. (2006). Transportation, urban form and economic growth. *ECMT Regional Round Table*, *137*.

Derr, V., & Tarantini, E. (2016). "Because we are all people": outcomes and reflections from young people's participation in the planning and design of child-friendly public spaces. *Local Environment*, *21*(12), 1534-1556. https://doi.org/10.1080/13549839.2016.1145643

Desjardins, E., Tavakoli, Z., Paez, A., & Waygood, E. O. D. (2022). Children's Access to Non-School Destinations by Active or Independent Travel: A Scoping Review. *International*

Journal of Environmental Research and Public Health, *19*(19). https://doi.org/ARTN 12345

10.3390/ijerph191912345

DiMaggio, C., Frangos, S., & Li, G. (2016). National safe routes to school program and risk of school-age pedestrian and bicyclist injury. *Annals of epidemiology*, *26*(6), 412-417.

Dodge, R., Daly, A., Huyton, J., & Sanders, L. (2012). The challenge of defining wellbeing. *International Journal of Wellbeing*, *2*. https://doi.org/10.5502/ijw.v2i3.4

Egli, V., Villanueva, K., Donnellan, N., Mackay, L., Forsyth, E., Zinn, C., Kytta, M., & Smith, M. (2020). Understanding children's neighbourhood destinations: presenting the Kids-PoND framework. *Children's Geographies*, *18*(4), 420-434. https://doi.org/10.1080/14733285.2019.1646889

El Murr, K., Waygood, O., & Boisjoly, G. (2022). How Good Is Your Basket of Parks? A Combined Index of Park Quality and Accessibility for Youth. *Journal of Transport & Health*, *25*. <Go to ISI>://WOS:000828751300014

Ewing, R., Schroeer, W., & Greene, W. (2004). School Location and Student Travel Analysis of Factors Affecting Mode Choice. *Transportation Research Record*, *1895*, 55-63. https://doi.org/10.3141/1895-08

Foster, S., Wood, L., Francis, J., Knuiman, M., Villanueva, K., & Giles-Corti, B. (2015). Suspicious minds: Can features of the local neighbourhood ease parents' fears about stranger danger? *Journal of Environmental Psychology*, *42*, 48-56. https://doi.org/https://doi.org/10.1016/j.jenvp.2015.02.001

Freeman, C., & Tranter, P. J. (2011). *Children and their urban environment: Changing worlds*. Routledge.

Furneaux, A., & Manaugh, K. (2019). Eyes on the alley: children's appropriation of alley space in Riverdale, Toronto. *Children's Geographies*, *17*(2), 204-216. https://doi.org/10.1080/14733285.2018.1482409

Fusco, C., Moola, F., Faulkner, G., Buliung, R., & Richichi, V. (2012). Toward an understanding of children's perceptions of their transport geographies: (non)active school travel and visual representations of the built environment. *Journal of Transport Geography*, *20*(1), 62-70. https://doi.org/10.1016/j.jtrangeo.2011.07.001

Fyhri, A., Hjorthol, R., Mackett, R. L., Fotel, T. N., & Kyttä, M. (2011). Children's active travel and independent mobility in four countries: Development, social contributing trends and measures. *Transport Policy*, *18*, 703-710. https://doi.org/10.1016/j.tranpol.2011.01.005

Gatersleben, B., Murtagh, N., & White, E. (2013). Hoody, goody or buddy? How travel mode affects social perceptions in urban neighbourhoods. *Transportation Research Part F: Traffic Psychology and Behaviour*, *21*(0), 219-230. https://doi.org/http://dx.doi.org/10.1016/j.trf.2013.09.005

Gemmell, E., Ramsden, R., Brussoni, M., & Brauer, M. (2023). Influence of Neighborhood Built Environments on the Outdoor Free Play of Young Children: a Systematic, Mixed-Studies Review and Thematic Synthesis. *Journal of Urban Health-Bulletin of the New York Academy of Medicine*, *100*(1), 118-150. https://doi.org/10.1007/s11524-022-00696-6

Geurs, K. T., & van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. *Journal of Transport Geography*, *12*(2), 127-140. https://doi.org/https://doi.org/10.1016/j.jtrangeo.2003.10.005

Gibson, J. E. (2012). Interviews and Focus Groups With Children: Methods That Match Children's Developing Competencies. *Journal of Family Theory & Review*, *4*(2), 148-159. https://doi.org/https://doi.org/10.1111/j.1756-2589.2012.00119.x

Giles-Corti, B., Wood, G., Pikora, T., Learnihan, V., Bulsara, M., Van Niel, K., Timperio, A., McCormack, G., & Villanueva, K. (2011). School site and the potential to walk to school: the impact of street connectivity and traffic exposure in school neighborhoods. *Health Place*, *17*(2), 545-550. https://doi.org/10.1016/j.healthplace.2010.12.011

Gobster, P. (2007). Urban Park Restoration and the "Museumification" of Nature. *Nature and Culture*, *2*, 95-114. https://doi.org/10.3167/nc2007.020201

Gong, X., van den Berg, P., & Arentze, T. (2024). A new measurement method of parental perception of child friendliness in neighborhoods to improve neighborhood quality and children's health and well-being. *Cities*, *149*, 104955. https://doi.org/https://doi.org/10.1016/j.cities.2024.104955

Guliani, A., Mitra, R., Buliung, R. N., Larsen, K., & Faulkner, G. E. J. (2015). Gender-based differences in school travel mode choice behaviour: Examining the relationship between the neighbourhood environment and perceived traffic safety. *Journal of Transport & Health*, *2*(4), 502-511. https://doi.org/10.1016/j.jth.2015.08.008

Hallgrimsdottir, B., Wennberg, H., Svensson, H., & Stahl, A. (2016). Implementation of accessibility policy in municipal transport planning - Progression and regression in Sweden between 2004 and 2014. *Transport Policy*, *49*, 196-205. https://doi.org/10.1016/j.tranpol.2016.05.002

Handy, S. (2020). Is accessibility an idea whose time has finally come? *Transportation Research Part D: Transport and Environment*, *83*, 102319. https://doi.org/10.1016/j.trd.2020.102319

Handy, S. L., Boarnet, M. G., Ewing, R., & Killingsworth, R. E. (2002). How the built environment affects physical activity: views from urban planning. *Am J Prev Med*, *23*(2 Suppl), 64-73. https://doi.org/10.1016/s0749-3797(02)00475-0

Harten, N., & Olds, T. (2004). Patterns of active transport in 11-12 year old Australian children. (1326-0200 (Print)).

Heary, C. M., & Hennessy, E. (2002). The Use of Focus Group Interviews in Pediatric Health Care Research. *Journal of Pediatric Psychology*, *27*(1), 47-57. https://doi.org/10.1093/jpepsy/27.1.47

Helliwell, J. F., & Putnam, R. D. (2004). The social context of well-being. *Philos Trans R Soc Lond B Biol Sci*, *359*(1449), 1435-1446. https://doi.org/10.1098/rstb.2004.1522

Herrmann, T., Boisjoly, G., Ross, N. A., & El-Geneidy, A. M. (2017). The Missing Middle: Filling the Gap Between Walkability and Observed Walking Behavior. *Transportation Research Record*, *2661*(1), 103-110. https://doi.org/10.3141/2661-12

Holder, M. D., Coleman, B., & Sehn, Z. L. (2009). The contribution of active and passive leisure to children's well-being. *J Health Psychol*, *14*(3), 378-386. https://doi.org/10.1177/1359105308101676

Huguenin-Richard, F. (2010). La mobilité des enfants à l'épreuve de la rue: Impacts de l'aménagement de zones 30 sur leurs comportements. *Enfances, Familles, Générations*(12), 66-87.

Hwang, J., Joh, K., & Woo, A. (2017). Social inequalities in child pedestrian traffic injuries: Differences in neighborhood built environments near schools in Austin, TX, USA. *Journal of Transport & Health*, *6*, 40-49. https://doi.org/10.1016/j.jth.2017.05.003

Iwasaki, Y. (2001). Contributions of leisure to coping with daily hassles in university students' lives. *Canadian Journal of Behavioural Science / Revue canadienne des sciences du comportement*, *33*(2), 128-141. https://doi.org/10.1037/h0087135

Jamshidi, E., Moradi, A., & Majdzadeh, R. (2017). Environmental risk factors contributing to traffic accidents in children: a case-control study. *International Journal of Injury Control and Safety Promotion*, *24*(3), 338-344. https://doi.org/10.1080/17457300.2016.1183031

Janssen, I., & Rosu, A. (2015). Undeveloped green space and free-time physical activity in 11 to 13-year-old children. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 26. https://doi.org/10.1186/s12966-015-0187-3

Jimenez, M. P., DeVille, N. V., Elliott, E. G., Schiff, J. E., Wilt, G. E., Hart, J. E., & James, P. (2021). Associations between Nature Exposure and Health: A Review of the Evidence. *Int J Environ Res Public Health*, *18*(9). https://doi.org/10.3390/ijerph18094790

Joshi, M. S., Maclean, M., & Carter, W. (1999). Children's journey to school : Spatial skills, knowledge and perceptions of the environment. *British Journal of Developmental Psychology*, *17*, 125-139. https://ezproxy.bibl.ulaval.ca/login?url=http://search.proquest.com/docview/65340538?accountid=12008

Kyttä, A. M., Broberg, A. K., & Kahila, M. H. (2012). Urban environment and children's active lifestyle: softGIS revealing children's behavioral patterns and meaningful places. *Am J Health Promot*, *26*(5), e137-148. https://doi.org/10.4278/ajhp.100914-QUAN-310

Kyttä, M. (2004). The extent of children's independent mobility and the number of actualized affordances as criteria of a child-friendly environment. *Journal of Environmental Psychology*, *24*, 179-198. https://doi.org/10.1016/S0272-4944(03)00073-2

