ACTIVE TRANSPORTATION AND INDEPENDENT MOBILITY OF SCHOOL-AGED CHILDREN AND THEIR PARENTS: A MULTI-SITE STUDY

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DEDICATION

Dedicated to my loving husband Taylor. Thank you for believing in me and standing by me when I needed you most. Your support was vital in giving me the confidence to do what I love, and allowing me to prioritize this part of my career. I see your love in all the home-cooked meals, and every time you forced me to take breaks when I had done enough for one day. To many more bike trips and adventures together.

ABSTRACT

Active transportation (AT) and independent mobility (IM) are important sources of physical activity for children. This study investigated whether parents' travel mode to school as a child, current travel mode to work, and parental accompaniment on the trip home from school are associated with their children's AT and IM. Children in grades 4-6 (n=1699) were recruited from urban, suburban, and rural schools in Vancouver, Ottawa and Trois-Rivières. Parents reported their current travel mode to work, IM, and school travel mode as a child. Children self-reported their IM using Hillman's six mobility licenses. Multiple imputation was performed to replace missing data. Gender-stratified generalized linear mixed models adjusted for child age, parent respondent's gender, urbanization, and socioeconomic status were used to examine parental influences on their child's AT and IM. The older a parent was allowed to travel alone as a child, the less IM their child was allowed. Older children and girls whose parents biked to work or lived in Trois-Rivières had higher IM. Parental accompaniment on the trip home from school was associated with less AT trips. Boys in Vancouver and Trois-Rivières reported more active trips compared to Ottawa, though there was no differences found between Vancouver and Trois-Rivières. No significant association was found between parent travel to school as a child and AT. There were no significant associations found between a parent's current travel mode to work with IM or AT in multivariable models. This project found that children may have more opportunities for AT if parents allow them to come home from school unaccompanied. Parents who experienced IM later may be more restrictive of their child's IM. This potential for a generational 'carry-over' effect has implications for future interventions to promote IM.

CONTRIBUTIONS OF AUTHORS

I would like to acknowledge all the co-authors of manuscripts 1 and 2 including the original researchers from the "Active Transportation and Independent Mobility (ATIM) study". This thesis is a continuation of the analysis of data collected by the ATIM study. Therefore, my thesis would not have been possible without the prior work completed by these researchers.

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LIST OF ABBREVIATIONS

ATIM	Active Transportation and Independent Mobility Project
AT	Active Transportation
CI	Confidence Interval
CMA	Census Metropolitan Area
ICC	Intraclass Correlation Coefficient
IM	Independent Mobility
MVPA	Moderate- to Vigorous-intensity Physical Activity
PA	Physical Activity
SES	Socioeconomic Status

CHAPTER 1: LITERATURE REVIEW

1.1 INTRODUCTION

The World Health Organization has identified physical inactivity to be a leading risk factor for noncommunicable diseases mortality (World Health Organization, 2021). Regular physical activity (PA) in children is shown to improve physical fitness, cardiometabolic health, bone health, cognitive outcomes, and mental health (Janssen & Leblanc, 2010; World Health Organization, 2021). Over the last few decades, the prevalence of obesity and poor cardiovascular fitness has increased substantially (Ng et al., 2014; Tomkinson et al., 2019; Tremblay et al., 2002). Physical inactivity also appears to be increasing, putting children at a higher risk for developing chronic conditions such as heart disease, stroke, cancer, and diabetes (Bassett et al., 2015; Candeias et al., 2010). Unfortunately, most children and youth across the world do not accumulate the recommended 60 minutes of moderate-to-vigorous PA (MVPA) (Aubert et al., 2018; Guthold et al., 2020; van Sluijs et al., 2021). This may also have been exacerbated by the COVID-19 pandemic (Paterson et al., 2021). The resultant loss of structured activities, closure of public sport venues, and restricted opportunities for outdoor play are likely to have further stifled children's movement behaviours (Riazi, et al., 2021). Collectively, this evidence emphasizes the need for implementing large-scale interventions to increase PA (van Sluijs et al., 2021).

Active transportation (AT) is using one's own power to get from one place to another and includes walking and cycling as common examples (Hillman et al., 1990). Increasing the use of active transportation (AT) has been suggested as a feasible strategy to achieve population-level impact in the promotion of PA (Sallis et al., 2006). A shift away from the use of fossil fuels for transportation purposes may also assist in reducing carbon emissions and particulate matter that

contribute to cardiovascular diseases (Larouche, 2018). Likewise, designing effective transportation policies aimed at increasing AT may have the added benefits of decreasing road congestion, improving air quality and reducing fuel costs (Maibach et al., 2009; Ogilvie et al., 2004).

1.2 CHILDREN'S ACTIVE TRANSPORTATION

Current trends of inactivity among children may be partly due to an increase in the use of motorized modes of transportation in place of active methods (World Health Organization, 2021). There is consistent evidence showing that children who engage in AT to/from school are more active than their peers who are driven (Carver et al., 2011; Faulkner et al., 2008). Although data on changes over time in overall PA is lacking, US data shows that use of AT and time spent outdoors have declined over the last three decades while sport participation has increased (Bassett et al., 2015; McDonald, 2007). Similarly, the use of AT to travel to and from school has declined in Canada and Australia (Buliung et al., 2009; Gray et al., 2014; van der Ploeg et al., 2007). It is estimated that the percentage of Canadian children and youth who used only inactive modes of transportation for school travel increased between the year 2000 and 2010 from 51% to 62% (Gray et al., 2014). According to more recent estimates, only 21% of 5- to 19-year-olds in Canada use only active modes of transportation to school (Barnes et al., 2018; ParticipACTION, 2020).

Travel by car is often perceived as taking less time, or being more convenient (Faulkner et al., 2010; Panter et al., 2013). However, many adults tend to overestimate the time it takes to walk or cycle, and underestimate how long a car ride can take (Sims et al., 2018). Traffic danger is a paradoxical barrier to AT to school, as parents driving their children to school are often the source of such traffic (Fyhri et al., 2011). Parental concerns about traffic may be moderated by

distance, with greater concerns reported for longer distances to school if a child is cycling but not for walking (Panter et al., 2010). Distance to school has increased in recent years, due to school preferences, liberal school choice policies, and the closure of smaller schools (Larouche, 2018). A study by McDonald estimated that distance to school may account for half of the decline in active transportation observed in recent years (McDonald, 2007). Distance to school has increased for many families due to the creation of larger schools drawing from larger catchment areas, freedom of choice, and enrollment in private schools or those offering specific programming (Fyhri et al., 2011). However, what constitutes “too far” may be somewhat subjective, as there have been lower proportions of schoolchildren who walk even a reasonable distance of 1.6 km to or from school in previous years (McDonald, 2007). It may be possible to overcome this barrier of distance however, as parents could drop children off at a “walkable” distance from which they could actively travel to school (Larouche et al., 2013). Likewise, children could be encouraged to actively travel to other locations than school instead such as parks, sports fields, shops, and the houses of friends or relatives (Larouche et al., 2013).

1.3 CHILDREN’S INDEPENDENT MOBILITY

Independent mobility (IM) is defined as a child’s freedom to travel and play around their neighborhood or city without parental supervision (Hillman et al., 1990). Previous research suggests that children who are allowed greater IM may accumulate more physical activity (PA) than those with less freedom to play and travel unsupervised (Page et al., 2009; Schoeppe et al., 2014). IM facilitates access to many recreational and social opportunities for a child and may also allow them to develop emotional bonds with the natural environment (Brown et al., 2008). Likewise, IM allows children to acquire, process and structure knowledge about their environment such as landmarks and routes and can teach them the responsibilities involved with

making their own decisions (Brown et al., 2008; Rissotto & Tonucci, 2002). Within the self-determination theory, autonomy, competence, and relatedness are considered basic psychological needs for optimal development and functioning (Barrable, 2020; Ryan & Deci, 2017). A child's need for autonomy can be undermined by the ways that children's travel has changed. While IM has often been framed as a construct that facilitates AT and PA, the psychological benefits cannot be understated.

IM has declined significantly in many countries, including USA, Britain, and Germany (McDonald, 2007; Shaw et al., 2015). A landmark study on IM showed that the proportion of 7-8-year-old children in Britain who travelled to school independently had decreased from 80% in the year 1971 to 9% in 1990 (Hillman et al., 1990). A more recent comparison between 16 countries surveyed between 2010-2012 found that Finnish children had the highest degree of IM (Shaw et al., 2015). At 7 years old, the majority of Finnish children were already allowed to travel to places within walking distance or cycle to places alone (Shaw et al., 2015). However, these freedoms have still declined over the past 20 years in Finland (Kyttä et al., 2015). Even in countries with a higher degree of children's IM like Finland, Germany, and Norway, significant restrictions are placed on children's mobility (Shaw et al., 2015). While a few Canadian studies on children's IM exist, most have been conducted in large cities such as Toronto and Vancouver (Buliung et al., 2017; Mitra et al., 2014; Vlaar et al., 2019). A study investigating communities in Finland and Belarus found that children in smaller communities had higher IM compared with those living in larger communities (Kyttä, 2004).

The decline seen in IM across the world may be due in part to increases in car ownership and use (Fyhri et al., 2011; Shaw et al., 2015). Other reasons may be more sociological, as parents may perceive driving their child to school to be an opportunity to spend time with their

child, or a reflection of what "good parenting" looks like (Larouche, 2018). Parents may also be concerned about traffic or dangerous people (i.e., "stranger danger"), perhaps enhanced by sensational media reports (Crawford et al., 2017). However, child abduction is much rarer than parents believe, and is more likely to be committed by a relative than a stranger (Dalley & Ruscoe, 2003). In a period of two years across Canada, the Royal Canadian Mounted Police confirmed only one case of child abduction by a complete stranger (Dalley & Ruscoe, 2003). While presenting such statistics is likely insufficient to reassure parents, creating neighbourhoods that offer natural surveillance (from other adults), and support social interaction could facilitate IM (Francis et al., 2017). Children typically enjoy exploring their surroundings, but may have their own concerns about bullies, animals, or getting lost in addition to their parents' apprehensions (Crawford et al., 2017; Riazi et al., 2019).

Before discussing the social-ecological correlates of AT and IM in greater depth, it is important to recognize that IM may be operationalized in several ways (Marzi & Reimers, 2018). Sharmin and Kamruzzaman describe four major indicators for IM, which include: license, destination, time and range (Marzi & Reimers, 2018; Sharmin & Kamruzzaman, 2017). IM "license" refers to whether a child is allowed to travel independently without their parents (i.e. what is allowed) (Sharmin & Kamruzzaman, 2017). This "license" can be distinguished from the child's actual mobility (i.e. the child's actual movement) (Sharmin & Kamruzzaman, 2017). The term "IM Destination" refers to children's travel to specific places, like schools, parks, local shops or the houses of friends and family (Marzi & Reimers, 2018). "Range" or "home range" is the distance a child can travel from their own home, while independent "time" is how many minutes a child will typically stay outside of the home independently (Sharmin & Kamruzzaman, 2017). The measurement of IM license and time has primarily been through self- or parent-

report, though GPS systems have also been used to quantify destination and range (Vlaar et al., 2019). A 2019 study using both self-report and GPS found that a higher IM license is associated with territorial range, suggesting that inquiry into IM allowance is a good proxy for territorial range (Vlaar et al., 2019).

1.4 AN ECOLOGICAL MODEL OF ACTIVE TRANSPORTATION AND INDEPENDENT MOBILITY

The decline in AT and IM has occurred simultaneously in the past few decades, as have the consequences to PA (Bassett et al., 2015; McDonald, 2007; Shaw et al., 2015). Previous research on the correlates of IM and AT consider the multiple levels of influence that affect ones behaviours (Bauman et al., 2012; Sallis et al., 2006). Many factors appear to influence AT and IM, and the social-ecological model provides a framework to understand why some children and adolescents are more likely to be active and have more IM than others. This approach proposes that inter-relations between individuals and their social and physical environments can contribute to the understanding of why some individuals engage in health-related behaviors while others do not (Bauman et al., 2012; Sallis et al., 2006). This can help inform the development of multilevel interventions that have the best chance of succeeding at increasing AT and IM and thereby the health of populations (Bauman et al., 2012).

The policy environment is the most upstream level of the ecological model. Policies that promote AT can be desirable both for their ability to improve the health of a nation while reducing greenhouse gas emissions (Woodcock et al., 2013). The policy environment can influence AT in a number of ways, from prioritizing building environment features to support AT to other incentives and programs that support active living (Sallis et al., 2006). School policies can encourage or discourage the use of different travel modes; for example, the lack of a

bike rack on the school premise makes it less likely that children will use active measures (Mitra, 2013).

Broader policies that promote the closure of smaller schools in favor of larger centralized schools can increase distance to school and make AT less appealing to families (Mitra & Buliung, 2012). While many parents choose schools farther from home for the appeal of specialized curriculum or extracurriculars, liberal school choice policies may also have the unintended effect of discouraging AT (Wilson et al., 2010). Morris et al. (2001). et al. have also noted that co-locating schools with facilities where extracurricular activities may occur can promote AT while also reducing parental time pressures. Nevertheless, there are still a wide range of policy-sensitive factors that can be targeted to increase IM and AT. Predictive models developed by Ermagun & Samimi (2015) found that addressing the safety concerns of parents could increase AT to school by up to 60%. Policy measures may benefit from a systems approach and an effective knowledge translation framework to support evidence-based decision-making.

At this time there is a lack of policy interventions that explicitly target IM (Shaw et al., 2015). While IM is often not explicitly mentioned in policy development, the best examples are initiatives that prioritize child-friendly design in urban environments (Shaw et al., 2015). While Canada's harsh winters are often cited as a barrier to AT interventions, the city of Vancouver is notable in their work to prioritize child-friendly urban design (Shaw et al., 2015). An example of this is the City of Vancouver's policy on high-density housing for families with children (City of Vancouver, 1992). These guidelines provide criteria for clear separation of pedestrian and vehicular access, and ensuring common play areas with natural surveillance from overlooking units (City of Vancouver, 1992). Finland is also a country with similar climate-related challenges

where municipal transportation policies and advocacy resulted in significant increases in AT use (Saidla, 2018). The policy environment may also impact socioeconomic and built environment factors that in turn influence AT and IM (e.g., income, access to walking and cycling infrastructure, etc.) (Larouche, 2018). A child's distance to school may also be influenced by the choice to build schools on the outskirts of cities where land is cheaper, or policies that define broad catchment areas that result in fewer children to live within a "walkable" distance (Larouche et al., 2013; United States Environmental Protection Agency, 2003). Temporary street closures, also known as "Play Streets", are one promising intervention suggested to challenge social norms and provide safe spaces for outdoor play, but their effect on IM is unclear (Umstattd Meyer et al., 2019). More recent policies related to the COVID-19 pandemic may also have impacted AT and MVPA, as parent and children may have been working and attending school from home respectively, thus reducing opportunities for AT.

Ecological models direct attention to some of the environmental factors that may be promoting physical inactivity (Sallis et al., 2006). It can be difficult for individuals and families to make sustained changes to PA and mobility-related behaviours without simultaneous changes to the built environment (Carlson et al., 2017). Neighborhood walkability and traffic safety were some of the most common barriers to AT cited by parents in a systematic review by Aranda-Balboa et al. (2020). Residential density and street connectivity are other key features that have been shown to promote AT to/from school in adolescents (Carlson et al., 2017); however, pedestrian-friendly environments can help to promote IM as well. Christian et al. (2015) observed that IM to school was inversely related to the distance to the closest large-size park. Other factors, like parks enroute to schools and other destinations can provide safe places to stop

and play, reducing children's exposure to traffic and enhancing their IM experience and safety (Christian et al., 2015; Mackett et al., 2007; Villaneuva et al., 2013).

Distance to school appears to be a particularly powerful predictor of AT, and has consistently shown to be a potential barrier to active school travel in children (Bere et al., 2008; McDonald, 2008; Mitra & Buliung, 2012; Nelson et al., 2008). Children who lived within 1 km of school and whose parents reported the route to school was safe appear to be more likely to take up active commuting according to a study by Panter et al (2013). A recent study on AT to school in Arizona also indicated that the impact of demographic factors on choice of travel mode to school decreased the farther a person lived from school (Ross & Kurka, 2022). Ross & Kurka's (2022) findings indicated that programming to improve safe routes to school may be especially effective if targeting children who live within a 0.8km (½ mile) from school. While distance to school is an important consideration, it's a difficult construct for municipal policy-makers to change. Many factors such as specialty programs offered may influence a parent's choice in their child's school, such as small school closures, the ability to learn a minority language, the availability of other specialty programs (Larouche et al., 2014; McDonald, 2008; Wilson et al., 2010). There are other built environment factors that may have an effect on AT and are more within the control of municipal infrastructure departments. Cycling lanes have been positively associated with active travel among children (Helbich et al., 2016; Oliver et al., 2014). Likewise, a study by Giles-Corti et al. (2021) found that living in a more walkable neighbourhood increased the odds of AST if traffic volume was low.

The concept of "Risky Play" has some similarities to children's IM and may provide some clues as to how to approach changes to the built environment to support IM. In this context, risk is distinct from a hazard that a child cannot assess for themselves (Sandseter &

Kennair, 2011). Instead, a "risk" is a situation whereby a child can recognize and evaluate a challenge and decide on a course of action (Brussoni et al., 2015). In their six categories of risky play, Sandseter includes "venturing out without adults" in addition to play at "great heights", "high speeds", and "near dangerous elements" among others (Sandseter, 2009). The type of play where children can explore on their own and have the risk of getting lost is considered a type of risky play, therefore independent mobility and risky play are closely related (Sandseter, 2007). Much like IM, current research suggests that risky outdoor play is associated with improved child development, mental health, physical activity, and healthy body weights (Brussoni et al., 2012; Engelen et al., 2013; Sandseter & Kennair, 2011).

Affordances of places offer opportunities and dangers for interaction, behavior, use, feeling or meaning (Heft, 1988; Kyttä, 2004; Lopes et al., 2018). These are also features that contribute to a child's risky play. In the context of youth-friendly environments, they can be objects for throwing, surfaces for running, etc. (Kyttä, 2004). A Finnish study found that while suburban neighborhoods may appear safer to parents, they often lack the "affordances" or interesting landscapes for children to want to explore (Kyttä, 2004). This illustrates a trade-off between safety and features that promote children's IM and outdoor risky play. Environments that lack interesting features and opportunities for risky play may therefore reduce the actualized mobility of the children in these environments (Kyttä, 2004). A promising area of research and practice is the idea that opportunities for play in the built environment can be designed, preferably with the involvement of children themselves (Martin et al., 2023). This would allow hazards like inadequate lighting and high traffic speeds to be minimized while including spaces for travelling alone, running at high speed and playing at great heights. Prioritizing children's

needs when designing built environments would not only contribute to the safety of these spaces for children but could increase a child's actualized mobility and active transportation.

A meta-analytic study by Sharmin & Kamruzzaman also identified other characteristics of the built environment that may affect IM (2017). In particular, the presence of a dead-end street is positively associated with IM, while vehicular street width is negatively associated (Sharmin & Kamruzzaman, 2017). However, a great deal of diversity is seen in regards to study locations, study designs, sample characteristics and measurement strategies of IM and built environment factors which limits the homogeneity of the findings (Sharmin & Kamruzzaman, 2017). Hence, more research is needed to examine built environment correlates of IM.

Meteorological conditions have also been cited as factors that can affect children's AT, though findings vary markedly across studies (Blanchette et al., 2021; Helbich et al., 2016; Kallio et al., 2016; Larouche, Gunnell, et al., 2019; Mitra & Faulkner, 2012). These heterogeneous findings could be associated with differences in measurement of AT as well as differences in social norms and variation in temperature between study locations. Furthermore, a study by Blanchette et al. (2021) suggests that the effect of weather on school travel mode is moderated by season and region. They found that girls in Ottawa had higher odds of using AT to school in the winter compared to other seasons, while this association did not exist in Vancouver and Trois-Rivières. Conversely, precipitation was found to reduce the odds of active school travel for boys from Vancouver in the warm seasons only (Blanchette et al., 2021). These results add to the idea that culture, acclimatization, and social norms further influence travel mode choice - what is perceived to be "too cold" for active school travel in one region, may be fair weather for children in another.