Kyttä, M., Oliver, M., Ikeda, E., Ahmadi, E., Omiya, I., & Laatikainen, T. (2018). Children as urbanites: mapping the affordances and behavior settings of urban environments for Finnish and Japanese children. *Children's Geographies*, *16*(3), 319-332. https://doi.org/10.1080/14733285.2018.1453923

Levinson, D. M. (1998). Accessibility and the journey to work. *Journal of Transport Geography*, *6*(1), 11-21. https://doi.org/https://doi.org/10.1016/S0966-6923(97)00036-7

Levinson, D. M., & Wu, H. (2020). Towards a general theory of access. *Journal of Transport and Land Use*, *13*(129-158). https://doi.org/https://doi.org/10.5198/jtlu.2020.1660

Levinson, D. M., & Wu, H. (2020). Towards a general theory of access. *Journal of Transport and Land Use*, *13*(1), 129-158. https://doi.org/10.5198/jtlu.2020.1660

Li, Z. Z., Zhou, X. H., Wang, X. A., & Guo, Z. Y. (2013). Study on Subjective and Objective Safety and Application of Expressway. *Intelligent and Integrated Sustainable Multimodal Transportation Systems Proceedings from the 13th Cota International Conference of Transportation Professionals (Cictp2013)*, *96*, 1622-1630. https://doi.org/10.1016/j.sbspro.2013.08.184

Livingston, I. M. (2022). *Variables That Affect Parental Goals for Visiting a Children's Museum* University of New Hampshire]. https://scholars.unh.edu/honors/641

Loebach, J., & Gilliland, J. (2016). Neighbourhood play on the endangered list: examining patterns in children's local activity and mobility using GPS monitoring and qualitative GIS. *Children's Geographies*, *14*(5), 573-589. https://doi.org/10.1080/14733285.2016.1140126

Loebach, J. E., & Gilliland, J. A. (2014). Free Range Kids? Using GPS-Derived Activity Spaces to Examine Children's Neighborhood Activity and Mobility. *Environment and Behavior*, *48*(3), 421-453. https://doi.org/10.1177/0013916514543177

Lovelace, R. (2021). Open source tools for geographic analysis in transport planning. *Journal of Geographical Systems*, *23*(4), 547-578. https://doi.org/10.1007/s10109-020-00342-2

Lynch, K. (1981). *A Theory of Good City*. MIT Press.

Marais, A., & Abi-Zeid, I. (2021). *A Method to Identify, Characterize and Engage Relevant Stakeholders in Decision Processes*. https://doi.org/10.13140/RG.2.2.23890.89287

Martens, K., & Golub, A. (2012). A justice-theoretic exploration of accessibility measures. In. https://doi.org/10.4337/9781781000106.00020

McDonald, N. C., & Aalborg, A. E. (2009). Why Parents Drive Children to School: Implications for Safe Routes to School Programs. *Journal of the American Planning Association*, *75*(3), 331-342. https://doi.org/10.1080/01944360902988794

McMillan, T. E. (2005). Urban form and a child's trip to school: The current literature and a framework for future research. *Journal of Planning Literature*, *19*(4), 440-456. https://doi.org/10.1177/0885412204274173

McMillan, T. E. (2007). The relative influence of urban form on a child's travel mode to school. *Transportation Research Part A: Policy and Practice*, *41*, 69-79. https://doi.org/10.1016/j.tra.2006.05.011

Meir, A., & Oron-Gilad, T. (2020). Understanding complex traffic road scenes: The case of child-pedestrians' hazard perception. *Journal of Safety Research*, *72*, 111-126. https://doi.org/10.1016/j.jsr.2019.12.014

Meir, A., Oron-Gilad, T., & Parmet, Y. (2015). Are child-pedestrians able to identify hazardous traffic situations? Measuring their abilities in a virtual reality environment. *Safety Science*, *80*, 33-40. https://doi.org/10.1016/j.ssci.2015.07.007

Meir, A., Parmet, Y., & Oron-Gilad, T. (2013). Towards understanding child-pedestrians' hazard perception abilities in a mixed reality dynamic environment. *Transportation Research Part F-Traffic Psychology and Behaviour*, *20*, 90-107. https://doi.org/10.1016/j.trf.2013.05.004

Milne, S. (2009). Moving Into and Through the Public World: Children's Perspectives on their Encounters with Adults. *Mobilities*, *4*(1), 103-118. https://doi.org/10.1080/17450100802657988

Mitra, R. (2013). Independent Mobility and Mode Choice for School Transportation: A Review and Framework for Future Research. *Transport Reviews*, *33*(1), 21-43. https://doi.org/10.1080/01441647.2012.743490

Mitra, R., ., & Manaugh, K. (2020). *Transport and Children's Wellbeing*. Elsevier.

Mitra, R., Buliung, R. N., & Roorda, M. J. (2010). Built Environment and School Travel Mode Choice in Toronto, Canada. *Transportation Research Record*, *2156*(1), 150-159. https://doi.org/10.3141/2156-17

Mitra, R., Faulkner, G. E. J., Buliung, R. N., & Stone, M. R. (2014). Do parental perceptions of the neighbourhood environment influence children's independent mobility? Evidence from Toronto, Canada. *Urban Studies*, *51*(16), 3401-3419. https://doi.org/10.1177/0042098013519140

Mitra, R., Rn., B., & Faulkner, G. E. (2010). Spatial clustering and the temporal mobility of walking school trips in the Greater Toronto Area, Canada. (1873-2054 (Electronic)).

Morency, C., Demers, M., & Lapierre, L. (2007). How many steps do you have in reserve? Thoughts and measures about a healthier way to travel. *Transportation Research Record*(2002), 1-6. https://doi.org/10.3141/2002-01

Morency, C., Verreault, H., & Frappier, A. (2020). Estimating latent cycling and walking trips in Montreal. *International Journal of Sustainable Transportation*, *14*(5), 349-360. https://doi.org/10.1080/15568318.2018.1558467

NACTO. (2020). Designing streets for kids. *National Association of City Transportation Officials*. https://doi.org/https://nacto.org/publication/designing-streets-for-kids/

Nevelsteen, K., Steenberghen, T., Van Rompaey, A., & Uyttersprot, L. (2012). Controlling factors of the parental safety perception on children's travel mode choice. *Accident Analysis and Prevention*, *45*, 39-49. https://doi.org/10.1016/j.aap.2011.11.007

Oliver, L. N., Schuurman, N., & Hall, A. W. (2007). Comparing circular and network buffers to examine the influence of land use on walking for leisure and errands. *Int J Health Geogr*, *6*, 41. https://doi.org/10.1186/1476-072x-6-41

Oliver, M., Badland, H., Mavoa, S., Witten, K., Kearns, R., Ellaway, A., Hinckson, E., Mackay, L., & Schluter, P. J. (2014). Environmental and socio-demographic associates of children's active transport to school: a cross-sectional investigation from the URBAN Study. *International Journal of Behavioral Nutrition and Physical Activity*, *11*(1), 70. https://doi.org/10.1186/1479-5868-11-70

Oliver, M., Mavoa, S., Badland, H., Parker, K., Donovan, P., Kearns, R. A., Lin, E.-Y., & Witten, K. (2015). Associations between the neighbourhood built environment and out of school physical activity and active travel: An examination from the Kids in the City study. *Health & Place*, *36*, 57-64. https://doi.org/https://doi.org/10.1016/j.healthplace.2015.09.005

Oliver, M., Witten, K., Kearns, R. A., Mavoa, S., Badland, H. M., Carroll, P., Drumheller, C., Tavae, N., Asiasiga, L., Jelley, S., Kaiwai, H., Opit, S., Lin, E.-Y. J., Sweetsur, P., Barnes,

H. M., Mason, N., & Ergler, C. (2011). Kids in the city study: research design and methodology. *BMC Public Health*, *11*(1), 587. https://doi.org/10.1186/1471-2458-11-587

Olsen, J. R., Mitchell, R., McCrorie, P., & Ellaway, A. (2019). Children's mobility and environmental exposures in urban landscapes: A cross-sectional study of 10-11 year old Scottish children. *Soc Sci Med*, *224*, 11-22. https://doi.org/10.1016/j.socscimed.2019.01.047

Owen, A., & Levinson, D. (2015). Modeling the commute mode share of transit using continuous accessibility to jobs. *Transportation Research Part A: Policy and Practice*, *74*. https://doi.org/10.1016/j.tra.2015.02.002

Pabayo, R. A., Gauvin, L., Barnett, T. A., Morency, P., Nikiéma, B., & Séguin, L. (2012). Understanding the determinants of active transportation to school among children: Evidence of environmental injustice from the Quebec longitudinal study of child development. *Health & Place*, *18*(2), 163-171. https://doi.org/10.1016/j.healthplace.2011.08.017

Páez, A., Scott, D. M., & Morency, C. (2012). Measuring accessibility: positive and normative implementations of various accessibility indicators. *Journal of Transport Geography*, *25*, 141-153. https://doi.org/https://doi.org/10.1016/j.jtrangeo.2012.03.016

Panter, J., Guell, C., Humphreys, D., & Ogilvie, D. (2019). Title: Can changing the physical environment promote walking and cycling? A systematic review of what works and how. *Health & Place*, *58*, 102161. https://doi.org/https://doi.org/10.1016/j.healthplace.2019.102161

Pearce, M., Page, A. S., Griffin, T. P., & Cooper, A. R. (2014). Who children spend time with after school: associations with objectively recorded indoor and outdoor physical activity. *International Journal of Behavioral Nutrition and Physical Activity*, *11*(1), 45. https://doi.org/10.1186/1479-5868-11-45

Pereira, R. H. M., Saraiva, M., Herszenhut, D., Braga, C. K. V., & Conway, M. W. . (2021). r5r: Rapid Realistic Routing on Multimodal Transport Networks with R5 in R. *Findings*. https://doi.org/10.32866/001c.21262

Pollard, E. L., & Lee, P. D. (2003). Child Well-being: A Systematic Review of the Literature. *Social Indicators Research*, *61*(1), 59-78. https://doi.org/10.1023/A:1021284215801

Prezza, M., Alparone, F. R., Renzi, D., & Pietrobono, A. (2010). Social Participation and Independent Mobility in Children: The Effects of Two Implementations of “We Go to School Alone”. *Journal of prevention & intervention in the community*, *38*, 8-25. https://doi.org/10.1080/10852350903393392

Qiu, L., & Zhu, X. (2021). Housing and Community Environments vs. Independent Mobility: Roles in Promoting Children's Independent Travel and Unsupervised Outdoor Play. *Int J Environ Res Public Health*, *18*(4). https://doi.org/10.3390/ijerph18042132

Reyes, M., Páez, A., & Morency, C. (2014). Walking accessibility to urban parks by children: A case study of Montreal. *Landscape and Urban Planning*, *125*. https://doi.org/10.1016/j.landurbplan.2014.02.002

Rissotto, A., & Tonucci, F. (2002). FREEDOM OF MOVEMENT AND ENVIRONMENTAL KNOWLEDGE IN ELEMENTARY SCHOOL CHILDREN. *Journal of Environmental Psychology*, *22*, 65-77.

Robillard, A., Boisjoly, G., & Waygood, E. O. D. (2023). Access to Parks and Green Spaces in Quebec City, Canada: Developing Children-Specific Accessibility Measures. *Transportation Research Record*. https://doi.org/10.1177/03611981231161618

Rothman, L., Buliung, R., Macarthur, C., To, T., & Howard, A. J. I. p. (2014). Walking and child pedestrian injury: a systematic review of built environment correlates of safe walking. *20*(1), 41-49.

Rothman, L., Buliung, R., To, T., Macarthur, C., Macpherson, A., Howard, A. J. J. o. T., & Health. (2015). Associations between parents′ perception of traffic danger, the built environment and walking to school. *2*(3), 327-335.

Rothman, L., Hagel, B., Howard, A., Cloutier, M. S., Macpherson, A., Aguirre, A. N., McCormack, G. R., Fuselli, P., Buliung, R., HubkaRao, T., Ling, R., Zanotto, M., Rancourt, M., & Winters, M. (2021). Active school transportation and the built environment across Canadian cities: Findings from the child active transportation safety and the environment (CHASE) study. *Preventive Medicine*, *146*, 106470. https://doi.org/10.1016/j.ypmed.2021.106470

Rothman, L., Macpherson, A. K., Ross, T., & Buliung, R. N. (2018). The decline in active school transportation (AST): A systematic review of the factors related to AST and changes in school transport over time in North America. *Prev Med*, *111*, 314-322. https://doi.org/10.1016/j.ypmed.2017.11.018

Rothman, L., To, T., Buliung, R., Macarthur, C., & Howard, A. (2014). Influence of social and built environment features on children walking to school: An observational study. *Preventive Medicine*, *60*, 10-15. https://doi.org/10.1016/j.ypmed.2013.12.005

Rothman, L. F., Liraz ; Cloutier, Marie-Soleil ; Manaugh, Kevin and Howard, Andrew (2019). Impact of road traffic and speed on children: Injuries, social inequities, and active transport. In *Transportation and Children's Well-Being* (pp. 103-117.). Elsevier.

Russo, A., & Andreucci, M. B. (2023). Raising Healthy Children: Promoting the Multiple Benefits of Green Open Spaces through Biophilic Design. *Sustainability*, *15*(3), 1982. https://www.mdpi.com/2071-1050/15/3/1982

Schlossberg, M., Greene, J., Phillips, P. P., Johnson, B., & Parker, B. (2006). School Trips: Effects of Urban Form and Distance on Travel Mode. *Journal of the American Planning Association*, *72*(3), 337-346. https://doi.org/10.1080/01944360608976755

Schwebel, D. C., & McClure, L. A. (2010). Using virtual reality to train children in safe street-crossing skills. *Injury Prevention*, *16*(1), E1-E5. https://doi.org/10.1136/ip.2009.025288

Scott, D. M., and Mark W. Horner. . (2008). “The Role of Urban Form in Shaping Access to Opportunities: An Exploratory Spatial Data Analysis.”. *Journal of Transport and Land Use*, *1*, 89–119. http://www.jstor.org/stable/26201615.

Sharmin, S., Kamruzzaman, M., & Haque, M. M. (2021). Modelling children's independent territorial range by discretionary and nondiscretionary trips. *Journal of Transport and Land Use*, *14*(1), 417-439. https://doi.org/10.5198/jtlu.2021.1889

Shutt, J. E., Miller, J. M., Schreck, C. J., & Brown, N. K. (2004). Reconsidering the Leading Myths of Stranger Child Abduction. *Criminal Justice Studies*, *17*(1), 127-134. https://doi.org/10.1080/0888431042000217688

Smeds, E., Verlinghieri, E., Connolly, J. T., Castañeda, P., Kocsis, J., Manaugh, K., Polgár, A., Wargent, M., & Waygood, E. O. D. (2023). 'Seeing like a citizen': rethinking city street transformations through the lens of epistemic justice. *Planning Theory and Practice*. https://orca.cardiff.ac.uk/id/eprint/163803

Smith, L., Aggio, D., & Hamer, M. (2017). Active travel to non-school destinations but not to school is associated with higher physical activity levels in an ethnically diverse sample of inner-city schoolchildren. *BMC Public Health*, *17*(1), 13. https://doi.org/10.1186/s12889-016-3920-1

Smoyer-Tomic, K. E., Hewko, J. N., & Hodgson, M. J. (2004). Spatial accessibility and equity of playgrounds in Edmonton, Canada. *Canadian Geographer-Geographe Canadien*, *48*(3), 287-302. https://doi.org/DOI 10.1111/j.0008-3658.2004.00061.x

Sørensen, M., & Mosslemi, M. (2009). Subjective and Objective Safety. *The effect of road*, *8*.

Soukhov, A., & Paez, A. (2023). TTS2016R: A data set to study population and employment patterns from the 2016 Transportation Tomorrow Survey in the Greater Golden Horseshoe area, Ontario, Canada. *Environment and Planning B-Urban Analytics and City Science*, *50*(2), 556-563. https://doi.org/10.1177/23998083221146781

StatisticsCanada. (2021). *Dissemination area* https://doi.org/https://www12.statcan.gc.ca/census-recensement/2021/ref/dict/az/definition-eng.cfm?ID=geo021

StatisticsCanada. (2022). Retrieved 2022-05-31 from

Stewart, N. (2020). Urban green space, social equity and human wellbeing. In P. S. P. Verma, R. Singh and A. S. Raghubanshi (Ed.), *Urban Ecology* (pp. 111-127). Elsevier.

Summers, J. K., Vivian, D. N., & Summers, J. T. (2019). The Role of Interaction with Nature in Childhood Development: An Under-Appreciated Ecosystem Service. *Psychol Behav Sci*, *8*(6), 142-150.

Tavakoli, Z., Abdollahi, S., Waygood, E. O. D., Páez, A., & Boisjoly, G. (2024). Traffic danger's potential impact on children's accessibility. *Transportation Research Part D: Transport and Environment*, *135*, 104370. https://doi.org/https://doi.org/10.1016/j.trd.2024.104370

Tavakoli , Z., Abdollahi , S., Waygood , O., & Paez , A. (Under Revision). Traffic danger's potential impact on children's accessibility. *Transportation Research Part D-Transport and Environment*, *Under Review*.

Tavakoli, Z., Waygood, O., Abdollahi, S., & Paez, A. (Under Revision). "Where Do Children Go?" Exploring Children's Daily Destinations with Children, Parents, And Experts". *Urban Planning*.

Tavakoli, Z., Waygood, O., & Boisjoly, G. (2022). Analyzing the Accuracy of Walk Score for Different Age Groups in Montreal, Canada. *Journal of Transport & Health*, *25*. <Go to ISI>://WOS:000828751300026

Teeuwen, R., Psyllidis, A., & Bozzon, A. (2023). Measuring children's and adolescents' accessibility to greenspaces from different locations and commuting settings. *Computers, Environment and Urban Systems*, *100*, 101912. https://doi.org/https://doi.org/10.1016/j.compenvurbsys.2022.101912

Tester, J. M., Rutherford, G. W., Wald, Z., & Rutherford, M. W. J. A. j. o. p. h. (2004). A matched case–control study evaluating the effectiveness of speed humps in reducing child pedestrian injuries. *94*(4), 646-650.

Tillmann, S., Tobin, D., Avison, W., & Gilliland, J. (2018). Mental health benefits of interactions with nature in children and teenagers: a systematic review. *Journal of Epidemiology and Community Health*, *72*(10), 958-966. https://doi.org/10.1136/jech-2018-210436

Tillyer, M. S., Tillyer, R., & Kelsay, J. (2015). The nature and influence of the victim-offender relationship in kidnapping incidents. *Journal of Criminal Justice*, *43*(5), 377-385. https://doi.org/https://doi.org/10.1016/j.jcrimjus.2015.07.002

Timperio, A., Ball, K., Salmon, J., Roberts, R., Giles-Corti, B., Simmons, D., Baur, L. A., & Crawford, D. (2006). Personal, family, social, and environmental correlates of active commuting to school. *Am J Prev Med*, *30*(1), 45-51. https://doi.org/10.1016/j.amepre.2005.08.047

Timperio, A., Crawford, D., Telford, A., & Salmon, J. (2004). Perceptions about the local neighborhood and walking and cycling among children. (0091-7435 (Print)).