This thesis primarily focused on inter- and personal levels of the socio-ecological model as they relate to children's IM and AT. Interpersonal and personal factors appear to be especially influential for a child's engagement in PA, AT, and their degree of IM. A 34-study review of parental influences on children's PA found that associations between parental and child PA levels were mixed, while associations between parental support and child PA level were largely significant and positive (Gustafson & Rhodes, 2006). A meta-analysis on family-based PA interventions recommends that while the child should be the agent of change, improving the family psychosocial environment should be considered when designing interventions to enhance effectiveness (Brown et al., 2016). These family-based interventions may also be tailored to the target population's cultural context, level of motivation, and time constraints of the family (Brown et al., 2016).

Of particular interest, parents are typically viewed as the 'gatekeepers' of children's IM (Faulkner et al., 2010; Mitra, 2013; Pont et al., 2011), and their attitudes, perceptions, and opinions influence the decisions that are made about a child's mode of travel (McMillan, 2005). Parental attitudes towards traffic or other neighborhood hazards are likely to impact a child's ability to travel places alone or participate in AT (Mammen et al., 2012). There is also research to suggest that mothers express greater concerns and place more limits on children's activities than fathers (Brussoni et al., 2013, 2018). Since mothers tend to be more risk averse, they may have different rules for where their child can go alone than those determined by the "risk expert" fathers (Brussoni et al., 2013). It is also likely that fathers and mothers may have had different travel behaviors as a child, as gender differences in IM are common (Brown et al., 2008; Mitra, 2013; O'Brien et al., 2000). Conceptually, associations between parental characteristics and

children's AT and IM exemplify the cross-level interactions that characterize the socio-ecological model.

Personal factors lie at the core of the socio-ecological model, and also relate closely to this thesis topic. A child's age is important individual factor to consider, as parents may perceive older children to be more competent travelers (Pabayo et al., 2011). However, according to the Canadian National Longitudinal Survey of Children and Youth, the use of AT to school increases from 6 years of age, peaks at ~10 years, then declines (Pabayo et al., 2011). This decline may be due to a longer distance to middle school, an increase in extracurricular activities, or working after school in the case of older adolescents (Buliung et al., 2009). There also appears to be a gender gap in the use of AT, as female children are more likely to be driven to school and may be more sedentary than boys (Colley & Buliung, 2016; Larouche et al., 2014; Larouche, Blanchette, et al., 2019; Larsen et al., 2018). Likewise, several studies indicate that boys tend to have greater IM than girls (Brown et al., 2008; Mitra, 2013; O'Brien et al., 2000).

Children typically enjoy walking and cycling to school, tend to have positive attitudes about these modes (Lorenc et al., 2008), and it's likely that many would travel independently if given the chance (Mitchell et al., 2007). However, children's viewpoints on travel mode choice are often excluded from research, and their views in matters pertaining to health and wellbeing are often ignored (Darbyshire et al., 2005; Fusco et al., 2012; Mitchell et al., 2007). A photovoice project by Fusco et al. (2012) indicated that children who walked to school expressed a greater engagement with nature and shared social interactions in their travel, while many children who travelled by car lamented the interesting things they were missing on their way to school. Although parents are the "gatekeepers" of children's travel behaviours (Carver et al., 2013; Pont et al., 2011), children can negociate for greater IM (Brown et al., 2008).

1.5 PARENTAL MODELING

Given that this thesis will focus on parental influence on their child's AT and IM, it is important to discuss this literature in more detail. Current research indicates that adults who are physically active tend to act as role models to promote positive attitudes towards PA and more active behaviors in their children (Mitchell et al., 2012). The results of an earlier descriptive study, the Children's Framingham Study, showed that children with two active parents were almost six times as likely to be active as children whose parents led a sedentary lifestyle (Moore et al., 1991). Likewise, 9 out of 10 studies included in Mitchell and colleagues' (2012) systematic review found a positive association between parents' and children's PA.

Both maternal and paternal sport participation have been positively associated with children's leisure-time physical activity (Schoeppe et al., 2016). Unfortunately, the onset of parenthood has also been reported as a reason for a steep decline in MVPA in parents (Bellows-Riecken & Rhodes, 2008; Rhodes et al., 2014). This pattern was further described by a 1-year prospective study by Rhodes et al. (2014) which indicated that parents expecting their second child had less MVPA, but had higher amounts of light activity and spent less time sedentary. Women's physical activity in particular appears to be affected by the transition to motherhood (McIntyre & Rhodes, 2009). Brown and Trost (2003) found that new mothers were 2.27 times more likely to be inactive compared to nonmothers, while Burke et al (2004) found that mothers were 15% more inactive than nonmothers. Several studies have found that maternal sport participation is especially significant for leisure-time activity in girls (Brouwer et al., 2018; Schoeppe et al., 2016). This is important to consider, as girls have been shown to exhibit lower levels of MVPA than boys in many countries around the world (Chaput et al., 2018; Farooq et al., 2018; Lijuan et al., 2017). Parental modeling has been encouraged through coactivity

interventions, where families engage in activities that both parents and children can take part in (Rhodes & Lim, 2018). Unfortunately, the success of coactivity interventions has been mixed in past research (Bäcklund et al., 2011; Guagliano et al., 2020; Morgan et al., 2014; Morrison et al., 2013; O'Dwyer et al., 2012; Olvera et al., 2008; Rhodes et al., 2010).

While fewer studies have examined associations between child and parents' travel behaviour, a recent cross-sectional study was suggestive of intergenerational effects on adolescent AT (Kwon et al., 2022). Specifically, adolescents with parents who engaged in at least 10 minutes of walking activity for work, transportation, exercise or leisure three or more days per week were 1.98 times as likely to use AT to commute to school compared to those whose parents walked only 0-2 days per week (Kwon et al., 2022). This association was strongest in father-son dyads, where boys were more than 4 times as likely to use active commuting to school if their father walked 3-7 days per week (Kwon et al., 2022). Similarly, Van Kann et al. (2016) observed that parental engagement in AT was associated with their children's engagement in AT to/from school in a multivariate model. Conversely, in a US survey, McDonald & Aalborg (2009) found that 75% of parents who drove their child to school over less than 2 miles (3.2 km) did so out of perceived convenience and to save time. Such findings suggest that perceived convenience of driving children to school on the way to work may be a key deterrent of AT. Hence, the authors criticized current AT interventions for not taking perceived convenience into account (McDonald et al., 2009; McDonald & Aalborg, 2009). There may also be an association between childhood AT and travel behaviors in adulthood. A recent doctoral thesis investigating the determinants of active commuting indicates that among current cyclists, 67.6% reported that they had cycled or walked to school during their childhood compared to 44.5% of car drivers (Martin, 2015).

Although studies consistently show a decline in children's IM and AT to school over the last few decades in countries around the world (Gaster, 1991; Gray et al., 2014; Hillman et al., 1990; McDonald, 2007; Shaw et al., 2015; van der Ploeg et al., 2007), there remains a lack of studies that examined associations between parental IM as a child and their child's current IM. Should such an association exist, this would suggest that, if effective, interventions aiming to increase children's IM may have carry over effects for future generations.

1.6 PARENTAL SUPPORT

Several factors related to parental influence on PA have been studied, including role modeling, parental support, parental attitudes about PA, general parenting styles, and overall family cohesion (Davison et al., 2013; Rhodes et al., 2016; Trost et al., 2013). Of all these concepts, parental support appears to have the most consistent evidence as a correlate of PA (Rhodes et al., 2016). It is often said that parents are the "gatekeepers" of children's travel behaviors, as they make the decisions to promote or restrict certain travel modes (Carver et al., 2013; Pont et al., 2011). Parents can also influence their child's AT and IM by verbally encouraging children to use a certain mode of travel or to travel with friends and/or siblings (rather than adults).

Parental support of youth PA appears to be associated with parental PA behavior, parental enjoyment of PA, and perceived importance of PA (Trost et al., 2003). Therefore, a parent's encouragement of AT may be a reflection of their own beliefs and attitudes about the risks and benefits, as well as their own values regarding AT and PA (Pont et al., 2011). A study by Larsen et al. (2018) found that children were about five times more likely to walk to school if the parents agreed that driving to school sets a bad example. Likewise, a study conducted in Great Britain by Dodd et al. (2021) found that children whose caregivers had more positive

attitudes towards risk-taking spent more time playing and were granted independence outdoors at a younger age.

Supportive behaviors such as observation, assistance with developing activity skills, and offering verbal encouragement may also influence a child's PA indirectly through their influence on self-efficacy (Trost et al., 2003). Currently, the best evidence for types of parental support of PA involves encouragement (e.g., providing information and pressure to be active) and logistics (facilitating PA, registering children in activities, and providing transportation) (Rhodes et al., 2016). Disparities in income and infrastructure may also affect the type of support that parents are able to provide as well. A qualitative study by Goodman et al. (2014) suggested that independence not only requires permission, but access to financial resources to travel by public transit. Access to free bus travel for youths aged 12-18 in London, England thus appeared to enhance mobilities and facilitate the acquisition of necessary skills, companions and security for travel (Goodman et al., 2014).

While research indicates the importance of parental support from both parents, there also appear to be gender differences in how parents support physical activity in their children (Davison et al., 2003). A study by Davison et al (2003) on PA in girls found that mothers reported more logistic support than fathers, while fathers reported more explicit modeling of PA. Several community interventions have been employed to encourage parental support of physical activity with a notable one focusing on the relationship between fathers and daughters. The Dad's and Daughters Exercising and Empowered (DADEE) project began in 2015 to address the under-representation of fathers as agents of change (Morgan et al., 2021). This intervention encouraged fathers and daughters to become role models and advocates for each other to improve PA (Morgan et al., 2021). While the DADEE project did not confer significant changes

to weight status, father's screen time, or self-reported MVPA, mean daily steps increased by over 1000 steps per day for both fathers and daughters (Morgan et al., 2021). Likewise, significant improvements were seen in the daughters' screen-time, fundamental movement skills, and some parenting practices (Morgan et al., 2021).

There is evidence that parental attitudes and support may influence the travel behaviours of children and adolescents as well (Mah et al., 2017; VanKann et al., 2016). Mah et al. found that the correlation between parental support and children's AT to school was independent of other correlates of AT including age, sex, distance to school, and other built environment correlates (Mah et al., 2017). Therefore, it may be possible for parents to still be able to promote AT in their children, even if they themselves are not physically active. They can do so by registering their child in different activities to develop their skills, provide contact with active peers, or take their child to an appropriate location for physical activity.

1.7 PARENTAL ACCOMPANIMENT

A qualitative study by Faulkner et al. (2010) suggests that travel to and from school involves a two-step decision making process concerning travel mode and accompaniment. While the mode of transport may be chosen due to perceptions of travel time and convenience, a parent's decision to escort their child or not appears to be influenced by road conditions, traffic, and personal safety concerns. It is possible for parents to accompany their children while walking, cycling, or using other forms of active travel and this can be an opportunity to teach them valuable skills for avoiding road hazards (Ghekiere et al., 2015). However, in practice parents are more commonly accompanying children by driving them to school (McDonald & Aalborg, 2009). A Canadian study by Williams et al. (2018) observed children aged 10–13 years with GPS devices and found that over 65% of time spent travelling occurred in a vehicle.

Walking school buses (WSB) are a strategy first proposed by activist David Engwicht, acting as a compromise between accompaniment and allowing a child to walk to school entirely alone (Engwicht, 1992). Walking school buses, or the less-studied “bicycle trains” for those on bicycles, involve at least one adult who acts as a “driver”, picking up children to join as “passengers” at scheduled stops along the way to school (Kearns et al., 2003). While these interventions do involve some adult supervision, they may be an appealing stepping stones for parents who aren’t quite ready to have their children complete the journey to school alone. WSB’s also allow parents to save time by sharing the responsibility of leading children to school each day while their children enjoy an opportunity for exercise and socialization (Kearns et al., 2003). Both WSB’s and bicycle trains have demonstrated increases in AT and PA in children, as well as a reduction in car trips (Mendoza et al., 2017; Sayers et al., 2012; Smith et al., 2015). However, they have also received some skepticism as well. Some critics point to WSBs as highly structured initiatives that reinforce the idea that children should be escorted by adults and are incapable of navigating places alone (Kearns et al., 2003). Nevertheless, the potential to increase parent comfort around granting children more independence and reducing reliance on vehicle travel should not be ignored (Collins & Kearns, 2010).

Engaging adults about their own childhood can often bring to light stark differences between what they were allowed to do and what they allow their own children to do. A 2020 survey of children 5-11 years old in the United Kingdom found a significant difference between the average age that children were reportedly allowed to be out alone (10.74 years) compared to their parents (8.91 years) (Dodd et al., 2021). It should be noted that over 100 participants did not let their children out alone at all and did not give an age, therefore this measure may underestimate the average age that children may be allowed to go places alone (Dodd et al.,

2021). Children's participation in urban public spaces used to be extensive, and their place was largely "outdoors", while "indoors" was primarily a space for adults (Karsten, 2005). The smaller area that children today cover in their day means they meet a smaller number and variety of people (Karsten, 2005). Not only does this supervised culture deprive them of experience, it also separates them from diversity thus dampening their ability to build bridges between children from different backgrounds outside of school (Karsten, 2005). A 2021 qualitative study by Riazi et al. (2021) recorded parents consistently referencing their own IM freedoms and indicated that they valued these experiences. While the participants wanted their children to have the same opportunities as themselves, they also expressed concerns around how society views IM (Riazi, Brussoni, et al., 2021). This study identified four key conditions that facilitated negotiation of children's IM within family units: the positive interpretation of parental childhood IM experiences; 2) children's individual characteristics (e.g., a child's confidence in their abilities); 3) communication between parents as well as parent-child discussions regarding details of IM or to negotiate a child's IM license; and 4) positive parental perceptions of the social environment on children's IM (Riazi, Brussoni, et al., 2021). These preconditions allow for open communication within family units, and an opportunity for children to display their skills and readiness (or lack thereof) for parents to evaluate (Riazi, Brussoni, et al., 2021). If a child has limited experience navigating their own neighborhood, their confidence may also be a limiting factor in their pursuit of IM. A conceptual model of the decision process for children's unsupervised outdoor activities was recently proposed by Brussoni et al (2020). This model includes "feeling safe" as a key variable for enhancing engagement in unsupervised outside activities, as well as "having things to do" (Brussoni et al., 2020). The affordances that neighborhoods offer may enhance what children perceive as important in their neighborhoods

(Brussoni et al., 2020; Kyttä, 2004). Likewise, independent AT may also fit into the definition of "having things to do" to further increase their comfort. It should also be noted that children may not always play and travel alone when they are unsupervised. Children's travel can often be a deeply social activity, as children often seek out companionship when they travel unsupervised by parents (Mikkelsen & Christensen, 2009). It is possible that not only parents but children themselves may be more comfortable increasing their home range accompanied by a sibling or friend their own age.

1.8 RATIONALE

In summary, children's travel behaviours and IM are associated with many factors spanning all levels of influence of the socio-ecological model. Given the important role that parents may play in supporting and/or restricting their children's mobility, this study will focus primarily on parental predictors of AT and IM. Specifically, the effect of parents' school travel mode and IM as a child, parents' current travel mode to work, and parental accompaniment on the trip home from school will be investigated as potential correlates of their child's AT and IM. This work is important because current AT interventions rarely consider the perceived convenience of driving as a potential challenge to overcome (McDonald et al., 2009). Most existing interventions have achieved trivial-to-small increases in AT, which shows a clear need for improvement or a consideration of the broader reasons for travel mode choice (Larouche et al., 2018). Currently there are no studies investigating correlation between parents' engagement in AT as a child or their current travel routines with their child's IM. Yet, escorting children to and from school on the way to work may limit the range of children's IM. The association between childhood active travel and current travel behaviors therefore requires further investigation.

1.9 RESEARCH QUESTIONS

This project aimed to address the three following questions:

1. **Is parents' travel mode to work associated with children's engagement in AT (to/from school and other destinations) and IM?**

Previous studies suggest that active parents tend to promote or model PA and AT for their children (Barkin et al., 2017; Schoeppe et al., 2016). Since workdays often extend beyond the school hours, it may be difficult for a parent who uses active commuting to return to accompany their child home. I hypothesized that parents who use AT are more likely to have children who engage in AT and grant their children more lenient IM licenses.

2. **Is parents' travel mode to school as a child associated with children's engagement in AT (to/from school and other destinations) and IM?**

Since walking or cycling to school during childhood appears to be associated with increased likelihood of using active travel modes for the commute to work during early adulthood (Martin, 2015), an association between parents' school travel mode as a child and their children's AT is plausible. For instance, parents who actively commuted to school as a child may reflect fondly on these times and may be more likely to encourage their children to do the same. I hypothesized that parental AT as a child is positively associated with children's engagement in AT and IM.

3. **Is parental accompaniment on the trip home from school associated with children's engagement in AT (to/from school and other destinations) and IM?**

There is some research that suggests that AT may be more common in the afternoon on the trip home from school (Wong et al., 2011). Parental accompaniment would, by definition, prevent a child from experiencing IM during this time frame. Previous research has also shown

children with greater IM license to be more active than their peers (Page et al., 2009; Schoeppe et al., 2014). Therefore, I hypothesized that parental accompaniment on the trip home from school is negatively associated with children's engagement in AT and IM.

1.10 REFERENCES

Aranda-Balboa, M. J., Huertas-Delgado, F. J., Herrador-Colmenero, M., Cardon, G. & Chillón, P. (2020). Parental barriers to active transport to school: a systematic review. *International Journal of Public Health*, *65*(1), 87–98. https://doi.org/10.1007/s00038-019-01313-1

Aubert, S., Barnes, J. D., Abdeta, C., Nader, P. A., Adeniyi, A. F., Aguilar-Farias, N., Tenesaca, D. S. A., Bhawra, J., Brazo-Sayavera, J., Cardon, G., Chang, C. K., Delisle Nyström, C., Demetriou, Y., Draper, C. E., Edwards, L., Emeljanovas, A., Gába, A., Galaviz, K. I., González, S. A., … Tremblay, M. S. (2018). Global Matrix 3.0 physical activity Report Card grades for children and youth: Results and analysis from 49 countries. *Journal of Physical Activity and Health*, *15*(Suppl 2), S251–S273. https://doi.org/10.1123/jpah.2018-0472

Bäcklund, C., Sundelin, G. & Larsson, C. (2011). Effects of a 2-year lifestyle intervention on physical activity in overweight and obese children. *Advances in Physiotherapy*, *13*(3), 97–109. https://doi.org/10.3109/14038196.2011.562540

Barkin, S. L., Lamichhane, A. P., Banda, J. A., JaKa, M. M., Buchowski, M. S., Evenson, K. R., Bangdiwala, S. I., Pratt, C., French, S. A. & Stevens, MS, J. (2017). Parent's Physical Activity Associated With Preschooler Activity in Underserved Populations. In *American Journal of Preventive Medicine* (Vol. 52, Issue 4, pp. 424–432). Elsevier Inc. https://doi.org/10.1016/j.amepre.2016.11.017

Barnes, J. D., Cameron, C., Carson, V., Chaput, J.-P., Colley, R. C., Faulkner, G. E. J., Janssen, I., Kramers, R., Saunders, T. J., Spence, J. C., Tucker, P., Vanderloo, L. M. & Tremblay, M. S. (2018). Results from Canada's 2018 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health*, *15*(s2), S328–S330.

https://doi.org/10.1123/jpah.2018-0454

Barrable, A. (2020). Shaping Space and Practice to Support Autonomy: Lessons from Natural Settings in Scotland. *Learning Environments Research*, *23*(3), 291–305. http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1267318&site=ehost-live&scope=site

Bassett, D. R., John, D., Conger, S. A., Fitzhugh, E. C. & Coe, D. P. (2015). Trends in Physical Activity and Sedentary Behaviors of United States Youth. *Journal of Physical Activity & Health*, *12*(8), 1102–1111. http://search.ebscohost.com/login.aspx?direct=true&db=s3h&AN=111413214&site=ehost-live&scope=site

Bauman, A. E., Reis, R. S., Sallis, J. F., Wells, J. C., Loos, R. J. F., Martin, B. W., Alkandari, J. R., Andersen, L. B., Blair, S. N., Brownson, R. C., Bull, F. C., Craig, C. L., Ekelund, U., Goenka, S., Guthold, R., Hallal, P. C., Haskell, W. L., Heath, G. W., Inoue, S., … Sarmiento, O. L. (2012). Correlates of physical activity: Why are some people physically active and others not? *The Lancet*, *380*(9838), 258–271. https://doi.org/10.1016/S0140-6736(12)60735-1

Bellows-Riecken, K. H. & Rhodes, R. E. (2008). A birth of inactivity? A review of physical activity and parenthood. *Preventive Medicine*, *46*(2), 99–110. https://doi.org/10.1016/j.ypmed.2007.08.003

Bere, E., van der Horst, K., Oenema, A., Prins, R. & Brug, J. (2008). Socio-demographic factors as correlates of active commuting to school in Rotterdam, the Netherlands. *Preventive Medicine*, *47*(4), 412–416. https://doi.org/10.1016/j.ypmed.2008.06.019

Blanchette, S., Larouche, R., Tremblay, M. S., Faulkner, G., Riazi, N. A. & Trudeau, F. (2021).

Influence of weather conditions on children's school travelmode and physical activity in 3 diverse regions of canada. *Applied Physiology, Nutrition and Metabolism*, *46*(6), 552–560. https://doi.org/10.1139/apnm-2020-0277

Brouwer, S. I., Küpers, L. K., Kors, L., Sijtsma, A., Sauer, P. J. J., Renders, C. M. & Corpeleijn, E. (2018). Parental physical activity is associated with objectively measured physical activity in young children in a sex-specific manner: The GECKO Drenthe cohort. *BMC Public Health*, *18*(1), 1–10. https://doi.org/10.1186/s12889-018-5883-x

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, H. E., Atkin, A. J., Panter, J., Wong, G., Chinapaw, M. J. M. & van Sluijs, E. M. F. (2016). Family-based interventions to increase physical activity in children: A systematic review, meta-analysis and realist synthesis. *Obesity Reviews*, *17*(4), 345–360. https://doi.org/10.1111/obr.12362

Brown, W. J. & Trost, S. G. (2003). Life transitions and changing physical activity patterns in young women. *American Journal of Preventive Medicine*, *25*(2), 140–143. https://doi.org/10.1016/S0749-3797(03)00119-3

Brussoni, M., Gibbons, R., Gray, C., Ishikawa, T., Sandseter, E. B. H., Bienenstock, A., Chabot, G., Fuselli, P., Herrington, S., Janssen, I., Pickett, W., Power, M., Stanger, N., Sampson, M. & Tremblay, M. S. (2015). What is the relationship between risky outdoor play and health in children? A systematic review. In *International Journal of Environmental Research and Public Health* (Vol. 12, Issue 6). https://doi.org/10.3390/ijerph120606423

Brussoni, M., Ishikawa, T., Han, C., Pike, I., Bundy, A., Faulkner, G. & Mâsse, L. C. (2018). Go

Play Outside! Effects of a risk-reframing tool on mothers' tolerance for, and parenting practices associated with, children's risky play: Study protocol for a randomized controlled trial. *Trials*, *19*(1), 1–9. https://doi.org/10.1186/s13063-018-2552-4

Brussoni, M., Lin, Y., Han, C., Janssen, I., Schuurman, N., Boyes, R., Swanlund, D. & Mâsse, L. C. (2020). A qualitative investigation of unsupervised outdoor activities for 10- to 13-year-old children: "I like adventuring but I don't like adventuring without being careful." *Journal of Environmental Psychology*, *70*(June), 101460. https://doi.org/10.1016/j.jenvp.2020.101460

Brussoni, M., Olsen, L. L., Creighton, G. & Oliffe, J. L. (2013). Heterosexual gender relations in and around childhood risk and safety. *Qualitative Health Research*, *23*(10), 1388–1398. https://doi.org/10.1177/1049732313505916

Brussoni, M., Olsen, L. L., Pike, I. & Sleet, D. A. (2012). Risky play and children's safety: Balancing priorities for optimal child development. *International Journal of Environmental Research and Public Health*, *9*(9), 3134–3148. https://doi.org/10.3390/ijerph9093134

Buliung, R. N., Larsen, K., Faulkner, G. & Ross, T. (2017). Children's independent mobility in the City of Toronto, Canada. *Travel Behaviour and Society*, *9*, 58–69. https://doi.org/10.1016/j.tbs.2017.06.001

Buliung, R. N., Mitra, R. & Faulkner, G. (2009). Active school transportation in the Greater Toronto Area, Canada: An exploration of trends in space and time (1986–2006). *Preventive Medicine*, *48*(6), 507–512. https://doi.org/10.1016/j.ypmed.2009.03.001

Burke, V., Beilin, L. J., Dunbar, D. & Kevan, M. (2004). Changes in health-related behaviours and cardiovascular risk factors in young adults: Associations with living with a partner. *Preventive Medicine*, *39*(4), 722–730. https://doi.org/10.1016/j.ypmed.2004.02.038

Candeias, V., Armstrong, T. P. & Xuereb, G. C. (2010). Diet and physical activity in schools: perspectives from the implementation of the WHO global strategy on diet, physical activity and health. *Canadian Journal of Public Health = Revue Canadienne de Sante Publique*, *101 Suppl*(August), S28-30. https://doi.org/10.1007/BF03405623

Carlson, J. A., Sallis, J. F., Kerr, J., Conway, T. L., Cain, K., Frank, L. D. & Saelens, B. E. (2017). Built environment characteristics and parent active transportation are associated with active travel to school in youth age 12–15. *Physiology & Behavior*, *176*(3), 139–148. https://doi.org/10.1136/bjsports-2013-093101.Built

Carver, A., Timperio, A. F., Hesketh, K. D., Ridgers, N. D., Salmon, J. L. & Crawford, D. A. (2011). How is active transport associated with children's and adolescents' physical activity over time? *The International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 126. https://doi.org/10.1186/1479-5868-8-126

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

Ceccato, R., Rossi, R. & Gastaldi, M. (2021). Travel demand prediction during covid-19 pandemic: Educational and working trips at the university of padova. *Sustainability (Switzerland)*, *13*(12), 1–20. https://doi.org/10.3390/su13126596

Chaput, J. P., Barnes, J. D., Tremblay, M. S., Fogelholm, M., Hu, G., Lambert, E. V., Maher, C., Maia, J., Olds, T., Onywera, V., Sarmiento, O. L., Standage, M., Tudor-Locke, C. & Katzmarzyk, P. T. (2018). Inequality in physical activity, sedentary behaviour, sleep duration and risk of obesity in children: a 12-country study. *Obesity Science and Practice*, *4*(3), 229–237. https://doi.org/10.1002/osp4.271

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. *Journal of Physical Activity & Health*, *12*(Suppl 1), S84–S93. https://doi.org/10.1123/jpah.2014-0271

City of Vancouver. (1992). High-Density Housing for Families With Children. *Land Use and Development Policies and Guidelines*, *September*. https://guidelines.vancouver.ca/guidelines-high-density-housing-for-families-with-children.pdf

Colley, M. & Buliung, R. N. (2016). Gender Differences in School and Work Commuting Mode Through the Life Cycle: Exploring Trends in the Greater Toronto and Hamilton Area, 1986 to 2011. *Transportation Research Record*, *2598*(1), 102–109. https://doi.org/10.3141/2598-12

Collins, D. & Kearns, R. A. (2010). Walking school buses in the Auckland region: A longitudinal assessment. *Transport Policy*, *17*(1), 1–8. https://doi.org/10.1016/j.tranpol.2009.06.003

Crawford, S. B., Bennetts, S. K., Hackworth, N. J., Green, J., Graesser, H., Cooklin, A. R., Matthews, J., Strazdins, L., Zubrick, S. R., D'Esposito, F. & Nicholson, J. M. (2017). Worries, 'weirdos', neighborhoods and knowing people: a qualitative study with children and parents regarding children's independent mobility. *Health and Place*, *45*(November 2016), 131–139. https://doi.org/10.1016/j.healthplace.2017.03.005

Dalley, M. & Ruscoe, J. (2003). The abduction of children by strangers in Canada: Nature and scope. *Royal Canadian Mounted Police*, *Ottawa*, *Ca*. https://www.publicsafety.gc.ca/lbrr/archives/cn33598-eng.pdf

Darbyshire, P., Macdougall, C. & Schiller, W. (2005). Multiple methods in qualitative research with children: more insight or just more? *Qualitative Research*, *5*(4), 417–436. https://doi.org/https://doi.org/10.1177/1468794105056921

Davison, K. K., Cutting, T. M. & Birch, L. L. (2003). Parents' activity-related parenting practices predict girls' physical activity. *Medicine and Science in Sports and Exercise*, *35*(9), 1589–1595. https://doi.org/10.1249/01.MSS.0000084524.19408.0C

Davison, K. K., Mâsse, L. C., Timperio, A., Frenn, M. D., Saunders, J., Mendoza, J. A., Gobbi, E., Hanson, P. & Trost, S. G. (2013). Physical activity parenting measurement and research: Challenges, explanations, and solutions. *Childhood Obesity*, *9*(SUPPL.1). https://doi.org/10.1089/chi.2013.0037

Dodd, H. F., Fitzgibbon, L., Watson, B. E. & Nesbit, R. J. (2021). Children's play and independent mobility in 2020: Results from the british children's play survey. *International Journal of Environmental Research and Public Health*, *18*(8). https://doi.org/10.3390/ijerph18084334

Engelen, L., Bundy, A. C., Naughton, G., Simpson, J. M., Bauman, A., Ragen, J., Baur, L., Wyver, S., Tranter, P., Niehues, A., Schiller, W., Perry, G., Jessup, G. & van der Ploeg, H. P. (2013). Increasing physical activity in young primary school children - it's child's play: A cluster randomised controlled trial. *Preventive Medicine*, *56*(5), 319–325. https://doi.org/10.1016/j.ypmed.2013.02.007

Engwicht, D. (1992). *Towards an eco-city: calming the traffic.* Envirobook.

Ermagun, A. & Samimi, A. (2015). Promoting active transportation modes in school trips. *Transport Policy*, *37*, 203–211. https://doi.org/10.1016/j.tranpol.2014.10.013

Farooq, M. A., Parkinson, K. N., Adamson, A. J., Pearce, M. S., Reilly, J. K., Hughes, A. R.,

Janssen, X., Basterfield, L. & Reilly, J. J. (2018). Timing of the decline in physical activity in childhood and adolescence: Gateshead Millennium Cohort Study. *British Journal of Sports Medicine*, *52*(15), 1002–1006. https://doi.org/10.1136/bjsports-2016-096933

Faulkner, G. E. J., Buliung, R. N., Flora, P. K. & Fusco, C. (2008). Active school transport, physical activity levels and body weight of children and youth: A systematic review. *Preventive Medicine*, *48*(1), 3–8. https://doi.org/10.1016/j.ypmed.2008.10.017

Faulkner, G. E. J., Richichi, V., Buliung, R. N., Fusco, C. & Moola, F. (2010). What's quickest and easiest Parental decision making about school trip mode. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 1–11. https://doi.org/10.1186/1479-5868-7-62

Francis, J., Martin, K., Wood, L. & Foster, S. (2017). 'I'll be driving you to school for the rest of your life': A qualitative study of parents' fear of stranger danger. *Journal of Environmental Psychology*, *53*, 112–120. https://doi.org/10.1016/j.jenvp.2017.07.004

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*(5), 703–710. https://doi.org/10.1016/j.tranpol.2011.01.005

Gaster, S. (1991). Urban Children's Access to Their Neighborhood: Changes Over Three Generations. *Environment and Behavior*, *23*(1), 70–85. https://www-proquest-com.ezproxy.uleth.ca/scholarly-journals/urban-childrens-access-their-neighborhood-

changes/docview/1292646851/se-2

Ghekiere, A., Carver, A., Veitch, J., Salmon, J., Deforche, B. & Timperio, A. (2015). Does parental accompaniment when walking or cycling moderate the association between physical neighbourhood environment and active transport among 10–12 year olds? *Journal of Science and Medicine in Sport*, *19*(2), 149–153. https://doi.org/10.1016/j.jsams.2015.01.003

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 and Place*, *17*(2), 545–550. https://doi.org/10.1016/j.healthplace.2010.12.011

Gill, T. (2022). Urban playground: how child-friendly planning and design can save cities. *Cities & Health*, *6*(3), 469–470. https://doi.org/10.1080/23748834.2021.2004723

Goodman, A., Jones, A., Roberts, H., Steinbach, R. & Green, J. (2014). “We Can All Just Get on a Bus and Go”: Rethinking Independent Mobility in the Context of the Universal Provision of Free Bus Travel to Young Londoners. *Mobilities*, *9*(2), 275–293. https://doi.org/10.1080/17450101.2013.782848

Gray, C. E., Larouche, R., Barnes, J. D., Colley, R. C., Bonne, J. C., Arthur, M., Cameron, C., Chaput, J.-P., Faulkner, G., Janssen, I., Kolen, A. M., Manske, S. R., Salmon, A., Spence, J. C., Timmons, B. W. & Tremblay, M. S. (2014). Are we driving our kids to unhealthy habits? Results of the active healthy kids Canada 2013 report card on physical activity for children and youth. *International Journal of Environmental Research and Public Health*, *11*(6), 6009–6020. https://doi.org/10.3390/ijerph110606009

Guagliano, J. M., Armitage, S. M., Brown, H. E., Coombes, E., Fusco, F., Hughes, C., Jones, A.

P., Morton, K. L. & Van Sluijs, E. M. F. (2020). A whole family-based physical activity promotion intervention: Findings from the families reporting every step to health (FRESH) pilot randomised controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *17*(1), 1–14. https://doi.org/10.1186/s12966-020-01025-3

Gustafson, S. L. & Rhodes, R. E. (2006). Parental correlates of physical activity in children and early adolescents. *Sports Medicine*, *36*(1), 79–97. https://doi.org/10.2165/00007256-200636010-00006

Guthold, R., Stevens, G. A., Riley, L. M. & Bull, F. C. (2020). Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. *The Lancet Child and Adolescent Health*, *4*(1), 23–35. https://doi.org/10.1016/S2352-4642(19)30323-2

Hansen Sandseter, E. B. (2007). Categorising risky play—how can we identify risk-taking in children's play? *European Early Childhood Education Research Journal*, *15*(2), 237–252. https://doi.org/10.1080/13502930701321733

Heft, H. (1988). Affordances of children's environments: A functional approach to environmental description. In *Children's environments quarterly* (Vol. 5, Issue 3, pp. 29–37). Children's Environments Research Group, The Graduate School and University Center, The City University of New York. https://www.jstor.org/stable/41514683

Helbich, M., Emmichoven, M. J. Z. van, Dijst, M. J., Kwan, M. P., Pierik, F. H. & Vries, S. I. d. (2016). Natural and built environmental exposures on children's active school travel: A Dutch global positioning system-based cross-sectional study. *Health and Place*, *39*, 101–109. https://doi.org/10.1016/j.healthplace.2016.03.003

Hillman, M., Adams, J. & Whitelegg, J. (1990). One false move: A study of children's

independent mobility. *Policy Studies Unit*, *January*. https://ci.nii.ac.jp/naid/10004535145/en/

Hjorthol, R. J. (2008). The mobile phone as a tool in family life: Impact on planning of everyday activities and car use. *Transport Reviews*, *28*(3), 303–320. https://doi.org/10.1080/01441640701630905

Janssen, I. & Leblanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *The International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 40. https://doi.org/10.1186/1479-5868-7-40

Kallio, J., Turpeinen, S., Hakonen, H. & Tammelin, T. (2016). Active commuting to school in Finland, the potential for physical activity increase in different seasons. *International Journal of Circumpolar Health*, *75*, 1–7. https://doi.org/10.3402/ijch.v75.33319

Karsten, L. (2005). It all used to be better? different generations on continuity and change in urban children's daily use of space. *Children's Geographies*, *3*(3), 275–290. https://doi.org/10.1080/14733280500352912

Kearns, R. A., Collins, D. C. A. & Neuwelt, P. M. (2003). The walking school bus: Extending children's geographies? *Area*, *35*(3), 285–292. https://doi.org/10.1111/1475-4762.00177

Kwon, S., Mason, M., Wang-schweig, M., Morrissey, J., Bartell, T. & Kandula, N. R. (2022). *The Association Between Adolescent Active Commuting to School and Parent Walking Behavior : The FLASHE Study*. *0*(0), 1–10. https://doi.org/10.1177/08901171221099271

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

Larouche, R, Barnes, J. & Tremblay, M. (2013). Too far to walk or bike? *Canadian Journal of*

Public Health, *104*(7), 487–490. https://doi.org/10.17269/cjph.104.4122

Larouche, R. (2018). Children's active transportation. In *Children's Active Transportation* (pp. 77–87). Elsevier. https://doi.org/10.1016/C2016-0-01988-5

Larouche, R., Blanchette, S., Faulkner, G., Riazi, N., Trudeau, F. & Tremblay, M. S. (2019). Correlates of Children's Physical Activity: A Canadian Multisite Study. In *Medicine and science in sports and exercise* (Vol. 51, Issue 12). https://doi.org/10.1249/MSS.0000000000002089

Larouche, R., Chaput, J.-P., Leduc, G., Boyer, C., Bélanger, P., LeBlanc, A. G., Borghese, M. M. & Tremblay, M. S. (2014). A cross-sectional examination of socio-demographic and school-level correlates of children's school travel mode in Ottawa, Canada. *BMC Public Health*, *14*(1), 497. https://doi.org/10.1186/1471-2458-14-497

Larouche, R., Gunnell, K. & Bélanger, M. (2019). Seasonal variations and changes in school travel mode from childhood to late adolescence: A prospective study in New Brunswick, Canada. *Journal of Transport and Health*, *12*(August 2018), 371–378. https://doi.org/10.1016/j.jth.2018.08.012

Larouche, R., Mammen, G., Rowe, D. A. & Faulkner, G. (2018). Effectiveness of active school transport interventions: a systematic review and update. *BMC Public Health*, *18*(1), 206. https://doi.org/10.1186/s12889-017-5005-1

Larsen, K., Larouche, R., Buliung, R. N. & Faulkner, G. E. J. (2018). A matched pairs approach to assessing parental perceptions and preferences for mode of travel to school. *Journal of Transport & Health*, *11*, 56–63. https://doi.org/10.1016/j.jth.2018.09.004

Lijuan, W., Jiancui, S. & Suzhe, Z. (2017). Parental influence on the physical activity of Chinese children: Do gender differences occur? *European Physical Education Review*, *23*(1), 110–

126. https://doi.org/10.1177/1356336X16641024

Lopes, F., Cordovil, R. & Neto, C. (2018). Independent mobility and social affordances of places for urban neighborhoods: A youth-friendly perspective. *Frontiers in Psychology*, *9*(NOV), 1–21. https://doi.org/10.3389/fpsyg.2018.02198

Mackett, R., Brown, B., Gong, Y., Kitazawa, K. & Paskins, J. (2007). Children's independent movement in the local environment. *Built Environment*, *33*(4), 454–468. https://doi.org/10.2148/benv.33.4.454

Mah, S. K., Nettlefold, L., Macdonald, H. M., Winters, M., Race, D., Voss, C. & McKay, H. A. (2017). Does parental support influence children's active school travel? *Preventive Medicine Reports*, *6*(C), 346–351. https://doi.org/10.1016/j.pmedr.2017.04.008

Maibach, E., Steg, L. & Anable, J. (2009). Promoting physical activity and reducing climate change: Opportunities to replace short car trips with active transportation. *Preventive Medicine*, *49*(4), 326–327. https://doi.org/10.1016/j.ypmed.2009.06.028

Mammen, G., Faulkner, G., Buliung, R. & Lay, J. (2012). Understanding the drive to escort: a cross-sectional analysis examining parental attitudes towards children's school travel and independent mobility. In *BMC public health* (Vol. 12, Issue 1, p. 862). BioMed Central Ltd. https://doi.org/10.1186/1471-2458-12-862

Martin, A. (2015). An exploration of the determinants and health impacts of active commuting [University of East Anglia]. In *PQDT - UK & Ireland*. https://ueaeprints.uea.ac.uk/57410/

Martin, M., Jelić, A. & Doktor Olsen Tvedebrink, T. (2023). Children's opportunities for play in the built environment: a scoping review. *Children's Geographies*, 1–17. https://doi.org/10.1080/14733285.2023.2214505

Marzi, I. & Reimers, A. K. (2018). Children's independent mobility: Current knowledge, future

directions, and public health implications. *International Journal of Environmental Research and Public Health*, *15*(11). https://doi.org/10.3390/ijerph15112441