Tsou, K. W., Hung, Y. T., & Chang, Y. L. (2005). An accessibility-based integrated measure of relative spatial equity in urban public facilities. *Cities*, *22*(6), 424-435. https://doi.org/10.1016/j.cities.2005.07.004

UNCRC. (1988). *Convention on the Rights of the Child, Adopted and opened for signature, ratification and accession by General Assembly resolution 44/25 of 20 November 1989*.

Veitch, J., Bagley, S., Ball, K., & Salmon, J. (2006). Where do children usually play? A qualitative study of parents' perceptions of influences on children's active free-play. *Health Place*, *12*(4), 383-393. https://doi.org/10.1016/j.healthplace.2005.02.009

Vidal, D. G., & Castro Seixas, E. (2022). Children's Green Infrastructure: Children and Their Rights to Nature and the City. *Frontiers in Sociology*, *7*, 804535. https://doi.org/10.3389/fsoc.2022.804535

Villanueva, K., Giles-Corti, B., Bulsara, M., McCormack, G. R., Timperio, A., Middleton, N., Beesley, B., & Trapp, G. (2012). How far do children travel from their homes? Exploring children's activity spaces in their neighborhood. *Health and Place*, *18*. https://doi.org/10.1016/j.healthplace.2011.09.019

Villanueva, K., Giles-Corti, B., Bulsara, M., Timperio, A., McCormack, G., Beesley, B., Trapp, G., & Middleton, N. (2012). Where Do Children Travel to and What Local Opportunities Are Available? The Relationship Between Neighborhood Destinations and Children’s

Independent Mobility. *Environment and Behavior*, *45*(6), 679-705. https://doi.org/10.1177/0013916512440705

Vogl, S., Schmidt, E.-M., & Kapella, O. (2023). Focus Groups With Children: Practicalities and Methodological Insights. *Forum Qualitative Sozialforschung Forum: Qualitative Social Research*, *24*. https://doi.org/https://doi.org/10.17169/fqs-24.2.3971

Wang, H., Morgan, C., Li, D., Huang, R., & Schwebel, D. C. (2021). Children's fear in traffic and its association with pedestrian decisions. *Journal of Safety Research*, *76*, 56-63. https://doi.org/10.1016/j.jsr.2020.11.010

Warner, M. E., & Zhang, X. (2020). Healthy Places for Children: The Critical Role of Engagement, Common Vision, and Collaboration. *Int J Environ Res Public Health*, *17*(24). https://doi.org/10.3390/ijerph17249277

Waygood, E. (2018). Transport and Child Well-Being: Case Study of Quebec City. In (pp. 199-218). https://doi.org/10.1007/978-3-319-76623-2_11

Waygood, E., Friman, M., Olsson, L., & Taniguichi, A. (2015). Transport and Child Well-Being. *Journal of Transport & Health*, *2*(2), S62-S63. https://doi.org/10.1016/j.jth.2015.04.599

Waygood, E. O. D. (2010). What Is the Role of Mothers in Transit-Oriented Development? *Women's Issues in Transportation*, 163.

Waygood, E. O. D., Friman, M., Olsson, L. E., & Taniguchi, A. (2017). Transport and child well-being: An integrative review. *Travel Behaviour and Society*, *9*, 32-49. https://doi.org/https://doi.org/10.1016/j.tbs.2017.04.005

Waygood, E. O. D., Olsson, L. E., Friman, M., & Mitra, R. (2020). *Transport and Children's Wellbeing*. https://doi.org/https://doi.org/10.1016/C2017-0-01786-X

Waygood, E. O. D., van de Berg, P., & Kemperman, A. (2022). The Social Dimensions of Children's Travel. In R. H. M. Pereira & G. Boisjoly (Eds.), *Social Issues in Transport Planning*. Elsevier.

Waygood, E. O. D., van den Berg, P., & Kemperman, A. (2021). Chapter Three - The social dimensions of children's travel. In R. H. M. Pereira & G. Boisjoly (Eds.), *Advances in Transport Policy and Planning* (Vol. 8, pp. 71-100). Academic Press. https://doi.org/https://doi.org/10.1016/bs.atpp.2021.06.002

Waygood, O., Olsson, L., Friman, M., & Taniguchi, A. (2017). Children's Life Satisfaction and Travel Satisfaction: An International Study. *Journal of Transport & Health*, *5*, S18-S18. https://doi.org/10.1016/j.jth.2017.05.298

Westman, J., Friman, M., & Olsson, L. E. (2017). What drives them to drive?—parents' reasons for choosing the car to take their children to school. *Frontiers in psychology*, 1970.

WHO. (2010). *Global recommendations on physical activity*

for health.

Williams, G. C., Borghese, M. M., & Janssen, I. (2018). Objectively measured active transportation to school and other destinations among 10–13 year olds. *International Journal of Behavioral Nutrition and Physical Activity*, *15*(1), 11. https://doi.org/10.1186/s12966-017-0634-4

Witten, K., Pearce, J., & Day, P. (2011). Neighbourhood Destination Accessibility Index: a GIS tool for measuring infrastructure support for neighbourhood physical activity. *Environment and Planning a-Economy and Space*, *43*(1), 205-223. https://doi.org/10.1068/a43219

Yang, J., Mu, L., & Rajbhandari-Thapa, J. (2023). Measuring and Mapping Physical Activity Disparity (PAD) Index Based on Physical Activity Environment for Children. *Isprs International Journal of Geo-Information*, *12*(3). https://doi.org/ARTN 134

10.3390/ijgi12030134

Zhao, J. H., Liang, M. M., Wang, Z. Y., Zhao, Y. Y., Cheng, J. L., & Du, Y. J. (2022). Evaluation and optimization of blends for attracting Trichogramma dendrolimi based on semiochemicals mediating tritrophic interactions in the orchard habitat. *Biological Control*, *173*. https://doi.org/ARTN 104998

10.1016/j.biocontrol.2022.104998

Ziakopoulos, A., & Yannis, G. (2020). A review of spatial approaches in road safety. *Accident Analysis and Prevention*, *135*. https://doi.org/ARTN 105323

10.1016/j.aap.2019.105323

APPENDIX A CHILD-RELEVANT DESTINATIONS DATA BASED ON PRIOR REVIEWS AND AVAILABILITY OF THE DATA IN CITY OF MONTRÉAL (OPENDATAMONTREAL, 2023)

Table A.1 Child-relevant destinations data based on prior reviews and availability of the data in city of Montréal (opendatamontreal, 2023)

Commercial activities	**Sport activities**
Electronic and household appliances	Skateboard area
Commercial tourist attraction	Martial Arts
Bakery, Chocolate, Confectionery, Pastry	Badminton
Mall	Ball at the wall
Photocopy, reproduction, printing center	Basketball
Video store (rental)	Fitness centers
Convenience store with gasoline	Specialized training centers (accessible to the public)
Convenience store (including tobacconist)	Indoor sports center
Grocery	Cricket
Specialized grocery store	Outdoor sports equipment
Aesthetics and beauty (Manicure/Pedicure)	Soccer
Florists	Sports and leisure facilities-
Fruit store	Water sports
Souvenir and gift shop	Mini tennis
Public market	Multisport
Pharmacy	Climbing wall
Supermarket	Pastille - Basketball
New clothes, shoes and accessories	Refrigerated skating rink / Basketball
	Ping-pong
Educational destinations	Outdoor pool
Primary school	Indoor pool
Secondary and vocational school	Bike path
Library	BMX track
Preschool	Rugby / 11-a-side soccer
Preschool - Elementary	11-a-side soccer
Preschool - Elementary - Secondary	4-5 Soccer, 4-5 underground soccer
Primary - Secondary	7-a/9-a side underground soccer

Table A.1 Child-relevant destinations data based on prior reviews and availability of the data in city of Montréal (opendatamontreal, 2023) – (continued)

Social-Cultural Destinations	**Sport activities**
Commercial artery	Sports, bikes and outdoors
Public art	Beach volleyball
Cultural tourist attraction	
Public library	**Public transport**
Cinema	Metro station
Fountain	Bus terminal
Art gallery	Mobility pole
Art Galleries, Works of Art	Taxi station
Museum	Train station
Museum and interpretive / exhibition centre	
Municipal Museum	**Leisure activities**
Community organization and recreation centre	Playground 18 months to 5 years old
Pediatrician	Playground 5-12 years old
Public square	Combined playground
Arts and entertainment production	Picnic Area
Pedestrian street	Ring, round of ice
Theatre and theatre	Café
Community Service	Cinema
Outdoor theatre	Hobbies, games, and leisure,
Theatre / auditorium / small venue	Paddling pool
	4 season skating rink
Green spaces	Ice ring with bands
Riparian strip	Refrigerated ice rink
Cemetery	Restaurants and fast food
Institutional space	Walking path
Green space	
Island of greenery	
Neighbourhood Park	
School Park	
Linear Park	
Metropolitan Park	
Urban Park	
Nature Park	
Public square	
Urban promenade	
Pedestrian street	
Square	

APPENDIX B REGRESSION ANALYSIS

Table B.1 Regression Analysis

Variables	Estimate	Std.error	Statistic	P.value	
(intercept)	1.60483417	0.31240438	5.13704128	6.63e-07	***
8 years old	0.06452728	0.4275011	0.15094063	0.88017545	
9 years old	-0.4902611	0.45016386	-1.0890726	0.27743899	
10 years old	0.13847822	0.44272419	0.31278667	0.75477029	
11 years old	0.75713003	0.49262423	1.53693219	0.12589836	
12 years old	1.10565962	0.43700156	2.53010453	0.0121774	*
13 years old	0.84969723	0.46278663	1.83604533	0.06784304	
14 years old	3.02580414	0.45379332	6.66780234	2.50e-10	***
Child's gender (male)	0.05610103	0.2452133	0.22878462	0.81927127	
Employment	3.55011012	4.83684005	0.73397302	0.46382906	
Pharmacy	0.52366452	4.48436753	0.11677556	0.90715568	
Childcare	-0.7259553	1.63286006	-0.4445913	0.65709829	
Health	-8.247292	11.3690253	-0.7254177	0.46904802	
Grocery	-2.5409402	3.27012163	-0.777017	0.43807138	
Education - primary school	-1.9128368	1.9030986	-1.005117	0.31606111	
Education - secondary school	0.51245472	1.91949481	0.26697375	0.78976583	
Library	-1.485907	2.61019039	-0.5692715	0.56981388	
Park	0.8131868	2.48358963	0.32742398	0.74369141	
Transit	-2.9679259	9.21584417	-0.322046	0.74775589	