McDonald, N. C. (2007). Active Transportation to School. Trends Among U.S. Schoolchildren, 1969-2001. *American Journal of Preventive Medicine*, *32*(6), 509–516. https://doi.org/10.1016/j.amepre.2007.02.022

McDonald, N. C. (2008). Children's mode choice for the school trip: The role of distance and school location in walking to school. *Transportation*, *35*(1), 23–35. https://doi.org/10.1007/s11116-007-9135-7

McDonald, N. C. & Aalborg, A. E. (2009). Why parents drive children to school. *Journal of the American Planning Association*, *75*(3), 331–342. https://doi.org/10.1080/01944360902988794

McDonald, N. C., Deakin, E. & Aalborg, A. E. (2009). Influence of the social environment on children's school travel. *Preventive Medicine*, *50*, S65–S68. https://doi.org/10.1016/j.ypmed.2009.08.016

McIntyre, C. A. & Rhodes, R. E. (2009). Correlates of leisure-time physical activity during transitions to motherhood. *Women and Health*, *49*(1), 66–83. https://doi.org/10.1080/03630240802690853

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

Mendoza, J., Haaland, W., Jacobs, M., Abbey-Lambertz, M., Miller, J., Salls, D., Todd, W., Madding, R., Ellis, K. & Kerr, J. (2017). Bicycle Trains, Cycling, and Physical Activity: A Pilot Cluster RCT. *American Journal of Preventive Medicine*, *53*(4), 481–489.

https://doi.org/https://doi.org/10.1016/j.amepre.2017.05.001

Mikkelsen, M. & Christensen, P. (2009). Is Children's Independent Mobility Really Independent? A Study of Children's Mobility Combining Ethnography and GPS/Mobile Phone Technologies1. *Mobilities*, *4*, 37–58. https://doi.org/10.1080/17450100802657954

Mitchell, H., Kearns, R. A. & Collins, D. C. A. (2007). Nuances of neighbourhood: Children's perceptions of the space between home and school in Auckland, New Zealand. *Geoforum*, *38*(4), 614–627. https://doi.org/10.1016/j.geoforum.2006.11.012

Mitchell, J., Skouteris, H., McCabe, M., Ricciardelli, L. A., Milgrom, J., Baur, L. A., Fuller-Tyszkiewicz, M. & Dwyer, G. (2012). Physical activity in young children: A systematic review of parental influences. *Early Child Development and Care*, *182*(11), 1411–1437. https://doi.org/10.1080/03004430.2011.619658

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. & Buliung, R. N. (2012). Built environment correlates of active school transportation: Neighborhood and the modifiable areal unit problem. *Journal of Transport Geography*, *20*(1), 51–61. https://doi.org/10.1016/j.jtrangeo.2011.07.009

Mitra, R. & Faulkner, G. (2012). There's no such thing as bad weather, just the wrong clothing: Climate, weather and active school transportation in Toronto, Canada. *Canadian Journal of Public Health*, *103*(SUPPL. 3), 35–41. https://doi.org/10.1007/bf03403833

Mitra, R., Faulkner, G. E., 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

Moore, L. L., Lombardi, D. A., White, M. J., Campbell, J. L., Oliveria, S. A. & Ellison, R. C. (1991). Influence of parents' physical activity levels on activity levels of young children. *The Journal of Pediatrics*, *118*(2), 215. https://doi.org/10.1016/s0022-3476(05)80485-8

Morgan, P. J., Collins, C. E., Plotnikoff, R. C., Callister, R., Burrows, T., Fletcher, R., Okely, A., Young, M. D., Miller, A., Lloyd, A. B., Cook, A. T., Cruickshank, J., Saunders, K. L. & Lubans, D. R. (2014). The "Healthy Dads, Healthy Kids" community randomized controlled trial: A community-based healthy lifestyle program for fathers and their children. *Preventative Medicine*, *116*, 90–99. https://doi.org/https://doi.org/10.1016/j.ypmed.2013.12.019

Morgan, P. J., Rayward, A. T., Young, M. D., Pollock, E. R., Eather, N., Barnes, A. T., Kennedy, S.-L., Saunders, K. L., Drew, R. J. & Lubans, D. R. (2021). Establishing Effectiveness of a Community-based, Physical Activity Program for Fathers and Daughters: A Randomized Controlled Trial. *Annals of Behavioral Medicine*, 1–14. https://doi.org/10.1093/abm/kaab056

Morris, J., Wang, F. & Lilja, L. (2001). School Children's Travel Patterns: A Look Back and a Way Forward. *Transport Engineering in Australia*, *7*(1/2), 15. http://search.informit.com.au/documentSummary;dn=470034740172518;res=IELENG

Morrison, R., Reilly, J. J., Penpraze, V., Westgarth, C., Ward, D. S., Mutrie, N., Hutchison, P., Young, D., McNicol, L., Calvert, M. & Yam, P. S. (2013). Children, parents and pets exercising together (CPET): Exploratory randomised controlled trial. *BMC Public Health*, *13*(1). https://doi.org/10.1186/1471-2458-13-1096

Nelson, N. M., Foley, E., O'Gorman, D. J., Moyna, N. M. & Woods, C. B. (2008). Active

commuting to school: How far is too far? *International Journal of Behavioral Nutrition and Physical Activity*, *5*, 1–9. https://doi.org/10.1186/1479-5868-5-1

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E. C., Biryukov, S., Abbafati, C., Abera, S. F., Abraham, J. P., Abu-Rmeileh, N. M. E., Achoki, T., Albuhairan, F. S., Alemu, Z. A., Alfonso, R., Ali, M. K., Ali, R., Guzman, N. A., … Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *384*(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8

O'Brien, M., Jones, D., Sloan, D. & Rustin, M. (2000). Children's Independent Spatial Mobility in the Urban Public Realm. *Childhood*, *7*(3), 257–277. https://doi.org/10.1177/0907568200007003002

O'Dwyer, M. V., Fairclough, S. J., Knowles, Z. & Stratton, G. (2012). Effect of a family focused active play intervention on sedentary time and physical activity in preschool children. *International Journal of Behavioral Nutrition and Physical Activity*, *9*, 1–13. https://doi.org/10.1186/1479-5868-9-117

Ogilvie, D., Egan, M., Hamilton, V. & Petticrew, M. (2004). Promoting walking and cycling as an alternative to using cars: Systematic review. *British Medical Journal*, *329*(7469), 763–766. https://doi.org/10.1136/bmj.38216.714560.55

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), 1–12.

https://doi.org/10.1186/1479-5868-11-70

Olvera, N. N., Knox, B., Scherer, R., Maldonado, G., Sharma, S. V., Alastuey, L. & Bush, J. A. (2008). A healthy lifestyle program for latino daughters and mothers: The bounce overview and process evaluation. *American Journal of Health Education*, *39*(5), 283–295. https://doi.org/10.1080/19325037.2008.10599052

Pabayo, R., Gauvin, L. & Barnett, T. A. (2011). Longitudinal changes in active transportation to school in Canadian youth aged 6 through 16 years. In *Pediatrics (Evanston)* (Vol. 128, Issue 2, p. e404). https://doi.org/10.1542/peds.2010-1612

Page, A. S., Cooper, A. R., Griew, P., Davis, L. & Hillsdon, M. (2009). Independent mobility in relation to weekday and weekend physical activity in children aged 10-11 years: The PEACH Project. *International Journal of Behavioral Nutrition and Physical Activity*, *6*, 1–9. https://doi.org/10.1186/1479-5868-6-2

Panter, J., Corder, K., Griffin, S. J., Jones, A. P. & van Sluijs, E. M. (2013). Individual, socio-cultural and environmental predictors of uptake and maintenance of active commuting in children: longitudinal results from the SPEEDY study. *The International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 83. https://doi.org/10.1186/1479-5868-10-83

Panter, J., Jones, A., Van Sluijs, E. & Griffin, S. (2010). Attitudes, social support and environmental perceptions as predictors of active commuting behaviour in school children. *Journal of Epidemiology and Community Health*, *64*(1), 41–48. https://doi.org/10.1136/jech.2009.086918

ParticipACTION. (2020). *2020 Report Card #Family influence.*

Paterson, D. C., Ramage, K., Moore, S. A., Riazi, N., Tremblay, M. S. & Faulkner, G. (2021).

Exploring the impact of COVID-19 on the movement behaviors of children and youth: A scoping review of evidence after the first year. *Journal of Sport and Health Science*, *10*(6), 675–689. https://doi.org/10.1016/j.jshs.2021.07.001

Pont, K., Ziviani, J., Wadley, D. & Abbott, R. (2011). The Model of Children's Active Travel (M-CAT): A conceptual framework for examining factors influencing children's active travel: a model of children's active travel. *Australian Occupational Therapy Journal*, *58*(3), 138–144. https://doi.org/10.1111/j.1440-1630.2010.00865.x

Rhodes, R. E., Blanchard, C. M., Benoit, C., Levy-Milne, R., Naylor, P. J., Symons Downs, D. & Warburton, D. E. R. (2014). Physical activity and sedentary behavior across 12 months in cohort samples of couples without children, expecting their first child, and expecting their second child. *Journal of Behavioral Medicine*, *37*(3), 533–542. https://doi.org/10.1007/s10865-013-9508-7

Rhodes, R. E. & Lim, C. (2018). Promoting Parent and Child Physical Activity Together: Elicitation of Potential Intervention Targets and Preferences. *Health Education and Behavior*, *45*(1), 112–123. https://doi.org/10.1177/1090198117704266

Rhodes, R. E., Naylor, P. J. & McKay, H. A. (2010). Pilot study of a family physical activity planning intervention among parents and their children. *Journal of Behavioral Medicine*, *33*(2), 91–100. https://doi.org/10.1007/s10865-009-9237-0

Rhodes, R. E., Spence, J. C., Berry, T., Deshpande, S., Faulkner, G., Latimer-Cheung, A. E., O'Reilly, N. & Tremblay, M. S. (2016). Understanding action control of parental support behavior for child physical activity. *Health Psychology*, *35*(2), 131–140. https://doi.org/10.1037/hea0000233

Riazi, N. A., Blanchette, S., Trudeau, F., Larouche, R., Tremblay, M. S. & Faulkner, G. (2019).

Correlates of children's independent mobility in canada: A multi-site study. *International Journal of Environmental Research and Public Health*, *16*(16), 1–14. https://doi.org/10.3390/ijerph16162862

Riazi, N. A., Brussoni, M., Vertinsky, P. & Faulkner, G. (2021). "Well, You Feel More Responsible When You're Unsupervised": Exploring Family Perspectives on Children's Independent Mobility. *Children*, *8*(3), 1–18. https://doi.org/10.3390/children8030225

Riazi, N. A., Wunderlich, K., Gierc, M., Brussoni, M., Moore, S. A., Tremblay, M. S. & Faulkner, G. (2021). "You Can't Go to the Park, You Can't Go Here, You Can't Go There": Exploring Parental Experiences of COVID-19 and Its Impact on Their Children's Movement Behaviours. *Children*, *8*(3). https://doi.org/10.3390/children8030219

Rissotto, A. & Tonucci, F. (2002). Freedom of movement and environmental knowledge in elementary school children. *Journal of Environmental Psychology*, *22*(1–2), 65–77. https://doi.org/10.1006/jevp.2002.0243

Ross, A. & Kurka, J. M. (2022). Predictors of Active Transportation Among Safe Routes to School Participants in Arizona: Impacts of Distance and Income. *Journal of School Health*, *92*(3), 282–292. https://doi.org/10.1111/josh.13125

Ryan, R. M. & Deci, E. L. (2017). *Self-Determination Theory : Basic Psychological Needs in Motivation, Development, and Wellness*. Guilford Publications. http://ebookcentral.proquest.com/lib/uleth/detail.action?docID=4773318

Saidla, K. (2018). Health promotion by stealth: active transportation success in Helsinki, Finland. *Health Promotion International*, *33*(4), 600–609. https://doi.org/10.1093/heapro/daw110

Sallis, J. F., Cervero, R. B., Ascher, W., Henderson, K. A., Kraft, M. K. & Kerr, J. (2006). An

ecological approach to creating active living communities. *Annual Review of Public Health*, *27*(1), 297–322. https://doi.org/10.1146/annurev.publhealth.27.021405.102100

Sandseter, E. B. H. (2009). Characteristics of risky play. *Journal of Adventure Education & Outdoor Learning*, *9*(1), 3–21. https://doi.org/10.1080/14729670802702762

Sandseter, E. B. H. & Kennair, L. E. O. (2011). Children's risky play from an evolutionary perspective: The Anti-phobic effects of thrilling experiences. *Evolutionary Psychology*, *9*(2), 257–284. https://doi.org/10.1177/147470491100900212

Sayers, S. P., Lemaster, J. W., Thomas, I. M., Petroski, G. F. & Ge, B. (2012). A walking school bus program: Impact on physical activity in elementary school children in Columbia, Missouri. *American Journal of Preventive Medicine*, *43*(5 SUPPL.4), 384–389. https://doi.org/10.1016/j.amepre.2012.07.009

Schoeppe, S., Duncan, M. J., Badland, H. M., Oliver, M. & Browne, M. (2014). Associations between children's independent mobility and physical activity. *BMC Public Health*, *14*(1). https://doi.org/10.1186/1471-2458-14-91

Schoeppe, S., Liersch, S., Röbl, M., Krauth, C. & Walter, U. (2016). Mothers and fathers both matter: The positive influence of parental physical activity modeling on children's leisure-time physical activity. *Pediatric Exercise Science*, *28*(3), 466–472. https://doi.org/10.1123/pes.2015-0236

Sharmin, S. & Kamruzzaman, M. (2017). Association between the built environment and children's independent mobility: A meta-analytic review. *Journal of Transport Geography*, *61*(April), 104–117. https://doi.org/10.1016/j.jtrangeo.2017.04.004

Shaw, B., Bicket, M., Elliott, B., Fagan-Watson, B., Mocca, E. & Hillman, M. (2015). Children's Independent Mobility: an international comparison and recommendations for action. In

Policy Studies Institute (Issue July). http://www.psi.org.uk/docs/7350_PSI_Report_CIM_final.pdf

Sims, D., Matthews, S. A., Bopp, M. J., Rovniak, L. S. & Poole, E. (2018). Predicting discordance between perceived and estimated walk and bike times among university faculty, staff, and students. *Transportmetrica A: Transport Science*, *14*(8), 691–705. https://doi.org/10.1080/23249935.2018.1427814

Smith, L., Norgate, S. H., Cherrett, T., Davies, N., Winstanley, C. & Harding, M. (2015). Walking School Buses as a Form of Active Transportation for Children-A Review of the Evidence. *Journal of School Health*, *85*(3), 197–210. https://doi.org/10.1111/josh.12239

Tomkinson, G. R., Lang, J. J. & Tremblay, M. S. (2019). Temporal trends in the cardiorespiratory fitness of children and adolescents representing 19 high-income and upper middle-income countries between 1981 and 2014. *British Journal of Sports Medicine*, *53*(8), 478–486. https://doi.org/10.1136/bjsports-2017-097982

Tremblay, M., Katzmarzyk, P. & Willms, J. (2002). Temporal trends in overweight and obesity in Canada, 1981-1996. *International Journal of Obesity*, *26*(4), 538–543. https://doi.org/https://doi.org/10.1038/sj.ijo.0801923

Trost, S. G., McDonald, S. & Cohen, A. (2013). Measurement of general and specific approaches to physical activity parenting: A systematic review. *Childhood Obesity*, *9*(SUPPL.1), 40–50. https://doi.org/10.1089/chi.2013.0027

Trost, S. G., Sallis, J. F., Pate, R. R., Freedson, P. S., Taylor, W. C. & Dowda, M. (2003). Evaluating a model of parental influence on youth physical activity. *American Journal of Preventive Medicine*, *25*(4), 277–282. https://doi.org/10.1016/S0749-3797(03)00217-4

Umstattd Meyer, M. R., Bridges, C. N., Schmid, T. L., Hecht, A. A. & Pollack Porter, K. M.

(2019). Systematic review of how Play Streets impact opportunities for active play, physical activity, neighborhoods, and communities. *BMC Public Health*, *19*(1), 1–16. https://doi.org/10.1186/s12889-019-6609-4

United States Environmental Protection Agency. (2003). *Travel and Environmental Implications of School Siting*. http://www.epa.gov/dced/pdf/school_travel.pdf

van der Ploeg, H. P., Merom, D., Corpuz, G. & Bauman, A. E. (2007). Trends in Australian children traveling to school 1971–2003: Burning petrol or carbohydrates? *Preventative Medicine*, *46*(1), 60–62. https://doi.org/10.1016/j.ypmed.2007.06.002

VanKann, D. H. H., Kremers, S. P. J., de Vries, S. I., de Vries, N. K. & Jansen, M. W. J. (2016). Parental Active Transportation Routines (PATRns) as a Moderator of the Association Between Neighborhood Characteristics and Parental Influences and Active School Transportation. *Environment and Behavior*, *48*(7), 946–965. https://doi.org/10.1177/0013916515574548

van Sluijs, E. M. F., Ekelund, U., Crochemore-Silva, I., Guthold, R., Ha, A., Lubans, D., Oyeyemi, A. L., Ding, D. & Katzmarzyk, P. T. (2021). Physical activity behaviours in adolescence: current evidence and opportunities for intervention. *The Lancet*, *398*(10298), 429–442. https://doi.org/10.1016/S0140-6736(21)01259-9

Villanueva, K., Giles-Corti, B., Bulsara, M., Timperio, A., McCormack, G., Beesley, B., Trapp, G., & Middleton, N. (2013). 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

Vlaar, J., Brussoni, M., Janssen, I. & Mâsse, L. C. (2019). Roaming the neighbourhood:

Influences of independent mobility parenting practices and parental perceived environment on children's territorial range. *International Journal of Environmental Research and Public Health*, *16*(17), 8–14. https://doi.org/10.3390/ijerph16173129

Williams, G. C., Borghese, M. M. & Janssen, I. (2018). Neighborhood walkability and objectively measured active transportation among 10–13 year olds. *Journal of Transport and Health*, *8*(September 2017), 202–209. https://doi.org/10.1016/j.jth.2017.12.006

Wilson, E. J., Marshall, J., Wilson, R. & Krizek, K. J. (2010). By foot, bus or car: Children's school travel and school choice policy. *Environment and Planning A*, *42*(9), 2168–2185. https://doi.org/10.1068/a435

Wong, B., Faulkner, G. & Buliung, R. (2011). GIS measured environmental correlates of active. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(39). https://doi.org/10.1186/1479-5868-8-39

Wood, J. & Hamilton, J. (2022). *Enabling Independent Travel for Young Scots: Age-appropriate Active Travel Infrastructure for 11-16 year olds*. http://aplaceinchildhood.org/wp-content/uploads/2022/10/Enabling-Independent-Travel-for-Young-Scots_Final.pdf

Woodcock, J., Givoni, M. & Morgan, A. S. (2013). Health Impact Modelling of Active Travel Visions for England and Wales Using an Integrated Transport and Health Impact Modelling Tool (ITHIM). *PLoS ONE*, *8*(1). https://doi.org/10.1371/journal.pone.0051462

World Health Organization. (2021). Physical activity fact sheet. *More Physical Activity*. https://www.who.int/publications/i/item/WHO-HEP-HPR-RUN-2021.2

CHAPTER 2: METHODS

2.1 STUDY DESIGN

This cross-sectional study used data from the Active Transportation and Independent Mobility (ATIM) Project, a multi-site school-based study conducted in three regions in Canada (Ottawa, Ontario; Vancouver, British Columbia; and Trois-Rivières, Québec) with the aim of examining AT, IM, and PA in elementary school children (Riazi et al., 2019). Ethics approval for conducting the ATIM project was obtained from the Research Ethics Boards at Children's Hospital of Eastern Ontario (15/103X), University of British Columbia (H15-02710), and Université du Québec à Trois-Rivières (CER-15-218-07.05), and contributing school boards. Approval for secondary use of data was obtained from the University of Lethbridge Human Participant Research Committee (2020-050) (Appendix 1).

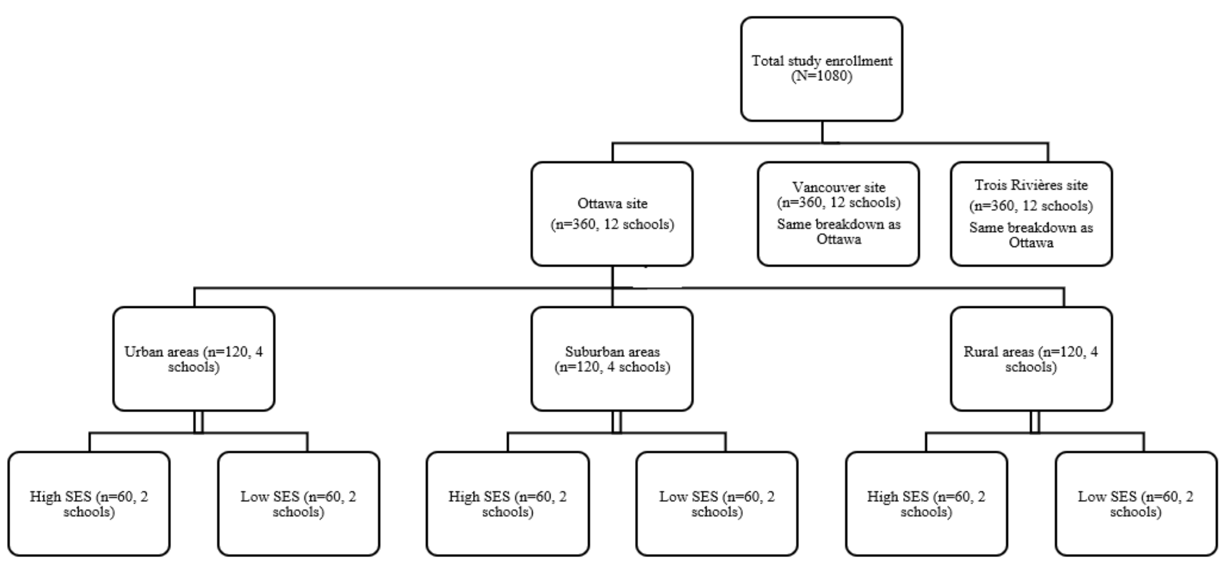
2.2 SAMPLING

In each site a purposive sampling method was used to select schools. The schools were stratified according to urbanization level (urban, suburban, rural) and socioeconomic status (SES) (low, high). Type of urbanization was determined following the approach of Rainham et al (2012), which primarily emphasized population density, but also considered characteristics such as urban form to distinguish urban and suburban areas School-level SES was estimated using the median household income of the school census tract based on the 2006 Canadian census (Riazi et al., 2019). From the pool of interested schools, two lower SES and two higher SES schools were recruited in urban, suburban, and rural areas respectively at each site (Delisle Nyström et al., 2019). In Vancouver, an additional urban school was recruited to achieve a total of 37 participating schools (Delisle Nyström et al., 2019). Once school board and school approval were obtained, children in grades 4 to 6 classrooms were invited to take part in data collection. A few

grade 7 students also participated in the study due to the presence of mixed grade classrooms. Written informed consent was obtained from parents and written assent was obtained from the children.

Figure 2.1

Sampling strategy for the ATIM study



We aimed to recruit a sample of at least 1080 children (8–12 years-old) within 36 schools to examine correlates of IM according to *a priori* power calculations (Larouche et al., 2019). Data were collected between March 2016 and June 2017. A total of 1951 children in grades 4-6 (mean age 10.2±1.0 years) took part in the study (54.2% response rate) and 1699 children (87.1%) returned at least the child or parent questionnaire and were included in the analyses (Delisle Nyström et al., 2019). A greater proportion of girls, children residing in a suburban area and those residing in the Trois-Rivières region were included in the analytical sample (Riazi et al., 2019).

2.3 MEASURES

AT and IM behaviors of parents and their children were collected with validated questionnaires offered in both English and French languages. Children self-reported their age, gender, and grade in the child questionnaire (Appendix 2) as well as the number of trips that they took to and from each of the following destinations on each day of the week: (1) school, (2) friends' houses, (3) relatives' houses, (4) parks, (5) shops, (6) sport venues, (7) faith places, and (8) other locations not listed. Based on this information, we calculated the total number of active trips. In a pilot study, the total number of trips reported by children and parents showed high test–retest reliability (intraclass correlation coefficient (ICC) = 0.91 and 0.66, respectively) (Larouche et al., 2017). In the present study, there was moderate agreement between the number of trips reported by children and their parent (ICC = 0.53, data not shown) (Larouche et al., 2020).

Children also self-reported on their degree of IM through several survey questions based on Hillman's six mobility licenses (Hillman et al., 1990). These questions on IM assessed children's permissions to do the following: travel home from school alone; cross main roads alone; cycle on main roads alone; travel on buses alone (other than school bus); travel alone to places other than school; go out alone after dark (Hillman et al., 1990). These six IM licenses were dichotomized (1 = yes; 0 = no), and an IM index was constructed ranging from 0 to 6 as the sum of scores for each mobility license, with higher values indicating a higher degree of IM (Riazi et al., 2019). In a pilot-study with a sample of English- and French-speaking children and parents, the IM index was found to have good test-retest reliability (intra-class correlation coefficient (ICC) range=0.63–0.88) and convergent validity between child and parent responses (ICC range=0.61–0.80) for both languages (Larouche et al., 2017).

The parent questionnaire (Appendix 3) included demographic questions about the responding parent's gender (man or woman) and age (under 30, 30-44, 45+), and at what age they were allowed to go places alone. Parents were asked to report if they currently used the following travel modes to commute to work: walking, cycling, public transit, or driving a car. Parents could select multiple options, so each mode was coded as "yes" or "no". Parents were asked how they travelled to school when they were a 10 to 12-year-old. Response options were: walked; cycled; school bus; local bus or train; car; other. These modes were combined into three categories: active, inactive, and public transit (includes school bus and local bus or train). Public transit is a potential source of parental AT and PA, as users often need to walk to and/or from transit stops (Besser & Dannenberg, 2005; Saelens et al., 2014). Parents were also asked how many days per week they accompanied their child home from school (using any mode of transport). Parental accompaniment has been shown to be associated with lower odds of AT to/from school (Mammen et al., 2012).

2.4 DATA TREATMENT

Multiple imputation was used to replace missing data points with the mice package in R version 4.2.1 software (R Core Team, 2022). As recommended by Graham (2009), the imputation model included all variables of interest for the present analyses as well as several additional variables to improve the prediction of missing values. A full list of variables included in the multiply imputed model can be found in Appendix 4. A total of 20 imputed datasets were created with 25 iterations produced per imputation (Riazi et al., 2019). Multiply imputed models were also compared with complete case models (Appendices 5 and 6) to examine the consistency of associations (Sterne et al., 2009).

Upon inspection of the distribution of the number of active trips, we observed the presence of extreme outliers (n = 16). We used winsorization to mitigate the effect of extreme outliers without dropping observations, similar to the approach used by Siegel et al (Siegel et al., 2013). Winsorization involves replacing extreme outliers with the value of a specified upper cut-point, and can be used in non-symmetrical data censoring (Dixon, 1960; Siegel et al., 2013). We deemed the 99th percentile to be a reasonable upper limit, which was 50 active trips per week in the multiply imputed data. Therefore, we replaced extreme outliers by this value. Models without winsorization can be found in Appendix 7.

2.5 ANALYSIS

IBM SPSS version 28.0 was used to calculate descriptive statistics (IBM Corp, 2021), while R version 4.2.1 (R Core Team, 2022) was used for bivariate and multivariate regression analyses. First, an empty model was fitted with only school entered as a random effect to determine the within-school ICC. Next, bivariate linear mixed-effects models were used to examine the association between parent- and child-reported variables in the model adjusted for school clustering. Variables were included in the model if they were significant at the 0.05 level.

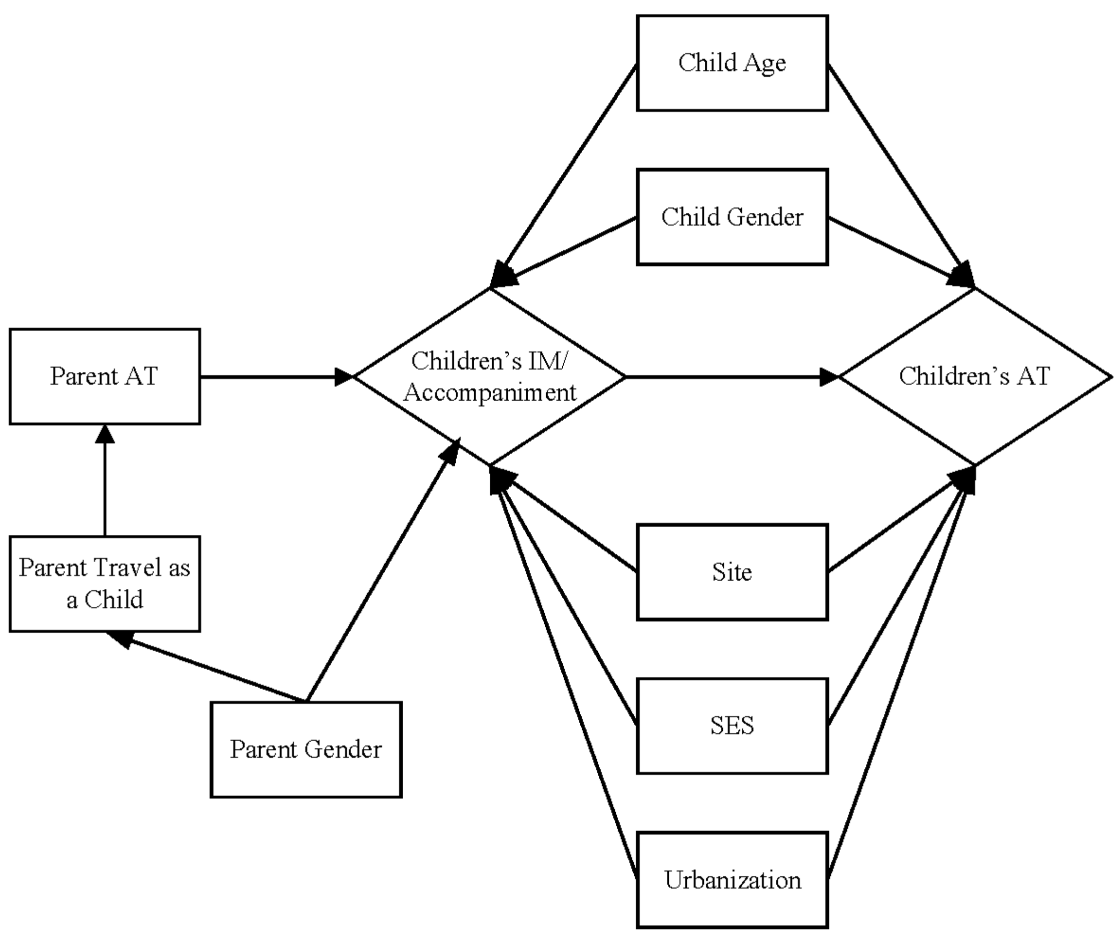
According to ecological models of health behavior, population level studies on PA should consider the dynamic relationships among environmental and individual factors, rather than focusing on unidimensional analyses of single determinants (Cerin, 2011). Therefore, generalized linear mixed models were generated to investigate associations between parental travel variables and both IM and AT (R Core Team, 2022). These models are more robust in case of unbalanced clusters and can assess within- and between-cluster effects (Cerin, 2011). The variance inflation factor was computed for all variables included in the model and no instances of multicollinearity were noted.

For models predicting IM, the lme4 package was used to investigate associations between variables (R Core Team, 2022). These models report the change in IM license for every 1-unit increase in the IM variable. For associations between parental travel variables and children's AT, the glmmTMB package was used to generate the statistical models. Given that many children reported no active trips, the models were fitted based on a negative binomial distribution (Larouche et al., 2020). Results related to children's active trips are reported as incidence rate ratios (IRR), which represent the percentage change in the dependent variable given a 1-unit increase in the independent variable, and 95% confidence intervals. Models were stratified by gender due to documented gender differences in IM (Brown et al., 2008; Carver et al., 2013; O'Brien et al., 2000) and AT (McMillan et al., 2006). Models without stratification are also provided.

Previous studies using this dataset have found significant clustering in AT and IM at the school level, which may reflect different policies that can either promote or discourage active travel engagement among students (Larouche et al., 2019; Riazi et al., 2019). Thus, school was included as a random effect in the models pertaining to both IM and AT. Site, urbanization, and SES were assigned as fixed effects for AT and IM to align with previous studies using this dataset (Larouche et al., 2019; Riazi et al., 2019). Consistent with previous papers from the ATIM study, the Ottawa site was used as reference group (Larouche et al., 2019; Riazi et al., 2019). AT models were also adjusted for parent respondent's gender due to some research showing gender-specific parental barriers to active school travel (Aibar Solana et al., 2018). The potential relationship between parent respondent's gender, accompaniment and AT is illustrated in Figure 2.2. Multiply imputed models were also compared with complete case models to examine the consistency of the findings.

Figure 2.2

Conceptual model showing expected correlates of children's IM and AT



2.6 REFERENCES

Aibar Solana, A., Mandic, S., Generelo Lanaspa, E., Gallardo, L. O. & Zaragoza Casterad, J. (2018). Parental barriers to active commuting to school in children: does parental gender matter? *Journal of Transport and Health*, *9*(November 2017), 141–149. https://doi.org/10.1016/j.jth.2018.03.005

Besser, L. M. & Dannenberg, A. L. (2005). Walking to public transit: Steps to help meet physical activity recommendations. *American Journal of Preventive Medicine*, *29*(4), 273–280. https://doi.org/10.1016/j.amepre.2005.06.010

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

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

Cerin, E. (2011). Statistical approaches to testing the relationships of the built environment with resident-level physical activity behavior and health outcomes in cross-sectional studies with cluster sampling. *Journal of Planning Literature*, *26*(2), 151–167. https://doi.org/10.1177/0885412210386229

Delisle Nyström, C., Barnes, J. D., Blanchette, S., Faulkner, G., Leduc, G., Riazi, N. A., Tremblay, M. S., Trudeau, F. & Larouche, R. (2019). Relationships between area-level socioeconomic status and urbanization with active transportation, independent mobility, outdoor time, and physical activity among Canadian children. *BMC Public Health*, *19*(1), 1–12. https://doi.org/10.1186/s12889-019-7420-y

Faulkner, G. E. J., Richichi, V., Buliung, R. N., Fusco, C. & Moola, F. (2010). What's quickest and easiest Parental decision making about school trip mode. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 1–11. https://doi.org/10.1186/1479-5868-7-62

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology*, *60*, 549–576. https://doi.org/10.1146/annurev.psych.58.110405.085530

Hillman, M., Adams, J. & Whitelegg, J. (1990). One false move: A study of children's independent mobility. *Policy Studies Unit*, *January*. https://ci.nii.ac.jp/naid/10004535145/en/

IBM Corp. (2021). *IBM SPSS Statistics for Windows, Version 28.0*.

Larouche, R, Blanchette, S., Faulkner, G., Riazi, N., Trudeau, F. & Tremblay, M. (2019). Correlates of Children's Physical Activity: A Canadian Multisite Study. *Medicine & Science in Sports & Exercise*, *51*(12), 2482–2490. https://doi.org/10.1249/MSS.0000000000002089

Larouche, R., Barnes, J. D., Blanchette, S., Faulkner, G., Riazi, N. A., Trudeau, F. & Tremblay, M. S. (2020). Relationships among children's independent mobility, active transportation, and physical activity: A multisite cross-sectional study. *Pediatric Exercise Science*, 32(4), 189–196. https://doi.org/10.1123/PES.2019-0238

Larouche, R., Blanchette, S., Faulkner, G., Riazi, N., Trudeau, F. & Tremblay, M. S. (2019). Correlates of Children's Physical Activity: A Canadian Multisite Study. In *Medicine and Science in Sports and Exercise* (Vol. 51, Issue 12). https://doi.org/10.1249/MSS.0000000000002089

Larouche, R., Eryuzlu, S., Livock, H., Leduc, G., Faulkner, G., Trudeau, F. & Tremblay, M. S.

(2017). Test-retest reliability and convergent validity of measures of children's travel behaviours and independent mobility. *Journal of Transport and Health*, *6*(May), 105–118. https://doi.org/10.1016/j.jth.2017.05.360

Larouche, R., Mammen, G., Rowe, D. A. & Faulkner, G. (2018). Effectiveness of active school transport interventions: a systematic review and update. *BMC Public Health*, *18*(1), 206. https://doi.org/10.1186/s12889-017-5005-1

Mammen, G., Faulkner, G., Buliung, R. & Lay, J. (2012). Understanding the drive to escort: a cross-sectional analysis examining parental attitudes towards children's school travel and independent mobility. In *BMC Public Health* (Vol. 12, Issue 1, p. 862). BioMed Central Ltd. https://doi.org/10.1186/1471-2458-12-862

Marshall, S. W. (2007). Power for tests of interaction: Effect of raising the Type I error rate. *Epidemiologic Perspectives and Innovations*, *4*, 1–7. https://doi.org/10.1186/1742-5573-4-4

Martin, A. (2015). An exploration of the determinants and health impacts of active commuting [University of East Anglia]. In *PQDT - UK & Ireland*. https://ueaeprints.uea.ac.uk/57410/

McMillan, T., Day, K., Boarnet, M., Alfonzo, M. & Anderson, C. (2006). Johnny walks to school-does Jane? Sex differences in children's active travel to school. *Children, Youth and Environments*, *16*(1), 75–89. https://escholarship.org/uc/item/22f7k6z8

O'Brien, M., Jones, D., Sloan, D. & Rustin, M. (2000). Children's Independent Spatial Mobility in the Urban Public Realm. *Childhood*, *7*(3), 257–277. https://doi.org/10.1177/0907568200007003002

Page, A. S., Cooper, A. R., Griew, P., Davis, L. & Hillsdon, M. (2009). Independent mobility in relation to weekday and weekend physical activity in children aged 10-11 years: The PEACH Project. *International Journal of Behavioral Nutrition and Physical Activity*, *6*, 1–

9. https://doi.org/10.1186/1479-5868-6-2

Page, A. S., Cooper, A. R., Griew, P. & Jago, R. (2010). Independent mobility, perceptions of the built environment and children's participation in play, active travel and structured exercise and sport: the PEACH Project. *The International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 17. https://doi.org/10.1186/1479-5868-7-17

R Core Team. (2022). R: A language and environment for statistical computing. (4.2.1). *R Foundation for Statistical Computing*. https://www.r-project.org/

Rainham, D. G., Bates, C. J., Blanchard, C. M., Dummer, T. J., Kirk, S. F. & Shearer, C. L. (2012). Spatial classification of youth physical activity patterns. *American Journal of Preventive Medicine*, *42*(5), e87–e96. https://doi.org/10.1016/j.amepre.2012.02.011

Riazi, N. A., Blanchette, S., Trudeau, F., Larouche, R., Tremblay, M. S. & Faulkner, G. (2019). Correlates of children's independent mobility in canada: A multi-site study. *International Journal of Environmental Research and Public Health*, *16*(16), 1–14. https://doi.org/10.3390/ijerph16162862

Saelens, B. E., Moudon, A. V., Kang, B., Hurvitz, P. M. & Zhou, C. (2014). Relation between higher physical activity and public transit use. *American Journal of Public Health*, *104*(5), 854–859. https://doi.org/10.2105/AJPH.2013.301696

Schoeppe, S., Duncan, M. J., Badland, H. M., Oliver, M. & Browne, M. (2014). Associations between children's independent mobility and physical activity. *BMC Public Health*, *14*(1), 1–9. https://doi.org/10.1186/1471-2458-14-91

Sterne, J. A. C., White, I. R., Carlin, J. B., Spratt, M., Royston, P., Kenward, M. G., Wood, A. M. & Carpenter, J. R. (2009). Multiple imputation for missing data in epidemiological and clinical research: Potential and pitfalls. *BMJ (Online)*, *339*(7713), 157–160.

https://doi.org/10.1136/bmj.b2393

Wong, B. Y.-M., Faulkner, G., Buliung, R. & Irving, H. (2011). Mode shifting in school travel mode: examining the prevalence and correlates of active school transport in Ontario, Canada. *BMC Public Health*, *11*(1), 618. https://doi.org/10.1186/1471-2458-11-618

CHAPTER 3 - PARENTAL TRAVEL BEHAVIOURS AS A CHILD, COMMUTING PRACTICES AND CHILDREN'S INDEPENDENT MOBILITY: A MULTI-SITE STUDY

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3.1 ABSTRACT

Purpose: Children who are allowed greater independent mobility (IM) are more physically active. This study investigated associations between parents' current travel mode to work, their own IM and school travel mode as a child, and their child's IM.