APPENDIX C SOCIO-DEMOGRAPHIC OF PARENTS WHO PARTICIPATED IN CHILDREN'S DESTINATIONS SURVEY

Table C.1 Socio-demographic of parents who participated in children's destinations survey

Category	n = 422	Percentage
Parents' Age	25-34	20.85
	35-44	49.53
	45-54	29.38
	55-64	0.24
Child's Age	7 years old	18.48
	8 years old	13.03
	9 years old	11.61
	10 years old	11.85
	11 years old	8.06
	12 years old	11.85
	13 years old	13.27
	14 years old	11.85
Parents' Gender	Female	63.51
	Male	36.49

Table C.1 Socio-demographic of parents who participated in children's destinations survey (continued)

Category	n = 422	Percentage
Education	College, CEGEP, or other non-university institution	26.54
	Degree in medicine, dentistry, veterinary, medicine or optometry (MD,DDS,DMD, DVM, OD)	0.95
	Doctoral degree (i.e., Ph.D.)	1.18
	Elementary school education	0.24
	High school diploma or equivalent	12.32
	Less than high school equivalent	0.47
	Master's of Art degree (e.g., MA., M.Sc., M.Ed., M.B.A.)	13.98
	Registered apprenticeship or other trade certificate or diploma	8.53
	University bachelor, Art degree	35.78
Origin	African Origins	5.45
	Asian origins	11.85
	Caribbean origins	1.66
	European origins	41.94
	Latin, Central, and South American origins	2.61
	North American Native Origins	5.92
	Other North American origins	25.12
	I prefer not to answer	5.45

Table C.1 Socio-demographic of parents who participated in children's destinations survey (continued)

Category	n = 422	Percentage
Province	Alberta	11.37
	British Columbia	14.93
	Manitoba	2.37
	New Brunswick	2.13
	Newfoundland and Labrador	0.71
	Nova Scotia	0.95
	Ontario	30.09
	Prince Edward Island	0.24
	Quebec	34.36
	Saskatchewan	2.37
	Yukon	0.47
Employment	Full time (more than 30 hours per weak)	73.7
	Homemaker	10.43
	Not currently employed but looking for a job	1.18
	Others	2.13
	Part time/Casual employment	9.95
	Retirement	0.71
	Student	1.9

Table C.1 Socio-demographic of parents who participated in children's destinations survey (continued)

Category	n = 422	Percentage
Income	Under $15,000	1.66
	$15,000-$29,999	2.37
	$30,000-$49,999	11.61
	$50,000-$74,999	15.88
	$75,000-$99,999	19.19
	$100,000-$149,999	21.56
	$150,000 or more	22.27
	I prefer not to answer	5.45
Number of Cars	0	4.5
	1	45.5
	2	42.89
	3	5.92
	More than 3	1.18

APPENDIX D SOCIO-DEMOGRAPHIC OF CHILDREN WHO PARTICIPATED IN CHILDREN'S DESTINATIONS SURVEY

Table D.1 Socio-demographic of children who participated in children's destinations survey

Category	n=583	Percentage
Child' Age	9 years old	19.55
	10 years old	20.58
	11 years old	16.98
	12 years old	18.87
	13 years old	1.2
Child's Gender	Male	47.51
	Female	52.32
	Other	0.17
Province	Alberta	12.86
	British Columbia	10.29
	Manitoba	3.95
	New Brunswick	1.03
	Newfoundland and Labrador	1.2
	Nova Scotia	3.77
	Ontario	33.62
	Prince Edward Island	0.69
	Quebec	29.67
	Saskatchewan	2.92

Table D.1 Socio-demographic of children who participated in children's destinations survey (continued)

Category	n=583	Percentage
	Household Information	
Parents' Age	18-24	0.34
	25-34	20.93
	35-44	57.29
	45-54	18.52
	I prefer not to answer	2.92
Parents' Education	College, CEGEP, or other non-university institution	26.59
	Degree in medicine, dentistry, veterinary, medicine or optometry (MD,DDS,DMD, DVM, OD)	0.69
	Doctoral degree (i.e., Ph.D.)	1.03
	Elementary school education	1.89
	High school diploma or equivalent	13.38
	Less than high school equivalent	2.92
	Master’s of Art degree (e.g., MA., M.Sc., M.Ed., M.B.A.)	10.46
	Registered apprenticeship or other trade certificate or diploma	8.4
	University bachelor, Art degree	33.28
	I prefer not to answer	1.37

Table D.1 Socio-demographic of children who participated in children's destinations survey (continued)

Category	n=583	Percentage
	Household Information	
Origin	African Origins	5.49
	Asian origins	14.75
	Caribbean origins	2.57
	European origins	38.25
	Latin, Central, and South American origins	2.57
	North American Native Origins	6.86
	Origins of Oceania	0.17
	Other North American origins	18.35
	I prefer not to answer	10.81
Employment	Full time (more than 30 hours per weak)	65.52
	Homemaker	10.29
	I prefer not to answer	1.72
	Not currently employed but looking for a job	2.4
	Others	2.06
	Part time/Casual employment	13.89
	Retirement	0.86
	Student	3.26
	I prefer not to answer	1.72

Table D.1 Socio-demographic of children who participated in children's destinations survey (continued)

Category	n=583	Percentage
	Household Information	
Income	Under $15,000	1.72
	$15,000-$29,999	6.52
	$30,000-$49,999	10.81
	$50,000-$74,999	14.75
	$75,000-$99,999	16.12
	$100,000-$149,999	23.67
	$150,000 or more	18.01
	I prefer not to answer	8.4
Number of Cars	0	3.43
	1	37.05
	2	51.63
	3	5.66
	More than 3	2.23

APPENDIX E SOCIO-DEMOGRAPHIC OF PARENTS WHO PARTICIPATED IN WELL-BEING SURVEY

Table E.1 Socio-demographic of parents who participated in well-being survey

Category	n=438	Percentage
Parents' Age	25-34	17.58
	35-44	42.47
	45-54	39.73
	I prefer not to answer	0.23
Child's Age	7 years old	14.38
	8 years old	11.87
	9 years old	12.33
	10 years old	13.01
	11 years old	10.27
	12 years old	11.64
	13 years old	13.93
	14 years old	12.56
Parents' Gender	Female	57.53
	Male	42.24
	Other	0.23

Table E.1 Socio-demographic of parents who participated in well-being survey (continued)

Category	n=438	Percentage
Education	College, CEGEP, or other non-university institution	27.63
	Degree in medicine, dentistry, veterinary, medicine or optometry (MD,DDS,DMD, DVM, OD)	1.14
	Doctoral degree (i.e., Ph.D.)	2.28
	Elementary school education	0.46
	High school diploma or equivalent	11.64
	I prefer not to answer	0.23
	Less than high school equivalent	0.68
	Master's degree (e.g., MA., M.Sc., M.Ed., M.B.A.)	11.42
	No formal education	0.23
	Registered apprenticeship or other trade certificate or diploma	7.99
	University bachelor degree	36.3
Origin	African Origins	4.34
	Asian origins	15.3
	Caribbean origins	0.91
	European origins	41.78
	Latin, Central, and South American origins	3.2
	North American Native Origins	5.71
	Origins of Oceania	0.68
	Other North American origins	23.74

Table E.1 Socio-demographic of parents who participated in well-being survey (continued)

Category	n=438	Percentage
Origin	I prefer not to answer	4.34
Province	Alberta	13.7
	British Columbia	11.87
	Manitoba	2.74
	New Brunswick	1.37
	Newfoundland and Labrador	1.83
	Nova Scotia	1.37
	Ontario	35.39
	Prince Edward Island	0.46
	Quebec	29
	Saskatchewan	2.05
	Yukon	0.23
Employment	Full time (more than 30 hours per weak)	71.46
	Homemaker	9.36
	Not currently employed but looking for a job	2.28
	Others	2.05
	Part time/Casual employment	12.1
	Retirement	1.6
	Student	0.91

Table E.1 Socio-demographic of parents who participated in well-being survey (continued)

Category	n=438	Percentage
Employment	I prefer not to answer	0.23
Income	Under $15,000	1.37
	$15,000-$29,999	3.65
	$30,000-$49,999	15.07
	$50,000-$74,999	18.72
	$75,000-$99,999	17.12
	$100,000-$149,999	18.72
	$150,000 or more	21
	I prefer not to answer	4.34
Number of Cars	0	3.65
	1	49.09
	2	42.24
	3	4.79
	More than 3	0.23

APPENDIX F SOCIO-DEMOGRAPHIC OF CHILDREN WHO PARTICIPATED IN WELL-BEING SURVEY

Table F.1 Socio-demographic of children who participated in well-being survey

Category	n=215	Percentage
Child's Age	8 years old	20.47
	9 years old	16.28
	10 years old	21.4
	11 years old	19.53
	12 years old	18.14
	13 years old	4.19
Child's Gender	Male	46.98
	Female	53.02
Province	Alberta	15.35
	British Columbia	9.77
	Manitoba	2.79
	New Brunswick	1.4
	Newfoundland and Labrador	0.47
	Nova Scotia	1.4
	Ontario	32.56
	Quebec	33.49
	Saskatchewan	2.79