Method: Children in grades 4-6 (n=1699) were recruited from urban, suburban, and rural schools in Vancouver, Ottawa and Trois-Rivières. Parents reported their current travel mode to work, IM, and school travel mode as a child. Children self-reported their IM using Hillman's six mobility licenses. Multiple imputation was performed to replace missing data. Gender-stratified generalized linear mixed models were adjusted for child age, parent gender, urbanization, and socioeconomic status.

Results: The older a parent was allowed to travel alone as a child, the less IM their child had (boys: β=-0.09, 95% CI=-0.13, -0.04; girls: β=-0.09, CI=-0.13, -0.06). Girls whose parents biked to work (β=0.45, CI=0.06, 0.83) or lived in Trois-Rivières vs. other sites (β=0.82, CI=-0.43, 1.21) had higher IM. IM increased with each year of age (boys: β=0.46, CI=0.34, 0.58; girls: β=0.38, CI=0.28, 0.48).

Conclusion: Parents who experienced IM later may be more restrictive of their child's IM. This potential for a generational 'carry-over' effect has implications for future interventions to promote IM.

Keywords: Active transportation; Independent mobility; Social-Ecological framework; Physical Activity; Socioeconomic status; Urbanization

3.2 INTRODUCTION

Regular physical activity (PA) in children has been shown to improve indicators of physical fitness, cardiometabolic health, bone health, cognitive outcomes, and mental health (Janssen & Leblanc, 2010; World Health Organization, 2021). Unfortunately, most children and youth across the world do not accumulate the recommended 60 minutes of moderate-to-vigorous PA (Aubert et al., 2018; Guthold et al., 2020; van Sluijs et al., 2021). Declines in active transportation (AT) and outdoor play have been identified as potential contributors to low levels of PA among US children (Bassett et al., 2015), and both of these trends could be associated with children's independent mobility (IM).

IM is defined as a child's freedom to travel and play around their neighborhood or city without parental supervision (Hillman et al., 1990). Children who are allowed greater IM may accumulate more PA than those with less freedom to play and travel unsupervised (Page et al., 2009; Schoeppe et al., 2014). IM also allows children to access many recreational and social opportunities and develop emotional bonds with their natural environment (Brown et al., 2008). Likewise, IM allows children to acquire, process and structure knowledge about their environment such as landmarks and routes and can teach them the responsibilities involved with making their own decisions (Brown et al., 2008; Rissotto & Tonucci, 2002).

However, there is consistent evidence showing that IM has declined over the last few decades in many countries (McDonald, 2007; Shaw et al., 2015). This trend coincided with a decline in AT to school (Larouche, 2018) depriving many children of an important source of PA (Larouche et al., 2014; Schoeppe et al., 2013). Existing research suggests that IM is an important enabler of both AT and PA (Mackett et al., 2007; Page et al., 2009; Wen et al., 2009).

As parents are believed to be the "gatekeepers" of their child's mobility (Faulkner et al., 2010; Mitra, 2013; Pont et al., 2011), their own mobility during childhood and current travel behaviours could be associated with their child's IM. For example, parents' current AT routines have been identified as a positive correlate of children's active school travel and may help alleviate the perception of "stranger danger" as a barrier (VanKann et al., 2016). Furthermore, a thesis published in 2015 indicated that walking or cycling to school during childhood was associated with an increased likelihood of using AT for the commute to work during early adulthood (Martin, 2015). Therefore, it is possible that parents who used AT for their school travel as children may be more willing to let their children do the same. However, to our knowledge, no previous studies have examined the association between a parent's AT as a child and their children's IM.

The aim of this study was to investigate the association between parents' school travel mode as a child, current work travel mode, and the age at which they were allowed to go places alone with their child's IM. We hypothesize that:

1. Parents who used active means to travel to school as a child have children with higher IM.
2. Parents who were able to go places alone at a younger age have children with higher IM.
3. Parents who currently use AT to commute have children with higher IM.

3.3 METHODS

3.3.1 Study Design

This cross-sectional study used data from the Active Transportation and Independent Mobility (ATIM) Project, a multi-site school-based study conducted in three regions in Canada

(Ottawa, Ontario; Vancouver, British Columbia; and Trois-Rivières, Québec) with the primary aim of examining AT, IM, and PA in elementary-aged school children (Riazi et al., 2019).

3.3.2 Participants

A purposive sampling strategy was used to recruit schools in each site. We aimed to recruit a sample of at least 1080 children (8–12 years-old) within 36 schools to examine correlates of IM according to a priori power calculations (Larouche et al., 2019). Data were collected between March 2016 and June 2017. A total of 37 schools were recruited and written consent and assent was obtained for 1951 children (54.2% response rate). Of the child-parent dyads that provided consent, 1699 children (87.1%) returned at least the child or parent questionnaire and were included in the analytical sample (Larouche et al., 2019). The schools were stratified according to urbanization level (urban, suburban, rural) and socioeconomic level (low, high). Schools were categorized as low or high SES based on data from the 2006 Canadian census (Larouche et al., 2019). Type of urbanization was determined following the approach of Rainham et al (2012). Once school board and school approval were obtained, children in grades 4 to 6 classrooms were invited to take part in data collection. A few grade 7 students also participated in the study due to the presence of mixed grade classrooms. Written informed consent was obtained from parents and written assent from the children.

3.3.3 Measures

Children self-reported their age, gender, and degree of IM through six questions based on Hillman's six mobility licenses in a questionnaire (Hillman et al., 1990). These questions on IM assessed children's permissions to do the following: travel home from school alone; cross main roads alone; cycle on main roads alone; travel on buses alone (other than school bus); travel alone to places other than school; go out alone after dark (Hillman et al., 1990). These six IM

licenses were dichotomized (1 = yes; 0 = no), and an IM index ranging from 0 to 6 was constructed as the sum of scores for each mobility license, with higher values indicating a higher degree of IM (Riazi et al., 2019). In a pilot-study with a sample of English- and French-speaking children and parents, the IM index was found to have good test-retest reliability (intra-class correlation coefficient (ICC) range=0.63–0.88) and convergent validity between child and parent responses (ICC range=0.61–0.80) for both languages (Larouche et al., 2017).

The parent who completed the survey provided their gender (man or woman) and age (under 30, 30-44, 45+), and indicated at what age (in years) they were allowed to go places alone. Parents were asked to report if they currently used the following travel modes to commute to work: walking, cycling, public transit, or driving a car. Parents could select multiple options, so each mode was coded as "yes" or "no". Parents were asked how they travelled to school when they were a 10- to 12-year-old child. Response options were: walked; cycled; school bus; local bus or train; car; other. These modes were combined into three categories: active, inactive, and public transit. Public transit was treated as a distinct category because it is also a potential source of parental AT and PA, as users often need to walk to and/or from transit stops (Besser & Dannenberg, 2005; Saelens et al., 2014). Both child and parent surveys are available in Appendices 2 and 3 respectively.

3.3.4 Statistical Analysis

Multiple imputation was used to replace missing data points with the mice package in RStudio software (RStudio Team, 2015). As recommended by Graham (2009), our imputation model included all variables of interest for the present analyses and several additional variables to improve the prediction of missing values (see Appendix 4 for the multiple imputation model). In total, 20 imputed datasets were created with 25 iterations produced per imputation (35).

IBM SPSS version 28.0 was used to calculate descriptive statistics (IBM Corp, 2021), while RStudio version 2022.07.2 Build 576 (RStudio Team, 2015) was used for bivariate and multivariate regression analysis. First, an empty model was fitted with only school entered as a random effect to determine the within-school ICC. Next, bivariate linear mixed-effects models were used to examine the association of child- and parent-reported variables with children's IM while adjusting only for school clustering. Variables were included in the model if they were significant at the $p<0.05$ level. Generalized linear mixed models were created with R Studio using the lme4 package (RStudio Team, 2015). These models are more robust in case of unbalanced clusters and can assess within- and between-cluster effects (Cerin, 2011). Sampling variables (site, urbanization and SES) were controlled as fixed effects in the final models. Consistent with a previous paper from the ATIM study, the Ottawa site was used as reference group (Larouche et al., 2019). Models were also adjusted for parent gender due to previously documented associations with IM (Riazi et al., 2019). The variance inflation factor (VIF) was computed for all variables included in the model and all VIF values were less than or equal to 1.35, therefore none were found to violate the assumption of multicollinearity. Models were also stratified by child gender due to documented gender differences in IM (Brown et al., 2008; Carver et al., 2013; O'Brien et al., 2000). Both stratified and non-stratified results are shown in Table 2. Multiply imputed models were also compared with complete case models to examine the consistency of associations (Sterne et al., 2009) (Appendix 5).

3.4 RESULTS

Table 1 presents the descriptive statistics for the study sample. Approximately 81% of parent respondents were women and over 98% of parents reported being 30 years of age or older. The mean IM index for the entire sample was 2.2. Boys had a higher mean IM index compared

to girls (girls: 2.07, $p < 0.01$, boys: 2.29). The mean age for parents being allowed to go places alone was 9.9 years with no significant difference between men and women (women: 9.79, men: 9.86, $p = 0.71$).

Table 3.1. *Descriptive characteristics of study participants.*

Parent characteristics	N	Percentage (%)	Child characteristics	N	Percentage (%)
Gender			**Gender**		
Woman	1345	79.2	Girl	936	55.0
Man	354	20.8	Boy	763	45.0
Age (years)			**Age (years)**		
Under 30	21	1.2	8	15	0.9
30-44	1135	66.8	9	444	26.1
45+	543	32.0	10	574	33.8
			11	496	29.2
			12	163	9.6
			13	6	0.4
Parent travel mode to work					
Walk	240	14.1			
Bike	119	7.0			
Public Transit	229	13.5			
Car	1184	69.7			
Parent travel mode as a child					
Active	1086	63.9			
Public Transit	486	28.6			
Inactive	90	5.3			
Other	37	2.2			

ǂParent could select multiple modes

In the bivariate analysis, child age ($p<0.001$), child gender ($p=0.001$), living in the Trois-Rivières region ($p<0.001$), and age a parent was allowed to go places alone ($p<0.001$) were found to be significant (data not shown) predictors of IM. There were no other significant associations observed.

Table 2 presents the associations between parental variables and children's IM while controlling for sampling variables. The older a parent was allowed to travel alone as a child, the less IM licenses their child had (β=-0.09 for each year of age for boys and girls). IM increased with each year of age (girls: β=0.38; boys: β=0.46). Children who lived in Trois-Rivières had higher IM than children living in Ottawa (Table 2) and Vancouver (girls: β=0.96, 95% CI=0.58, 1.34; boys: β=0.60, 95% CI=0.16, 1.03), but this finding was only significant in girls. IM was higher among girls whose parent respondent reported traveling to school by bus as a child rather than using AT (β=0.22), and who biked to work at the time of the survey (β=0.45). Boys' IM was lower if their mother was the respondent, though the association was not significant.

Table 3.2. *Associations between sampling variables, parent and child characteristics, and independent mobility.*

Variable	β, Both genders (n=1699)	β, Girls (n=936)	β, Boys (n=763)
Site			
Ottawa (reference)	0	0	0
Vancouver	-0.23 (-0.57, 0.11)	-0.17 (-0.55, 0.20)	-0.30 (-0.74, 0.14)
Trois-Rivières	**0.67 (0.32, 1.03)****	**0.82 (0.43, 1.21)****	0.41 (-0.05, 0.87)
Urbanization			
Urban (reference)	0	0	0
Suburban	-0.05 (-0.38, 0.29)	0.05 (-0.32, 0.42)	-0.13 (-0.55, 0.29)
Rural	0.16 (-0.18, 0.50)	0.17 (-0.21, 0.55)	0.14 (-0.30, 0.59)
School SES			
High (reference)	0	0	0
Low	-0.02 (-0.30, 0.26)	-0.15 (-0.46, 0.16)	0.08 (-0.27, 0.44)
Child age (year)	**0.40 (0.32, 0.47)****	**0.38 (0.28, 0.48)****	**0.46 (0.34, 0.58)****
Age Parent was allowed to go places alone (each additional year)	**-0.09 (-0.12, -0.07)****	**-0.09 (-0.13, -0.06)****	**-0.09 (-0.13, -0.04)****

Parent gender			
Man (reference)	0	0	0
Woman	-0.12 (-0.29, 0.06)	-0.03 (-0.25, 0.20)	-0.25 (-0.52, 0.02)
Parent travel to school as a child			
Active (reference)	0	0	0
Bus	0.08 (-0.09, 0.24)	**0.22 (0.00, 0.44)***	-0.11 (-0.37, 0.16)
Inactive	0.11 (-0.21, 0.43)	0.27 (-0.15, 0.69)	-0.12 (-0.61, 0.37)
Parent travel mode to work‡			
Walk	0 (-0.22, 0.22)	0.03 (-0.26, 0.31)	0.03 (-0.33, 0.38)
Bike	0.28 (-0.01, 0.58)	**0.45 (0.06, 0.83)***	0.13 (-0.32, 0.59)
Public Transit	-0.10 (-0.32, 0.13)	-0.23 (-0.52, 0.06)	-0.00 (-0.34, 0.34)
Car	-0.07 (-0.23, 0.10)	-0.07 (-0.28, 0.14)	-0.05 (-0.31, 0.21)

Note: β = unstandardized regression coefficients; SES = socioeconomic status. **p*-value <0.05; ***p*-value <0.01;
School-level intraclass correlation coefficient 0.06 for Both, 0.07 for Girls and 0.07 for Boys
‡Parent could select multiple modes and, for each mode, the reference is "no".

3.5 DISCUSSION

This study investigated the association between parents' school travel mode as a child, current work travel mode, and the age at which they were allowed to go places alone with their child's IM. In our study, older children were granted more IM. Parents' school travel mode as a child was significantly associated with girls' but not boys' IM, thus only partially supporting our first hypothesis. In line with our second hypothesis, we found that boys and girls whose parents were granted IM at an older age had significantly lower IM after controlling for sampling variables and potential confounders. Similar to our first hypothesis, parents' current work travel mode was significantly associated with girls' but not boys' IM. We also found that older children and those who lived in Trois-Rivières compared to the other sites had higher IM, though this difference was not statistically significant for boys. Together, these findings suggest that mobility experiences during childhood may affect parents' willingness to grant IM to their child.

It is generally believed that parents are the "gatekeepers" of children's mobility, as they make the decisions to promote or restrict certain travel modes (Carver et al., 2013; Pont et al., 2011). While the choice of whether to escort a child to school is complex, this decision appears to be influenced by traffic concerns, children's personal safety, and parental perception of the child's maturity and cognitive ability to travel to or from school safely on their own (Faulkner et al., 2010). In the literature, age is a consistent correlate of children's IM - as children grow older, they gain the knowledge, skills and maturity that parents feel is required for greater roaming privileges (Alparone & Pacilli, 2012; Christian et al., 2015; Riazi et al., 2019; Veitch et al., 2008). As hypothesized, the older a parent was able to go places alone, the lower IM index their child reported. While the observed effect size seems small (-0.09 licenses for every year older a parent was allowed to go places alone), this might still be meaningful in a population with low IM overall.

Refreshing adult's memory about their own childhood can often bring to light stark differences between what they were allowed to do and what they allow their own children to do. A 2020 survey of 5- to 11-year- olds in the United Kingdom found a significant difference between the average age that children were reportedly allowed to be out alone (10.74 years) compared to their parents (8.91 years) (Dodd et al., 2021). Our findings suggest that in spite of the well-known decline in IM, children whose parents were granted IM earlier had greater IM license. These preliminary findings suggest that if we were able to intervene to support children's IM, there may be possible carry-over effects for future generations. This also supports the potential for family-based interventions that may be more effective in addressing a parent's own experiences, discussing the "risk" involved in IM and negotiating a child's license to travel alone.

Consistent with previous studies, we found that boys had higher IM than girls (Brown et al., 2008; Mitra, 2013; O'Brien et al., 2000), but there were no significant differences in the age at which parent respondents were allowed to go places alone as a child. However, the girls in this study were more sensitive to differences in their parent's travel behaviours than boys. Girls whose parent currently biked to work had a higher IM index. Parents who bike to work likely value AT and they may want to enable their children to engage in AT. For example, the study by Larsen et al. (2018) showed that when distance and built environments are held constant, parental preferences were the most important factors in travel mode choice. In particular, children were more likely to walk if parents agreed that driving them to school sets a bad example (Larsen et al., 2018).

We found that girls had higher IM if their parents took the bus to school as children and if their parents biked to work at the time of the survey, although these associations were not found in boys. In Canada, eligibility for school bussing is primarily based on the distance between home and school. For example, the Ottawa Student Transportation Authority indicates that students taking the bus in grades 1-8 must reside 1.6 km or more from their school (Ottawa Student Transportation Authority, n.d.). It is therefore possible that many parents who took the bus grew up in less populated areas which are farther from their schools. Although such areas may be less likely to offer proximity to school, they could offer greater access to environmental features that support IM such as cul-de-sacs and greenspaces (Riazi et al., 2022; Sharmin & Kamruzzaman, 2017). However, a systematic review found that studies examining differences in IM between children living in urban, suburban, and rural areas reported inconsistent results (Riazi et al., 2022). Given that our findings were mixed and the lack of previous studies

examining the association between parents' school travel mode as child and their children's IM, there is a clear need for more research in this area.

We found that girls in Trois-Rivières had almost one more IM license than those in Ottawa and Vancouver. This finding is consistent with a previous analysis of the social-ecological correlates of IM using this dataset (Riazi et al., 2019). The Trois-Rivières census metropolitan area (CMA) has a smaller population compared to the other recruitment locations (Ottawa/Gatineau CMA = 1,488,307; Vancouver CMA = 2,642,825; Trois-Rivières CMA = 161,489) (Statistics Canada, 2023), and this could be a contributing factor. Although Riazi et al. (2019) found no differences between sites in parent-perceived informal social control and safety concerns, there are likely other reasons that explain this disparity. Thus, more research is needed to investigate the social-ecological factors that can explain how and why IM differs by region.

It should be noted that almost 80% of parent respondents in this study were women. This may have reduced our statistical power to assess whether children's IM differed based on parent gender. We found that when the parent respondent identified as woman, boys had 0.25 less IM licenses on average, however this difference was not statistically significant ($p = 0.073$). Previous research on IM suggests that women are less comfortable with risk than their male counterparts (Brussoni et al., 2013; Schoeppe et al., 2015). Future studies should attempt to engage fathers in responding to household surveys to gain a more accurate depiction of gender differences in parental tolerance of IM.

Strengths of this study include a large sample size, the inclusion of urban, suburban, and rural schools, stratified by socioeconomic status, in three diverse regions, and the use of a validated IM index. This study had several limitations that should be considered. This study is cross-sectional, making it impossible to infer causality, and it relied on self-reported measures,

which are vulnerable to social desirability and recall bias. Recall bias may be particularly important for questions about parents' IM and school travel mode as a child. Parents' IM as a child was assessed with a single item that focused only on travel to school. Parents' ability to travel independently to/from other places during childhood may also have influenced their willingness to grant IM to their child. If that is the case, then we may have underestimated the association between parental mobility as a child and their child's IM. Finally, it is important to reiterate that almost 80% of parent respondents identified as woman. This is not uncommon in research; in many studies that require parental participation there is usually a higher response from mothers (Eiser & Morse, 2001). The underrepresentation of fathers limits our ability to discuss their influence on children's IM (Davison et al., 2016).

3.6 CONCLUSION

In this study, we found that parents who experienced childhood IM later may be more restrictive of their child's IM. This suggests that interventions promoting IM may have inter-generational effects, but intervention studies with long-term follow-up will be required to test this hypothesis. Girls appear to be more sensitive to differences in their parents' travel behaviours, particularly their current travel mode to work, suggesting that promoting AT to/from work could also encourage children's IM. Future research should seek to address the underrepresentation of fathers in studies on parenting and child health as having the perspective of both parents could expand our understanding of decision making related to IM.

3.7 REFERENCES

Alparone, F. R. & Pacilli, M. G. (2012). On children's independent mobility: The interplay of demographic, environmental, and psychosocial factors. *Children's Geographies*, *10*(1), 109–122. https://doi.org/10.1080/14733285.2011.638173

Aubert, S., Barnes, J. D., Abdeta, C., Nader, P. A., Adeniyi, A. F., Aguilar-Farias, N., Tenesaca, D. S. A., Bhawra, J., Brazo-Sayavera, J., Cardon, G., Chang, C. K., Delisle Nyström, C., Demetriou, Y., Draper, C. E., Edwards, L., Emeljanovas, A., Gába, A., Galaviz, K. I., González, S. A., … Tremblay, M. S. (2018). Global Matrix 3.0 physical activity Report Card grades for children and youth: Results and analysis from 49 countries. *Journal of Physical Activity and Health*, *15*(Suppl 2), S251–S273. https://doi.org/10.1123/jpah.2018-0472

Bassett, D. R., John, D., Conger, S. A., Fitzhugh, E. C. & Coe, D. P. (2015). Trends in Physical Activity and Sedentary Behaviors of United States Youth. *Journal of Physical Activity & Health*, *12*(8), 1102–1111. https://doi.org/10.1123/jpah.2014-0050

Besser, L. M. & Dannenberg, A. L. (2005). Walking to public transit: Steps to help meet physical activity recommendations. *American Journal of Preventive Medicine*, *29*(4), 273–280. https://doi.org/10.1016/j.amepre.2005.06.010

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

Brussoni, M., Olsen, L. L., Creighton, G. & Oliffe, J. L. (2013). Heterosexual gender relations in and around childhood risk and safety. *Qualitative Health Research*, *23*(10), 1388–1398. https://doi.org/10.1177/1049732313505916

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

Cerin, E. (2011). Statistical approaches to testing the relationships of the built environment with resident-level physical activity behavior and health outcomes in cross-sectional studies with cluster sampling. *Journal of Planning Literature*, *26*(2), 151–167. https://doi.org/10.1177/0885412210386229

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. *Journal of Physical Activity & Health*, *12*(Suppl 1), S84–S93. https://doi.org/10.1123/jpah.2014-0271

Davison, K. K., Gicevic, S., Aftosmes-Tobio, A., Ganter, C., Simon, C. L., Newlan, S. & Manganello, J. A. (2016). Fathers' Representation in Observational Studies on Parenting and Childhood Obesity: A Systematic Review and Content Analysis. *American Journal of Public Health*, *106*(11), e14–e21. https://doi.org/10.2105/AJPH.2016.303391

Dodd, H. F., Fitzgibbon, L., Watson, B. E. & Nesbit, R. J. (2021). Children's play and independent mobility in 2020: Results from the british children's play survey. *International Journal of Environmental Research and Public Health*, *18*(8). https://doi.org/10.3390/ijerph18084334

Eiser, C. & Morse, R. (2001). Can Parents Rate Their Child's Health-Related Quality of Life? Results of a Systematic Review. In *Quality of life research* (Vol. 10, Issue 4, pp. 347–357). Kluwer Academic Publishers. https://doi.org/10.1023/A:1012253723272

Faulkner, G. E. J., Richichi, V., Buliung, R. N., Fusco, C. & Moola, F. (2010). What's quickest

and easiest Parental decision making about school trip mode. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 1–11. https://doi.org/10.1186/1479-5868-7-62

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology*, *60*, 549–576. https://doi.org/10.1146/annurev.psych.58.110405.085530

Guthold, R., Stevens, G. A., Riley, L. M. & Bull, F. C. (2020). Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. *The Lancet Child and Adolescent Health*, *4*(1), 23–35. https://doi.org/10.1016/S2352-4642(19)30323-2

Hillman, M., Adams, J. & Whitelegg, J. (1990). One false move: A study of children's independent mobility. *Policy Studies Unit*, *January*. https://ci.nii.ac.jp/naid/10004535145/en/

IBM Corp. (2021). *IBM SPSS Statistics for Windows, Version 28.0*.

Janssen, I. & Leblanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *The International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 40. https://doi.org/10.1186/1479-5868-7-40

Larouche, R, Blanchette, S., Faulkner, G., Riazi, N., Trudeau, F. & Tremblay, M. (2019). Correlates of Children's Physical Activity: A Canadian Multisite Study. *Medicine & Science in Sports & Exercise*, *51*(12), 2482–2490. https://doi.org/10.1249/MSS.0000000000002089

Larouche, R. (2018). *Last Child Walking?—Prevalence and Trends in Active Transportation* (Richard Larouche (ed.); pp. 53–75). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-12-811931-0.00004-1

Larouche, R., Eryuzlu, S., Livock, H., Leduc, G., Faulkner, G., Trudeau, F. & Tremblay, M. S. (2017). Test-retest reliability and convergent validity of measures of children's travel behaviours and independent mobility. *Journal of Transport and Health*, *6*(December 2016), 105–118. https://doi.org/10.1016/j.jth.2017.05.360

Larouche, R., Saunders, T. J., Faulkner, G. E. J., Colley, R. & Tremblay, M. (2014). Associations between active school transport and physical activity, body composition, and cardiovascular fitness: A systematic review of 68 studies. *Journal of Physical Activity and Health*, *11*(1), 206–227. https://doi.org/10.1123/jpah.2011-0345

Larsen, K., Larouche, R., Buliung, R. N. & Faulkner, G. E. J. (2018). A matched pairs approach to assessing parental perceptions and preferences for mode of travel to school. *Journal of Transport & Health*, *11*, 56–63. https://doi.org/10.1016/j.jth.2018.09.004

Mackett, R., Brown, B., Gong, Y., Kitazawa, K. & Paskins, J. (2007). Children's independent movement in the local environment. *Built Environment*, *33*(4), 454–468. https://doi.org/10.2148/benv.33.4.454

Martin, A. (2015). An exploration of the determinants and health impacts of active commuting [University of East Anglia]. In *PQDT - UK & Ireland*. https://ueaeprints.uea.ac.uk/57410/

McDonald, N. C. (2007). Active Transportation to School. Trends Among U.S. Schoolchildren, 1969-2001. *American Journal of Preventive Medicine*, *32*(6), 509–516. https://doi.org/10.1016/j.amepre.2007.02.022

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

O'Brien, M., Jones, D., Sloan, D. & Rustin, M. (2000). Children's Independent Spatial Mobility

in the Urban Public Realm. *Childhood*, *7*(3), 257–277. https://doi.org/10.1177/0907568200007003002

Ottawa Student Transportation Authority. (n.d.). *Frequently Asked Questions (FAQs)*. Retrieved January 9, 2023, from http://www.ottawaschoolbus.ca/school-bus-routes/frequently-asked-questions-faqs/

Page, A. S., Cooper, A. R., Griew, P., Davis, L. & Hillsdon, M. (2009). Independent mobility in relation to weekday and weekend physical activity in children aged 10-11 years: The PEACH Project. *International Journal of Behavioral Nutrition and Physical Activity*, *6*, 1–9. https://doi.org/10.1186/1479-5868-6-2

Pont, K., Ziviani, J., Wadley, D. & Abbott, R. (2011). The Model of Children's Active Travel (M-CAT): A conceptual framework for examining factors influencing children's active travel: a model of children's active travel. *Australian Occupational Therapy Journal*, *58*(3), 138–144. https://doi.org/10.1111/j.1440-1630.2010.00865.x

Rainham, D. G., Bates, C. J., Blanchard, C. M., Dummer, T. J., Kirk, S. F. & Shearer, C. L. (2012). Spatial classification of youth physical activity patterns. *American Journal of Preventive Medicine*, *42*(5), e87–e96. https://doi.org/10.1016/j.amepre.2012.02.011

Riazi, N. A., Blanchette, S., Trudeau, F., Larouche, R., Tremblay, M. S. & Faulkner, G. (2019). Correlates of children's independent mobility in canada: A multi-site study. *International Journal of Environmental Research and Public Health*, *16*(16), 1–14. https://doi.org/10.3390/ijerph16162862

Riazi, N. A., Wunderlich, K., Yun, L., Paterson, D. C. & Faulkner, G. (2022). Social-Ecological Correlates of Children's Independent Mobility: A Systematic Review. *International Journal of Environmental Research and Public Health*, *19*(3).

https://doi.org/10.3390/ijerph19031604

Rissotto, A. & Tonucci, F. (2002). Freedom of movement and environmental knowledge in elementary school children. *Journal of Environmental Psychology*, *22*(1–2), 65–77. https://doi.org/10.1006/jevp.2002.0243

RStudio Team. (2015). *RStudio: Integrated Development for R* (1.3.1073). https://www.rstudio.com/

Saelens, B. E., Moudon, A. V., Kang, B., Hurvitz, P. M. & Zhou, C. (2014). Relation between higher physical activity and public transit use. *American Journal of Public Health*, *104*(5), 854–859. https://doi.org/10.2105/AJPH.2013.301696

Schoeppe, S., Duncan, M. J., Badland, H. M., Alley, S., Williams, S., Rebar, A. L. & Vandelanotte, C. (2015). Socio-demographic factors and neighbourhood social cohesion influence adults' willingness to grant children greater independent mobility: A cross-sectional study. *BMC Public Health*, *15*(1), 1–8. https://doi.org/10.1186/s12889-015-2053-2

Schoeppe, S., Duncan, M. J., Badland, H. M., Oliver, M. & Browne, M. (2014). Associations between children's independent mobility and physical activity. *BMC Public Health*, *14*(1), 1–9. https://doi.org/10.1186/1471-2458-14-91

Schoeppe, S., Duncan, M. J., Badland, H., Oliver, M. & Curtis, C. (2013). Associations of children's independent mobility and active travel with physical activity, sedentary behaviour and weight status: a systematic review. *Journal of Science & Medicine in Sport*, *16*(4), 312–319. https://doi.org/10.1016/j.jsams.2012.11.001

Sharmin, S. & Kamruzzaman, M. (2017). Association between the built environment and children's independent mobility: A meta-analytic review. *Journal of Transport Geography*, *61*(April), 104–117. https://doi.org/10.1016/j.jtrangeo.2017.04.004

Shaw, B., Bicket, M., Elliott, B., Fagan-Watson, B., Mocca, E. & Hillman, M. (2015). Children's Independent Mobility: an international comparison and recommendations for action. In *Policy Studies Institute* (Issue July). http://www.psi.org.uk/docs/7350_PSI_Report_CIM_final.pdf

Statistics Canada (2023). Census Profile. 2021 Census of Population. Statistics Canada Catalogue number 98-316-X2021001. Ottawa. Released March 29, 2023. https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/index.cfm?Lang=E

Sterne, J. A. C., White, I. R., Carlin, J. B., Spratt, M., Royston, P., Kenward, M. G., Wood, A. M. & Carpenter, J. R. (2009). Multiple imputation for missing data in epidemiological and clinical research: Potential and pitfalls. *BMJ (Online)*, *339*(7713), 157–160. https://doi.org/10.1136/bmj.b2393

VanKann, D. H. H., Kremers, S. P. J., de Vries, S. I., de Vries, N. K. & Jansen, M. W. J. (2016). Parental Active Transportation Routines (PATRns) as a Moderator of the Association Between Neighborhood Characteristics and Parental Influences and Active School Transportation. *Environment and Behavior*, *48*(7), 946–965. https://doi.org/10.1177/0013916515574548

VanSluijs, E. M. F., Ekelund, U., Crochemore-Silva, I., Guthold, R., Ha, A., Lubans, D., Oyeyemi, A. L., Ding, D. & Katzmarzyk, P. T. (2021). Physical activity behaviours in adolescence: current evidence and opportunities for intervention. *The Lancet*, *398*(10298), 429–442. https://doi.org/10.1016/S0140-6736(21)01259-9

Veitch, J., Salmon, J. & Ball, K. (2008). Children's active free play in local neighborhoods: A behavioral mapping study. *Health Education Research*, *23*(5), 870–879. https://doi.org/10.1093/her/cym074

Wen, L. M., Kite, J., Merom, D. & Rissel, C. (2009). Time spent playing outdoors after school and its relationship with independent mobility: A cross-sectional survey of children aged 10-12 years in Sydney, Australia. *International Journal of Behavioral Nutrition and Physical Activity*, *6*, 1–8. https://doi.org/10.1186/1479-5868-6-15

World Health Organization. (2021). Physical activity fact sheet. *More Physical Activity*. https://www.who.int/publications/i/item/WHO-HEP-HPR-RUN-2021.2

CHAPTER 4 – PARENTAL TRAVEL BEHAVIOURS, ACCOMPANIMENT, AND CHILDREN'S ACTIVE TRANSPORTATION: A MULTI-SITE STUDY

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4.1 ABSTRACT

Purpose: Active transportation (AT) is an important source of physical activity for children. This study investigated whether parents' travel mode to school as a child, current travel mode to work, and parental accompaniment on the trip home from school are associated with their children's AT.

Methods: Grade 4-6 children were recruited from urban, suburban, and rural schools in the regions of Vancouver, Ottawa and Trois-Rivières, Canada. Parents reported their current travel mode(s) to work, school travel mode as a child, and how many days they accompanied their child home from school. Children reported the number of active trips to various destinations they took over 7 consecutive days. The sample included 1699 children (55% girls) and multiple imputation was performed to replace missing data. Generalized linear mixed models based on a negative binomial distribution were used to investigate associations. Models were stratified by gender and adjusted for child age, parent respondent's gender, level of urbanization, and school-area socioeconomic status.

Results: For each day a parent accompanied their child home from school, girls participated in 6% less active trips (95%CI 0.91-0.97) while boys had 7% less active trips (95%CI 0.90-0.96). Boys living in Vancouver had 55% more active trips (95% CI 1.13-2.04) and boys in Trois Rivières had 33% more active trips compared to Ottawa (95% CI 1.00-1.77).

Conclusions: Children may have more opportunities for AT if parents allow them to come home from school unaccompanied.

Keywords: Active transportation; Ecological framework; Physical Activity; Social; Socioeconomic status; Urbanization

4.2 INTRODUCTION

Travel to school is a routine behaviour for children and youth that presents an important opportunity to promote physical activity (Faulkner et al., 2010; Larouche, Saunders, et al., 2014). Active transportation (AT) is using one's own power to get from one place to another and includes walking and cycling as common examples (Hillman et al., 1990). Previous systematic reviews indicate that children and youth using AT to travel to/from school accumulate more physical activity (PA) (Lubans et al., 2011; Larouche, Saunders, et al., 2014; Campos-Garzón et al, 2023) and have higher cardiovascular fitness than those who are driven by car or bus (Cooper et al., 2006; Larouche, Faulkner, et al., 2014; Larouche, Saunders, et al., 2014). Other research also shows associations between AT and reduced rates of stress (Lambiase et al., 2010) and higher academic achievement (Martínez-Gómez et al., 2011). AT also has the additional benefit of reducing emissions of greenhouse gases and other pollutants due to the reduced reliance on fossil fuels (Chapman, 2007; Woodcock et al., 2009). Declines in AT and outdoor play have been identified as potential contributors to low levels of PA among children in the USA (Bassett et al., 2015).

AT has decreased considerably in many countries over the past few decades in spite of the apparent benefits (Booth et al., 2015; Larouche, 2018). A study set in the greater Toronto area found that the prevalence of AT to school among adolescents has declined significantly between 1986 to 2006 (Buliung et al., 2009). A more recent survey showed that AT among school-aged children decreased from 28% to 24% between 2000 and 2010 while the proportion of youth using inactive modes increased from 51% to 62% (Gray et al., 2014). Distance to school or other locations and concerns around crime and road traffic are commonly cited deterrents for AT in children (Carver et al., 2008; Panter et al., 2008). Increased rules and restrictions on

children's mobility may be another reason why children have less opportunities for AT (Larouche, 2018). Independent mobility (IM) is defined as a child's freedom to travel and play around their neighborhood or city without parental supervision (Hillman et al., 1990). Similar to trends in AT, there is consistent evidence showing that IM has declined over the last few decades in many countries (McDonald, 2007; Shaw et al., 2015). Children who are allowed greater IM also tend to accumulate more PA than those with less freedom to play and travel unsupervised (Page et al., 2009; Schoeppe et al., 2014).

Parents are believed to be the "gatekeepers" of their child's mobility, and have significant influence on their children's travel mode (Faulkner et al., 2010; Mitra, 2013; Pont et al., 2011). While the choice of whether to escort a child to school is complex, this decision appears to be influenced by perceived convenience, travel time, traffic concerns, children's personal safety, and the child's maturity and cognitive ability to navigate to or from school safely (Faulkner et al., 2010). Parents and caregivers are often conflicted between known benefits of PA and AT with concerns about time scarcity, neighborhood safety and societal norms (Dowling, 2000). An example of this is how driving children to school or local destinations may be seen as an opportunity to manage complex routines or a reflection of "good parenting" (Dowling, 2000). In contrast, a study by Larsen et al. (2018) found that children were about five times more likely to walk to school if their parents agreed that driving to school sets a bad example.

Parental attitudes towards traffic or other neighborhood hazards are likely to impact a child's ability to travel places alone or participate in AT (Mammen et al., 2012). A parent's encouragement of AT may reflect their own beliefs and attitudes about the risks and benefits, as well as their own values regarding AT and PA (Pont et al., 2011). A parent's own mode of transport to school during childhood and current travel behaviours could be associated with their

child’s AT. For example, parent AT routines have been identified as a positive correlate of children’s active school travel and may help alleviate the perception of “stranger danger” as a barrier (VanKann et al., 2016). Studies in Canada, the Netherlands, and the USA have found that children whose parents use AT have higher IM (Kwon et al., 2022; Larouche et al., 2023; VanKann et al., 2016). Furthermore, a thesis indicated that walking or cycling to school during childhood was associated with an increased likelihood of using AT for the commute to work during early adulthood (Martin, 2015). Therefore, parents who used AT for their school travel as children may be more willing to let their children do the same. Yet, to our knowledge, no published studies have examined the association between parent’s school travel mode as a child with their children’s AT.

The aim of this study was to investigate the relationship between parental travel behaviours in the present and past with parental accompaniment to/from school and children’s AT. The research hypotheses were as follows:

1. We anticipated that parents who used active means to commute to school as a child will have children with a higher number of active trips.
2. We expected that parents who were able to go places alone at a younger age will have children with a higher number of active trips.
3. We hypothesized that parents who use AT to commute to work will have children with a higher number of active trips.

4.3 METHODS

4.3.1 Study Design

This cross-sectional study used data from the Active Transportation and Independent Mobility (ATIM) Project, a multi-site school-based study conducted in three regions in Canada

(Ottawa, Ontario; Vancouver, British Columbia; and Trois-Rivières, Québec) with the aim of examining AT, IM, and PA in elementary school children (Riazi et al., 2019). Ethics approval for conducting the ATIM project was obtained from the Research Ethics Boards at Children's Hospital of Eastern Ontario (15/103X), University of British Columbia (H15-02710), and Université du Québec à Trois-Rivières (CER-15-218-07.05), and contributing school boards. Approval for secondary use of data was obtained from the University of Lethbridge Human Participant Research Committee (2020-050).

4.3.2 Participants

Recruitment of schools took place using a purposive sampling strategy in each area of Canada. We aimed to recruit a minimum sample of 1080 children (8–12 years old) within 36 schools according to *a priori* power calculations (Larouche et al., 2019). A total of 37 schools were recruited; written consent from parents and verbal assent from children was obtained for a total sample of 1951 children (54.2% response rate) (Larouche et al., 2019). Of the child-parent dyads that provided consent, 1699 children (87.1%) returned at least the child or parent questionnaire and were included in the final sample (Larouche et al., 2019). Schools were stratified according to urbanization level (urban, suburban, rural) and socioeconomic status (SES) level (low, high) (Riazi et al., 2019). Data from the 2006 Canadian census were used to categorize each school as low or high SES (Larouche et al., 2020). Urbanization level was determined following the approach of Rainham et al. (2012). Once school board and school approvals were obtained, children in grades 4 to 6 classrooms were invited to take part in data collection. Due to the presence of mixed-grade classrooms, several grade 7 students also participated in the study.

4.3.3 Measures

Children self-reported their age, gender, and grade in the child questionnaire as well as the number of trips that they took to and from each of the following destinations on each day of the week: (1) school, (2) friends' houses, (3) relatives' houses, (4) parks, (5) shops, (6) sport venues, (7) faith places, and (8) other. In a pilot study, the total number of trips reported by children and parents showed high test–retest reliability (intraclass correlation coefficient (ICC) = 0.91 and 0.66, respectively) (Larouche et al., 2017). In the present study, there was moderate agreement between the number of trips reported by children and their parent (ICC = 0.53, data not shown) (Larouche et al., 2020).