Table F.1 Socio-demographic of children who participated in well-being survey (continued)

Category	n=215	Percentage
	Household Information	
Parents' Age	25-34	15.35
	35-44	61.86
	45-54	21.4
	I prefer not to answer	1.4
Parents' Education	College, CEGEP, or other non-university institution	36.28
	Doctoral degree (i.e., Ph.D.)	0.93
	Elementary school education	0.93
	High school diploma or equivalent	12.09
	Less than high school equivalent	0.93
	Master's degree (e.g., MA., M.Sc., M.Ed., M.B.A.)	8.37
	Registered apprenticeship or other trade certificate or diploma	5.58
	University bachelor degree	33.95
	I prefer not to answer	0.93
Origin	African Origins	2.33
	Asian origins	7.44
	Caribbean origins	0.93
	European origins	45.58
	Latin, Central, and South American origins	2.79

Table F.1 Socio-demographic of children who participated in well-being survey (continued)

Category	n=215	Percentage
	Household Information	
Origin	North American Native Origins	8.37
	Other North American origins	23.26
	I prefer not to answer	9.3
Employment	Full time (more than 30 hours per weak)	69.77
	Homemaker	14.42
	Not currently employed but looking for a job	1.86
	Others	0.47
	Part time/Casual employment	10.23
	Retirement	0.47
	Student	1.4
	I prefer not to answer	1.4
Income	Under $15,000	0.93
	$15,000-$29,999	3.72
	$30,000-$49,999	12.09
	$50,000-$74,999	13.49
	$75,000-$99,999	14.42
	$100,000-$149,999	29.3
	$150,000 or more	18.6

Table F.1 Socio-demographic of children who participated in well-being survey (continued)

Category	n=215	Percentage
	Household Information	
Income	I prefer not to answer	7.44
Number of Cars	0	2.79
	1	34.42
	2	54.42
	3	5.58
	More than 3	2.79

APPENDIX G DETAILS OF PARENTS AND CHILDREN'S FREQUENCY SCORE ON EACH DESTINATION

Table G.1 Details of parents and children's frequency score on each destination

Destinations	Parents' average frequency score	Children's average frequency score	The average frequency score of both groups	Parents' hierarchy ranking	Children's hierarchy ranking	Difference
School	4.25	3.95	4.10	1	1	0
Neighborhood playground	3.31	3.54	3.42	2	2	0
Street in front of house - Summer	3.15	3.45	3.30	4	3	1
Primary school playground field after school weekend	3.22	3.38	3.30	3	4	-1
Fast-food restaurants	2.95	3.22	3.09	12	5	7
Outdoor pool - Summer	3.09	3.20	3.15	7	6	1
Street in front of house - Winter	2.99	3.17	3.08	10	7	3
Green near river	2.91	3.16	3.03	16	8	8
Neighbourhood greenspace other than playground	3.11	3.14	3.13	5	9	-4
Bike path - Summer	3.02	3.12	3.07	9	10	-1
Outdoor sports No Team - Summer	3.10	3.08	3.09	6	11	-5
Library	2.94	3.08	3.01	13	12	1
Convenience store	2.93	3.08	3.00	14	13	1
Mall	2.85	3.08	2.96	18	14	4

Table G.1 Details of parents and children's frequency score on each destination (continued)

Destinations	Parents' average frequency score	Children's average frequency score	The average frequency score of both groups	Parents' hierarchy ranking	Children's hierarchy ranking	Difference
Big supermarket	2.91	3.06	2.99	15	15	0
Toy store	2.61	2.96	2.79	33	16	17
Indoor pool - Winter	2.76	2.95	2.85	20	17	3
After school program	2.97	2.92	2.94	11	18	-7
Small grocery	2.68	2.89	2.78	25	19	6
Outdoor sports Team - Summer	2.86	2.87	2.87	17	20	-3
Paddling pool splash park - Summer	2.77	2.86	2.82	19	21	-2
Bakery, chocolate stores	2.60	2.84	2.72	35	22	13
Sidewalk	3.06	2.82	2.94	8	23	-15
Nature Park	2.67	2.75	2.71	27	24	3
Clothing stores	2.56	2.74	2.65	37	25	12
Picnic Area - Summer	2.72	2.73	2.73	22	26	-4
Outdoor basketball - Summer	2.62	2.71	2.67	31	27	4
Community organization recreation centre	2.64	2.70	2.67	30	28	2
Toboggan Hills - Winter	2.69	2.69	2.69	24	29	-5
Local shopping street	2.74	2.69	2.71	21	30	-9

Table G.1 Details of parents and children's frequency score on each destination (continued)

Destinations	Parents' average frequency score	Children's average frequency score	The average frequency score of both groups	Parents' hierarchy ranking	Children's hierarchy ranking	Difference
Other indoor sports - Winter	2.67	2.68	2.67	29	31	-2
Hiking trail - Summer	2.70	2.68	2.69	23	32	-9
Cinema	2.44	2.64	2.54	42	33	9
Indoor skating rink - Winter	2.67	2.63	2.65	28	34	-6
Back alley - Summer	2.60	2.61	2.60	34	35	-1
Linear Park	2.56	2.61	2.59	36	36	0
Book store	2.54	2.61	2.57	39	37	2
Outdoor skating rink - Winter	2.61	2.60	2.60	32	38	-6
High school fields afterschool, weekend	2.67	2.58	2.62	26	39	-13
Metropolitan Park	2.52	2.57	2.55	41	40	1
Cafe	2.40	2.53	2.46	45	41	4
Urban park	2.53	2.50	2.51	40	42	-2
Pedestrian street	2.55	2.49	2.52	38	43	-5
Tourist attractions	2.40	2.46	2.43	44	44	0
Back alley - Winter	2.35	2.36	2.35	47	45	2
Bus stop	2.44	2.34	2.39	43	46	-3
Public market	2.29	2.32	2.30	49	47	2
Public square	2.35	2.30	2.32	46	48	-2
Fruit store	2.23	2.29	2.26	51	49	2

Table G.1 Details of parents and children's frequency score on each destination (continued)

Destinations	Parents' average frequency score	Children's average frequency score	The average frequency score of both groups	Parents' hierarchy ranking	Children's hierarchy ranking	Difference
Outdoor tennis - Summer	2.31	2.28	2.29	48	50	-2
Pharmacy	2.21	2.26	2.24	52	51	1
Skateboard park - Winter	2.25	2.25	2.25	50	52	-2
Video game rental	2.14	2.23	2.18	61	53	8
Theatre	2.14	2.21	2.18	57	54	3
Museum	2.19	2.19	2.19	55	55	0
Haircut	2.20	2.18	2.19	53	56	-3
Metro subway station	2.19	2.18	2.19	54	57	-3
Dance Class - Summer	2.14	2.16	2.15	60	58	2
Martial Arts - Summer	2.12	2.15	2.13	63	59	4
Church religious center	2.18	2.12	2.15	56	60	-4
Martial Arts - Winter	2.12	2.12	2.12	64	61	3
BMX - Summer	2.14	2.12	2.13	59	62	-3
Train station	2.06	2.11	2.09	66	63	3
Dance Class - Winter	2.12	2.11	2.11	62	64	-2
Public art spot	2.14	2.11	2.13	58	65	-7
Art Galleries	2.10	2.10	2.10	65	66	-1
Doctor	2.01	1.90	1.96	68	67	1
Dentist	2.03	1.86	1.94	67	68	-1
Optometrist	1.93	1.84	1.88	69	69	0

Table G.1 Details of parents and children's frequency score on each destination (continued)

Destinations	Parents' average frequency score	Children's average frequency score	The average frequency score of both groups	Parents' hierarchy ranking	Children's hierarchy ranking	Difference
Florists	1.87	1.81	1.84	71	70	1
Medical specialist	1.93	1.79	1.86	70	71	-1
Cemetery	1.80	1.64	1.72	72	72	0

APPENDIX H DETAILS OF T-TEST FOR PARENTS AND CHILDREN'S FREQUENCY SCORE ON EACH DESTINATION

Table H.1 Details of t-test for parents and children's frequency score on each destination

Destinations	Mean parents	Mean children	P_value		T_statistic	Df
Educational destinations						
School	4.25	3.95	<0.001	*	5.49	1001.04
After school program	2.97	2.92	NS		0.69	932.88
Library	2.94	3.08	<0.05	*	-2.25	890.29
Green destinations						
Green near river	2.91	3.16	<0.001	*	-4.05	954.40
Primary school playground/field after school or on the weekend	3.22	3.38	<0.05	*	-2.31	885.10
Middle or high-school fields after school or on the weekend	2.67	2.58	NS		1.40	914.14
Neighborhood playground	3.31	3.54	<0.001	*	-3.69	903.87
Neighbourhood greenspace other than playground	3.11	3.14	NS		-0.59	947.33
Linear Park	2.56	2.61	NS		-0.75	927.15
Metropolitan Park	2.52	2.57	NS		-1.05	936.58
Nature Park	2.67	2.75	NS		-1.46	951.19
Urban park	2.53	2.50	NS		0.46	938.66
Healthcare destinations						
Doctor	2.01	1.90	<0.01	*	3.20	982.08
Dentist	2.03	1.86	<0.001	*	5.08	1000.53
Medical specialist	1.93	1.79	<0.001	*	3.93	973.80
Optometrist	1.93	1.84	<0.01	*	2.96	987.25

Table H.1 Details of t-test for parents and children's frequency score on each destination (continued)

Destinations	Mean parents	Mean children	P_value		T_statistic	Df
Social/cultural						
Restaurants, fast-food	2.95	3.22	<0.001	*	-4.95	926.95
Cafe	2.40	2.53	<0.05	*	-2.19	967.57
Cinema	2.44	2.64	<0.001	*	-3.94	907.27
Art Galleries	2.10	2.10	NS		-0.12	958.94
Museum	2.19	2.19	NS		-0.10	944.37
Theatre	2.14	2.21	NS		-1.50	962.30
Cemetery	1.80	1.64	<0.001	*	4.21	950.39
Public art spot	2.14	2.11	NS		0.84	948.30
Church religious center	2.18	2.12	NS		0.89	951.74
Community organization recreation centre	2.64	2.70	NS		-1.08	948.53
Public space						
Sidewalk	3.06	2.82	<0.001	*	3.31	930.82
Public square	2.35	2.30	NS		0.91	914.80
Pedestrian street	2.55	2.49	NS		0.86	923.16
Street front of house- Summer	3.15	3.45	<0.001	*	-3.88	913.91
Street front of house- Winter	2.99	3.17	<0.05	*	-2.43	931.38
Back alley- Winter	2.35	2.36	NS		-0.29	941.68
Back alley- Summer	2.60	2.61	NS		-0.11	955.82

Table H.1 Details of t-test for parents and children's frequency score on each destination (continued)

Destinations	Mean parents	Mean children	P_value		T_statistic	Df
Sports and leisure						
Skateboard park- Winter	2.25	2.25	NS		0.11	932.11
Outdoor skating rink- Winter	2.61	2.60	NS		0.27	916.94
Indoor skating rink- Winter	2.67	2.63	NS		0.56	901.22
Indoor pool- Winter	2.76	2.95	<0.001	*	-3.31	930.17
Other indoor sports- Winter	2.67	2.68	NS		-0.21	902.84
Toboggan Hills- Winter	2.69	2.69	NS		0.04	899.15
Martial Arts- Winter	2.12	2.12	NS		-0.13	964.31
Dance Class- Winter	2.12	2.11	NS		0.23	955.66
Outdoor sports Team- Summer	2.86	2.87	NS		-0.10	919.58
Outdoor sports No Team- Summer	3.10	3.08	NS		0.30	892.21
Outdoor basketball- Summer	2.62	2.71	NS		-1.32	959.52
Outdoor pool- Summer	3.09	3.20	NS		-1.63	922.42
Outdoor tennis- Summer	2.31	2.28	NS		0.62	940.55
Bike path- Summer	3.02	3.12	NS		-1.51	899.31
BMX- Summer	2.14	2.12	NS		0.39	923.71
Martial Arts- Summer	2.12	2.15	NS		-0.43	946.21
Dance Class- Summer	2.14	2.16	NS		-0.27	956.62
Picnic Area - Summer	2.72	2.73	NS		-0.14	920.27
Paddling pool splash park- Summer	2.77	2.86	NS		-1.36	922.70
Hiking trail - Summer	2.70	2.68	NS		0.47	933.31

Table H.1 Details of t-test for parents and children's frequency score on each destination (continued)

Destinations	Mean parents	Mean children	P_value		T_statistic	Df
Transport						
Metro subway station	2.19	2.18	NS		0.21	906.71
Bus stop	2.44	2.34	NS		1.43	880.05
Train station	2.06	2.11	NS		-0.98	949.17
Commercial						
Local shopping street	2.74	2.69	NS		0.93	950.78
Book store	2.54	2.61	NS		-1.15	945.22
Convenience store	2.93	3.08	<0.05	*	-2.35	925.78
Small grocery	2.68	2.89	<0.001	*	-3.52	927.50
Toy store	2.61	2.96	<0.001	*	-6.40	927.32
Tourist attractions	2.40	2.46	NS		-1.17	893.60
Bakery chocolate stores	2.60	2.84	<0.001	*	-4.36	917.55
Mall	2.85	3.08	<0.001	*	-4.17	962.21
Video game rental	2.14	2.23	<0.05	*	-2.06	957.01
Big supermarket	2.91	3.06	<0.01	*	-2.62	959.21
Haircut	2.20	2.18	NS		0.49	969.62
Florists	1.87	1.81	NS		1.76	977.18
Fruit store	2.23	2.29	NS		-1.08	973.78
Public market	2.29	2.32	NS		-0.47	968.71
Pharmacy	2.21	2.26	NS		-0.91	993.62
Clothing stores	2.56	2.74	<0.01	*	-3.32	964.46

APPENDIX I DESTINATIONS FOR LOW INTENSITY PHYSICAL WELL-BEING

Table I.1 Destinations for low intensity physical well-being

Destination	Low Intensity Physical Health (Parents' Perspective)	Low Intensity Physical Health (Children's Perspective)	Agreement on Low Intensity Physical Health	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
Linear Park	60.08	52.14	Strong Agreement	2.56	2.61	2.59
Nature park	59.33	52.50	Strong Agreement	2.67	2.75	2.71
Neighborhood playground	59.10	50.80	Strong Agreement	3.31	3.54	3.42
Paddling pool splash park - Summer	51.78	56.82	Strong Agreement	2.77	2.86	2.82
Street front of house - Summer	60.06	52.38	Strong Agreement	3.15	3.45	3.30
Urban park	57.27	50.89	Strong Agreement	2.53	2.50	2.51
Street front of house - Winter	57.19	56.10	Strong Agreement	2.99	3.17	3.08
Green near river	57.02	45.86	Low Agreement	2.91	3.16	3.03
Neighbourhood greenspace other than playground	55.37	47.65	Low Agreement	3.11	3.14	3.13
Pedestrian street	49.03	44.96	Low Agreement	2.55	2.49	2.52
Primary school playground field after school or on the weekend	53.71	42.77	Low Agreement	3.22	3.38	3.30
School	58.31	44.71	Low Agreement	4.25	3.95	4.10

Table I.1 Destinations for low intensity physical well-being (continued)

Destination	Low Intensity Physical Health (Parents' Perspective)	Low Intensity Physical Health (Children's Perspective)	Agreement on Low Intensity Physical Health	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
Sidewalk	49.60	43.30	Low Agreement	3.06	2.82	2.94
Back alley - Summer	42.41	57.14	Low Agreement	2.60	2.61	2.60
Hiking trail - Summer	62.12	44.14	Low Agreement	2.70	2.68	2.69

APPENDIX J DESTINATIONS FOR MEDIUM TO HIGH INTENSITY PHYSICAL ACTIVITY

Table J.1 Destinations for medium to high intensity physical activity

Destination	Medium to High Intensity Physical Health (Parents' Perspective)	Medium to High Intensity Physical Health (Children's Perspective)	Agreement on Medium Intensity Physical Well-being	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
Neighborhood playground	56.02	52.94	Strong Agreement	3.31	3.54	3.42
Primary school playground field after school or on the weekend	58.75	61.45	Strong Agreement	3.22	3.38	3.30
Outdoor sports No Team - Summer	64.69	66.00	Strong Agreement	3.10	3.08	3.09
Bike path - Summer	62.76	61.33	Strong Agreement	3.02	3.12	3.07
Outdoor sports Team - Summer	71.84	67.52	Strong Agreement	2.86	2.87	2.87
Indoor pool - Winter	60.38	64.12	Strong Agreement	2.76	2.95	2.85
Toboggan Hills - Winter	65.17	61.73	Strong Agreement	2.69	2.69	2.69
Hiking trail - Summer	49.49	52.41	Strong Agreement	2.70	2.68	2.69
Other indoor sports - Winter	62.29	60.34	Strong Agreement	2.67	2.68	2.67
Outdoor basketball - Summer	60.42	55.79	Strong Agreement	2.62	2.71	2.67
Indoor skating rink - Winter	61.63	60.14	Strong Agreement	2.67	2.63	2.65
Middle or high school fields after school or on the weekend	52.79	50.00	Strong Agreement	2.67	2.58	2.62

Table J.1 Destinations for medium to high intensity physical activity (continued)

Destination	Medium to High Intensity Physical Health (Parents' Perspective)	Medium to High Intensity Physical Health (Children's Perspective)	Agreement on Medium Intensity Physical Well-being	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
Outdoor skating rink - Winter	61.92	60.54	Strong Agreement	2.61	2.60	2.60
Metropolitan Park	53.69	52.58	Strong Agreement	2.52	2.57	2.55
Dance Class - Summer	49.57	54.39	Strong Agreement	2.14	2.16	2.15
Martial Arts - Winter	52.83	50.00	Strong Agreement	2.12	2.12	2.12
Dance Class - Winter	50.00	50.00	Strong Agreement	2.12	2.11	2.11
School	54.57	46.15	Low Agreement	4.25	3.95	4.10
Street front of house - Summer	48.38	49.40	Low Agreement	3.15	3.45	3.30
Outdoor pool - Summer	56.71	48.34	Low Agreement	3.09	3.20	3.15
After school program	56.82	46.15	Low Agreement	2.97	2.92	2.94
Outdoor tennis - Summer	54.33	26.53	Low Agreement	2.31	2.28	2.29
Skateboard Park - Winter	56.58	39.68	Low Agreement	2.25	2.25	2.25
Martial Arts - Summer	58.59	37.84	Low Agreement	2.12	2.15	2.13

APPENDIX K DESTINATIONS FOR PSYCHOLOGICAL WELL-BEING, FEELING CALM AND RELAXED

Table K.1 Destinations for psychological well-being, feeling calm and relaxed

Destination	Psychological well-being, feeling calm and relaxed (Parents' Perspective)	Psychological well-being, feeling calm and relaxed (Children's Perspective)	Agreement on Psychological well-being, feeling calm and relaxed	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
Library	73.23	64.67	Strong Agreement	2.94	3.08	3.01
Picnic Area - Summer	65.05	52.99	Strong Agreement	2.72	2.73	2.73
Nature park	68.33	53.75	Strong Agreement	2.67	2.75	2.71
Linear Park	63.31	51.28	Strong Agreement	2.56	2.61	2.59
Church religious center	58.33	54.12	Strong Agreement	2.18	2.12	2.15
Neighbourhood greenspace other than playground	54.70	35.57	Low Agreement	3.11	3.14	3.13
Green near river	64.19	44.20	Low Agreement	2.91	3.16	3.03
Hiking trail - Summer	53.58	42.76	Low Agreement	2.70	2.68	2.69
Book store	59.01	44.51	Low Agreement	2.54	2.61	2.57
Haircut	49.09	29.14	Low Agreement	2.20	2.18	2.19
Art Galleries	54.19	36.90	Low Agreement	2.10	2.10	2.10

APPENDIX L DESTINATIONS FOR PSYCHOLOGICAL WELL-BEING, FEELING HAPPY AND EXCITED

Table L.1 Destinations for psychological well-being, feeling happy and excited

Destination	Psychological well-being, feeling happy and excited (Parents' Perspective)	Psychological well-being, feeling happy and excited (Children's Perspective)	Agreement on Psychological well-being, feeling happy and excited	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
Neighborhood playground	70.87	66.31	Strong Agreement	3.308	3.535	3.42
Primary school playground field after school or on the weekend	64.39	59.64	Strong Agreement	3.220	3.381	3.30
Street front of house - Summer	62.66	51.79	Strong Agreement	3.149	3.448	3.30
Outdoor pool - Summer	70.81	72.19	Strong Agreement	3.090	3.202	3.15
Restaurants fast-food	67.87	70.65	Strong Agreement	2.955	3.221	3.09
Green near river	62.53	55.80	Strong Agreement	2.908	3.161	3.03
Convenience store	49.85	49.71	Strong Agreement	2.929	3.075	3.00
Mall	63.87	64.48	Strong Agreement	2.846	3.075	2.96
After school program	61.36	55.77	Strong Agreement	2.969	2.918	2.94
Indoor pool - Winter	65.09	60.59	Strong Agreement	2.756	2.947	2.85
Paddling pool splash park - Summer	70.36	65.15	Strong Agreement	2.775	2.861	2.82
Toy store	76.64	81.01	Strong Agreement	2.611	2.964	2.79
Picnic Area - Summer	56.40	52.24	Strong Agreement	2.723	2.731	2.73
Bakery chocolate stores	71.28	72.44	Strong Agreement	2.600	2.837	2.72

Table L.1 Destinations for psychological well-being, feeling happy and excited (continued)

Destination	Psychological well-being, feeling happy and excited (Parents' Perspective)	Psychological well-being, feeling happy and excited (Children's Perspective)	Agreement on Psychological well-being, feeling happy and excited	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
Toboggan Hills - Winter	73.45	68.52	Strong Agreement	2.692	2.690	2.69
Community organization recreation centre	60.00	57.81	Strong Agreement	2.635	2.702	2.67
Winter Indoor skating rink	63.18	55.41	Strong Agreement	2.668	2.631	2.65
Outdoor skating rink - Winter	61.57	57.82	Strong Agreement	2.611	2.595	2.60
Cinema	75.80	77.37	Strong Agreement	2.443	2.638	2.54
Tourist attractions	71.95	53.79	Strong Agreement	2.403	2.461	2.43
Video game rental	66.67	56.72	Strong Agreement	2.135	2.233	2.18
Theatre	57.46	53.21	Strong Agreement	2.145	2.213	2.18
Dance Class - Summer	52.14	50.88	Strong Agreement	2.142	2.158	2.15
Dance Class - Winter	56.67	51.72	Strong Agreement	2.121	2.108	2.11
School	62.30	46.63	Low Agreement	4.246	3.950	4.10
Neighbourhood greenspace other than playground	55.70	44.97	Low Agreement	3.107	3.144	3.13
Outdoor sports No Team - Summer	63.37	47.33	Low Agreement	3.102	3.081	3.09
Street front of house - Winter	53.08	47.56	Low Agreement	2.993	3.168	3.08
Bike path - Summer	60.69	46.67	Low Agreement	3.021	3.120	3.07

Table L.1 Destinations for psychological well-being, feeling happy and excited (continued)

Destination	Psychological well-being, feeling happy and excited (Parents' Perspective)	Psychological well-being, feeling happy and excited (Children's Perspective)	Agreement on Psychological well-being, feeling happy and excited	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
Outdoor sports Team - Summer	57.96	48.72	Low Agreement	2.863	2.870	2.87
Other indoor sports - Winter	63.56	44.83	Low Agreement	2.668	2.681	2.67
Outdoor basketball - Summer	59.90	43.16	Low Agreement	2.623	2.710	2.67
Clothing stores	54.12	43.26	Low Agreement	2.557	2.738	2.65
Middle or high school fields after school or on the weekend	54.31	43.33	Low Agreement	2.668	2.581	2.62
Back alley - Summer	59.49	42.86	Low Agreement	2.600	2.607	2.60
Metropolitan Park	55.67	48.45	Low Agreement	2.517	2.575	2.55
Cafe	53.85	34.44	Low Agreement	2.400	2.527	2.46
Public square	54.63	45.87	Low Agreement	2.346	2.302	2.32
Skateboard Park - Winter	51.32	42.86	Low Agreement	2.251	2.245	2.25

APPENDIX M DESTINATIONS FOR SOCIAL WELL-BEING, INTERACTION WITH OTHER CHILDREN

Table M.1 Destinations for social well-being, interaction with other children

Destination	Social well-being, interaction with other children (Parents' Perspective)	Social well-being, interaction with other children (Children's Perspective)	Agreement on Social well-being, interaction with other children	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
School	85.71	79.81	Strong Agreement	4.25	3.95	4.10
Neighborhood playground	70.31	64.17	Strong Agreement	3.31	3.54	3.42
Primary school playground field after school or on the weekend	68.25	62.65	Strong Agreement	3.22	3.38	3.30
Street front of house - Summer	64.94	56.55	Strong Agreement	3.15	3.45	3.30
Outdoor pool - Summer	66.11	52.98	Strong Agreement	3.09	3.20	3.15
Street front of house - Winter	56.85	50.61	Strong Agreement	2.99	3.17	3.08
After school program	70.45	60.58	Strong Agreement	2.97	2.92	2.94
Paddling pool splash park - Summer	64.03	57.58	Strong Agreement	2.77	2.86	2.82
Toboggan Hills - Winter	64.14	51.23	Strong Agreement	2.69	2.69	2.69
Community organization recreation centre	62.46	49.22	Strong Agreement	2.64	2.70	2.67
Outdoor skating rink - Winter	61.92	50.34	Strong Agreement	2.61	2.60	2.60
Neighbourhood greenspace other than playground	52.35	44.30	Low Agreement	3.11	3.14	3.13

Table M.1 Destinations for social well-being, interaction with other children (continued)

Destination	Social well-being, interaction with other children (Parents' Perspective)	Social well-being, interaction with other children (Children's Perspective)	Agreement on Social well-being, interaction with other children	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
Outdoor sports No Team - Summer	63.37	48.00	Low Agreement	3.10	3.08	3.09
Outdoor sports Team - Summer	68.16	47.01	Low Agreement	2.86	2.87	2.87
Indoor pool - Winter	61.64	45.88	Low Agreement	2.76	2.95	2.85
Picnic Area - Summer	55.02	47.01	Low Agreement	2.72	2.73	2.73
Other indoor sports - Winter	60.59	38.79	Low Agreement	2.67	2.68	2.67
Outdoor basketball - Summer	60.42	43.16	Low Agreement	2.62	2.71	2.67
Indoor skating rink - Winter	62.79	46.62	Low Agreement	2.67	2.63	2.65
Middle or high school fields after school or on the weekend	54.82	44.44	Low Agreement	2.67	2.58	2.62
Back alley - Summer	49.37	36.36	Low Agreement	2.60	2.61	2.60
Metropolitan Park	52.71	39.18	Low Agreement	2.52	2.57	2.55
Back alley - Winter	50.63	32.05	Low Agreement	2.35	2.36	2.35
Public square	49.07	42.20	Low Agreement	2.35	2.30	2.32
Skateboard park - Winter	50.00	38.10	Low Agreement	2.25	2.25	2.25
Dance Class - Summer	55.56	35.09	Low Agreement	2.14	2.16	2.15
Dance Class - Winter	55.00	37.93	Low Agreement	2.12	2.11	2.11

APPENDIX N DESTINATIONS FOR SOCIAL WELL-BEING, INTERACTION WITH ADULTS

Table N.1 Destinations for social well-being, interaction with adults

Destination	Social well-being, interaction with adults (Parents' Perspective)	Social well-being, interaction with adults (Children's Perspective)	Agreement on Social well-being, interaction with adults	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
School	67.21	33.17	Low Agreement	4.25	3.95	4.10
After school program	50.45	20.19	Low Agreement	2.97	2.92	2.94
Doctor	62.25	41.26	Low Agreement	2.01	1.90	1.96
Dentist	59.11	41.12	Low Agreement	2.03	1.86	1.94
Optometrist	58.00	36.13	Low Agreement	1.93	1.84	1.88
Medical specialist	50.71	30.94	Low Agreement	1.93	1.79	1.86

APPENDIX O DESTINATIONS FOR COGNITIVE WELL-BEING

Table O.1 Destinations for cognitive well-being

Destination	Cognitive Well-Being (Parents' Perspective)	Cognitive Well-Being (Children's Perspective)	Agreement on Cognitive Well-Being	Average frequency score from parents' perspective	Average frequency score from children's perspective	Average frequency score for both groups
School	87.35	85.58	Strong Agreement	4.25	3.95	4.10
Library	63.38	74.85	Strong Agreement	2.94	3.08	3.01
Museum	59.34	62.20	Strong Agreement	2.19	2.19	2.19