The parent who completed the survey provided their sex (man or woman) and age (under 30, 30-44, 45+), and at what age they were allowed to go places alone. Parents were asked to report if they currently used the following travel modes to commute to work: walking, cycling, public transit, or driving a car. Parents could select multiple options, so each mode was coded as "yes" or "no". Parents were asked how they travelled to school when they were a 10 to 12-year-old. Response options were: walked; cycled; school bus; local bus or train; car; other. These modes were combined into three categories: active, inactive, and public transit (includes school bus and local bus or train). Public transit is a potential source of parental AT and PA, as users often need to walk to and/or from transit stops (Besser & Dannenberg, 2005; Saelens et al., 2014). Parents were also asked how many days per week they accompanied their child home from school (using any mode of transport). Parental accompaniment has been shown to be associated with lower odds of AT to/from school (Mammen et al., 2012).

4.3.4 Statistical Analyses

Multiple imputation was used to replace missing data points with the mice package in R version 4.2.1 software (R Core Team, 2022). As recommended by Graham (2009), the imputation model included all variables of interest for the present analyses as well as several additional variables to improve the prediction of missing values. A total of 20 imputed datasets were created with 25 iterations produced per imputation (Riazi et al., 2019). Multiply imputed models were also compared with complete case models to examine the consistency of associations (Sterne et al., 2009).

IBM SPSS version 28.0 was used to calculate descriptive statistics (IBM Corp, 2021), while R version 4.2.1 (R Core Team, 2022) was used for bivariate and multivariate regression analyses. First, an empty model was fitted with only school entered as a random effect to determine the within-school ICC. Next, bivariate linear mixed-effects models were used to examine the association of child- and parent-reported variables in the model adjusted for school clustering. Variables were included in the model if they were significant at the 0.05 level.

Upon inspection of the distribution of the number of active trips, we observed the presence of several extreme outliers (n = 16). We used winsorization to mitigate the effect of extreme outliers without dropping observations, similar to the approach used by Siegel et al (2013). Winsorization involves replacing extreme outliers with the value of a specified upper cut-point, and can be used in non-symmetrical data censoring (Dixon, 1960; Siegel et al., 2013). We deemed the 99th percentile to be a reasonable upper limit, which was 50 active trips per week in the multiply imputed data. Therefore, we replaced extreme outliers by this value. Models without winsorization can be found in Appendix 7.

Generalized linear mixed models were created in R using the glmmTMB package (R Core Team, 2022). Results are reported as incidence rate ratios (IRR), which represent the percentage change in the dependent variable given a 1-unit increase in the independent variable, and 95% confidence intervals. These models are more robust in case of unbalanced clusters and can assess within- and between-cluster effects (Cerin, 2011). Given that many children reported no active trips, the models were fitted based on a negative binomial distribution (Larouche et al., 2020). The three sampling variables (site, urbanization and SES) were assigned as fixed effects in the final models. Models were also adjusted for parent respondent's gender due to some research showing gender-specific parental barriers to active school travel (Aibar Solana et al., 2018). The variance inflation factor was computed for all variables included in the model and no instances of multicollinearity were noted. Models were also stratified by child gender given that the prevalence and correlates of AT can vary by sex/gender (McMillan et al., 2006). Stratified and non-stratified results are listed in Table 2. Complete case analysis was also used to examine the consistency of the findings (Appendix 6).

4.4 RESULTS

Table 1 presents the descriptive statistics for the study sample, based on multiply imputed models. Over half of the children were girls (55%) and the mean age was 10.2 ± 1.0 years. More than three quarters (80.9%) of parent respondents were women and over 98% of parents reported being 30 years of age or older. The mean number of active trips for the entire sample was 11.2 ± 10.0 with no significant difference between boys and girls (boys: 11.6, girls: 10.9, p =<0.001). The mean age for parents being allowed to go places alone was 9.8 ± 2.9 with no significant difference between men and women (men: 9.86, women: 9.79, $p = 0.71$).

Table 4.1. *Descriptive characteristics of study participants.*

Parent characteristics	N	Percentage (%)	Child characteristics	N	Percentage (%)
Gender			**Gender**		
Woman	1345	79.2	Girl	936	55.0
Man	354	20.8	Boy	763	45.0
Age (years)			**Age (years)**		
Under 30	21	1.2	8	15	0.9
30-44	1135	66.8	9	444	26.1
45+	543	32.0	10	574	33.8
			11	496	29.2
			12	163	9.6
			13	6	0.4
Parent travel mode to work					
Walk	240	14.1			
Bike	119	7.0			
Public Transit	229	13.5			
Car	1184	69.7			
Parent travel mode as a child					
Active	1086	63.9			
Public Transit	486	28.6			
Inactive	90	5.3			
Other	37	2.2			

In the bivariate analysis (data not shown), children whose parent traveled to school by bus as a child ($p=0.032$) were found to have higher AT trips. Children who were more frequently accompanied on the trip home from school by their parent had significantly fewer AT trips ($p<0.001$). Parental commute to work by walking ($p=0.027$) and driving a car ($p=0.046$) were found to be significantly associated with more child AT trips.

Table 2 presents the associations between parental variables and children's active trips while controlling for sampling variables. For each day a parent accompanied their child home from school, girls participated in 6% less active trips while boys participated in 7% less active

trips (95% CI for girls 0.91-0.97, boys 0.90-0.96). Boys living in Vancouver had 55% more active trips (95% CI 1.13-2.04) and boys in Trois Rivières had 33% more active trips compared to Ottawa (95% CI 1.00-1.77). However, boys AT did not differ between Vancouver and Trois-Rivières (0.91; 95% CI 0.73-1.13). Parent's current work travel mode was not independently associated with their child's AT. Results for both boys and girls were consistent in the winsorized complete case models.

Table 4.2. *Incidence rate ratios (IRR) and 95% confidence intervals between sampling variables, parent and child characteristics, and active trips.*

Variable	IRR, Both (n=1699)	IRR, Girls (n=936)	IRR, Boys (n=763)
Site			
Ottawa (reference)	0	0	0
Vancouver	**1.25 (1.01 – 1.56)***	1.11 (0.86 – 1.42)	**1.55 (1.18 – 2.04)****
Trois-Rivières	1.14 (0.91 – 1.43)	1.02 (0.79 – 1.33)	**1.33 (1.00 – 1.77)***
Urbanization			
Urban (reference)	0	0	0
Suburban	0.99 (0.81 – 1.23)	0.85 (0.67 – 1.08)	1.20 (0.93 – 1.55)
Rural	1.14 (0.91 – 1.43)	0.81 (0.63 – 1.04)	1.06 (0.81 – 1.40)
School-level Socioeconomic Status(SES)			
High (reference)	0	0	0
Low	1.02 (0.85 – 1.21)	1.05 (0.86 – 1.28)	1.00 (0.80 – 1.24)
Child age (years)	0.96 (0.91 – 1.01)	0.94 (0.88 – 1.01)	0.98 (0.91 – 1.06)
Days a parent accompanied child home from school	**0.94 (0.91 – 0.96)****	**0.94 (0.91 – 0.97)****	**0.93 (0.90 – 0.96)****
Parent respondent's gender	0	0	0
Man (reference)	1.05 (0.93 – 1.18)	1.01 (0.86 – 1.42)	1.09 (0.91 – 1.30)
Woman			
Parent travel mode to school as a child			
Active (reference)	0	0	0

Public transit	0.90 (0.80 – 1.01)	0.89 (0.77 – 1.04)	0.89 (0.75 – 1.05)
Inactive	0.95 (0.77 – 1.17)	0.95 (0.71 – 1.27)	0.92 (0.67 – 1.27)
Parent travel mode to work			
Walk	1.12 (0.96 – 1.29)	1.10 (0.90 – 1.34)	1.19 (0.94 – 1.50)
Bike	1.02 (0.84 – 1.25)	1.06 (0.81 – 1.39)	0.94 (0.70 – 1.27)
Public transit	1.10 (0.95 – 1.28)	1.09 (0.89 – 1.34)	1.16 (0.93 – 1.46)
Car	0.94 (0.84 – 1.05)	0.95 (0.82 – 1.11)	0.90 (0.76 – 1.07)

Note: School-level intraclass correlation coefficient 0.07 for Both, 0.07 for Girls and 0.08 for Boys
*p-value <0.05; **p-value <0.01

4.5 DISCUSSION

This study investigated the association between parents' travel mode as a child, current travel mode to work, and the age at which they were allowed to go places alone and their child's AT. In line with our third hypothesis, we found that boys and girls who were more often accompanied by their parents on the trip home from school reported 7% and 6% less active trips respectively after controlling for sampling variables and potential confounders. In the bivariate models, children whose parents walk or drove to work reported more active trips. However, this association was not significant when controlling for covariates. Parents' school travel mode as a child was not associated with their child's AT; therefore, our other hypotheses are only partially supported.

Our results suggest that allowing children to come home from school unaccompanied may increase their opportunities for AT. It is notable that our questionnaire did not include an item about accompaniment on the trip to school and/or other destinations, so we may have underestimated the effect of accompaniment. Our findings are consistent with another published article from the ATIM study, which found that each additional IM license was associated with a 9% increase in active trips and a 19% increase in the total volume of AT to/from school

(Larouche et al., 2020). This also mirrors the findings by Mammen et al (2012), who found that children who were escorted to school by their parents were less likely to use active school travel. While most other studies on this topic have only investigated travel to school, they have also provided similar results (Carver et al., 2014). This consistency in findings emphasizes the need for supporting IM as a critical enabler of children's AT.

In bivariate models, we found that children whose parents walked or drove to work at the time of the survey reported more active trips. The association between parents' walking to work and their children's AT is consistent with our hypothesis as well as previous research (Kwon et al., 2022; Larouche et al., 2023; VanKann et al., 2016). However, given that previous research suggests that the perceived convenience of driving children to school on the way to work is an important barrier to AT to school (Faulkner et al., 2010; McDonald et al., 2009; McDonald & Aalborg, 2009), a positive association between driving to work and children's AT was unexpected. In any case, parents' commuting was not associated with their children's AT in multivariable models controlling for accompaniment and study site among other variables. It is plausible that accompaniment acts as a mediator, and this should be investigated in future longitudinal research.

The lack of association between parents' AT in childhood and their child's AT could be partly linked to the intergenerational decline in AT to/from school (Buliung et al., 2009; Larouche, 2018). It is also worth noting that our child survey assessed trips to/from a broader range of destinations whereas parents were only asked about their school travel in childhood. Given the lack of previous studies examining the association between parents' school travel mode as child and their children's AT, there is a clear need for more research in this area.

Boys in Vancouver and Trois Rivières were found to engage in more AT than boys in Ottawa, but the difference between Vancouver and Trois Rivières was not significant. One potential reason for this may be the lack of subsidized bus provision by school boards in the City of Vancouver (Larouche et al., 2020). In our study, associations between study site and AT were weaker and less consistent across genders than in the previous study by Larouche et al. (2020), which examined the volume of AT to/from school in km/week as the dependent variable. This suggests that differences between study sites may be associated more with school trips than other trips. Unlike many previous studies showing that female children are more likely to be driven to school and/or less likely to engage in AT than boys (Colley & Buliung, 2016; Larouche et al., 2019; Larouche, Chaput, et al., 2014; Larsen et al., 2018; Trapp et al., 2011), we found no gender differences in AT, even in bivariate analyses. Moreover, responding parent gender was not associated with the number of trips reported by their child.

Strengths of this study include the large sample size (n=1699), the inclusion of three diverse regions of Canada and the stratified sampling strategy that ensured variability in urbanization and area-level SES. While most studies on this topic consider only active travel to school (Larouche, 2018), this study included a variety of other locations that children may travel to. A major limitation of this study is its reliance on many self-reported measures which are vulnerable to social desirability and recall bias. Recall bias may be particularly important for the questions about parents' IM and travel mode as a child. Parents' AT as a child was assessed with a single item that focused only on travel to school, and it is possible that they may have travelled actively to other locations. This may have influenced their willingness to allow their child to travel actively, potentially underestimating the association between parental travel as a child and their child's AT. The survey question on accompaniment only asked about the trip home from

school. There tends to be a higher prevalence of AT on the trip back home than the trip to school (Wong et al., 2011), and parental accompaniement for other trips is common (Hjorthol & Fyhri, 2009). Future studies should inquire about accompaniment for the trip to school and to other destinations. The cross-sectional methodology of this study also limits our ability to establish causality. Given the large number of hypotheses tested in the models, the risk of type 1 error is considerable, though the fact that many of the significant variables were at the $p<0.01$ threshold provides some reassurance. Finally, almost 80% of parent respondents identified as women. This study did not specifically recruit parent participants of each gender, but the responses suggest a need for future studies to make deliberate efforts to recruit fathers.

4.6 CONCLUSION

Our findings suggest that children may have more opportunities for AT if parents allow them to come home from school unaccompanied. Hence, there is a need for more research to investigate the determinants of IM and how to overcome parent-perceived barriers to AT and IM. Given that parents may drive their child to/from school on the way to work, interventions to promote children's AT should address the perceived convenience of driving, encourage active commuting to work among parents, and encourage parents to allow their children to actively travel to school. More research is needed to investigate associations between past and current parental travel behaviours and their children's travel behaviours.

4.7 REFERENCES

Aibar Solana, A., Mandic, S., Generelo Lanaspa, E., Gallardo, L. O. & Zaragoza Casterad, J. (2018). Parental barriers to active commuting to school in children: does parental gender matter? *Journal of Transport and Health*, *9*(November 2017), 141–149. https://doi.org/10.1016/j.jth.2018.03.005

Besser, L. M. & Dannenberg, A. L. (2005). Walking to public transit: Steps to help meet physical activity recommendations. *American Journal of Preventive Medicine*, *29*(4), 273–280. https://doi.org/10.1016/j.amepre.2005.06.010

Booth, V. M., Rowlands, A. V. & Dollman, J. (2015). Physical activity temporal trends among children and adolescents. *Journal of Science and Medicine in Sport*, *18*(4), 418–425. https://doi.org/10.1016/j.jsams.2014.06.002

Buliung, R. N., Mitra, R. & Faulkner, G. (2009). Active school transportation in the Greater Toronto Area, Canada: An exploration of trends in space and time (1986–2006). *Preventive Medicine*, *48*(6), 507–512. https://doi.org/10.1016/j.ypmed.2009.03.001

Campos-Garzón, P., Sevil-Serrano, J., García-Hermoso, A., Chillón, P. & Barranco-Ruiz, Y. (2023). Contribution of active commuting to and from school to device-measured physical activity levels in young people: A systematic review and meta-analysis. Scandinavian Journal of Medicine and Science in Sports, July, 1–15. https://doi.org/10.1111/sms.14450"https://doi.org/10.1111/sms.14450

Carver, A, Panter, J. R., Jones, A. P. & van Sluijs, E. M. F. (2014). Independent mobility on the journey to school: A joint cross-sectional and prospective exploration of social and physical environmental influences. *Journal of Transport & Health*, *1*(1), 25–32. https://doi.org/10.1016/j.jth.2013.12.003

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

Cerin, E. (2011). Statistical approaches to testing the relationships of the built environment with resident-level physical activity behavior and health outcomes in cross-sectional studies with cluster sampling. *Journal of Planning Literature*, *26*(2), 151–167. https://doi.org/10.1177/0885412210386229

Chapman, L. (2007). Transport and climate change: a review. *Journal of Transport Geography*, *15*(5), 354–367. https://doi.org/10.1016/j.jtrangeo.2006.11.008

Colley, M. & Buliung, R. N. (2016). Gender Differences in School and Work Commuting Mode Through the Life Cycle: Exploring Trends in the Greater Toronto and Hamilton Area, 1986 to 2011. *Transportation Research Record*, *2598*(1), 102–109. https://doi.org/10.3141/2598-12

Cooper, A. R., Wedderkopp, N., Wang, H., Andersen, L. B., Froberg, K. & Page, A. S. (2006). Active travel to school and cardiovascular fitness in Danish children and adolescents. *Medicine and Science in Sports and Exercise*, *38*(10), 1724–1731. https://doi.org/10.1249/01.mss.0000229570.02037.1d

Davison, K. K., Gicevic, S., Aftosmes-Tobio, A., Ganter, C., Simon, C. L., Newlan, S. & Manganello, J. A. (2016). Fathers' representation in observational studies on parenting and childhood obesity: A systematic review and content analysis. *American Journal of Public Health*, *106*(11), e14–e21. https://doi.org/10.2105/AJPH.2016.303391

Dowling, R. (2000). Cultures of mothering and car use in suburban Sydney: A preliminary investigation. *Geoforum*, *31*(3), 345–353. https://doi.org/10.1016/S0016-7185(99)00048-2

Faulkner, G. E. J., Richichi, V., Buliung, R. N., Fusco, C. & Moola, F. (2010). What's quickest and easiest Parental decision making about school trip mode. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 62. https://doi.org/10.1186/1479-5868-7-62

Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual Review of Psychology*, *60*, 549–576. https://doi.org/10.1146/annurev.psych.58.110405.085530

Gray, C. E., Larouche, R., Barnes, J. D., Colley, R. C., Bonne, J. C., Arthur, M., Cameron, C., Chaput, J.-P., Faulkner, G., Janssen, I., Kolen, A. M., Manske, S. R., Salmon, A., Spence, J. C., Timmons, B. W. & Tremblay, M. S. (2014). Are we driving our kids to unhealthy habits? Results of the Active Healthy Kids Canada 2013 report card on physical activity for children and youth. *International Journal of Environmental Research and Public Health*, *11*(6), 6009–6020. https://doi.org/10.3390/ijerph110606009

Hillman, M., Adams, J. & Whitelegg, J. (1990). One false move: A study of children's independent mobility. *Policy Studies Institute*, *January*. https://ci.nii.ac.jp/naid/10004535145/en/

Hjorthol, R. & Fyhri, A. (2009). Do organized leisure activities for children encourage car-use? *Transportation Research Part A: Policy and Practice*, *43*(2), 209–218. https://doi.org/10.1016/j.tra.2008.11.005

IBM Corp. (2021). *IBM SPSS Statistics for Windows, Version 28.0*.

Kwon, S., Mason, M., Wang-schweig, M., Morrissey, J., Bartell, T. & Kandula, N. R. (2022). The association between adolescent active commuting to school and parent walking behavior : The FLASHE Study. *American Journal of Health Promotion*, *0*(0), 1–10. https://doi.org/10.1177/08901171221099271

Lambiase, M. J., Barry, H. M. & Roemmich, J. N. (2010). Effect of a simulated active commute

to school on cardiovascular stress reactivity. *Medicine and Science in Sports and Exercise*, *42*(8), 1609–1616. https://doi.org/10.1249/MSS.0b013e3181d0c77b

Larouche, R., Blanchette, S., Faulkner, G., Riazi, N., Trudeau, F. & Tremblay, M. (2019). Correlates of children's physical activity: A Canadian multisite study. *Medicine & Science in Sports & Exercise*, *51*(12), 2482–2490. https://doi.org/10.1249/MSS.0000000000002089

Larouche, R. (2018). *Last Child Walking?—Prevalence and Trends in Active Transportation* (R. Larouche (ed.); pp. 53–75). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-12-811931-0.00004-1

Larouche, R., Barnes, J. D., Blanchette, S., Faulkner, G., Riazi, N. A., Trudeau, F. & Tremblay, M. S. (2020). Relationships among children's independent mobility, active transportation, and physical activity: A multisite cross-sectional study. *Pediatric Exercise Science*, *32*(4), 189–196. https://doi.org/10.1123/PES.2019-0238

Larouche, R., Bélanger, M., Brussoni, M., Faulkner, G., Gunnell, K. & Tremblay, M. S. (2023). Canadian children's independent mobility during the COVID-19 pandemic: A national survey. *Health and Place*, *81*(March), 1–8. https://doi.org/10.1016/j.healthplace.2023.103019

Larouche, R., Chaput, J.-P., Leduc, G., Boyer, C., Bélanger, P., LeBlanc, A. G., Borghese, M. M. & Tremblay, M. S. (2014). A cross-sectional examination of socio-demographic and school-level correlates of children's school travel mode in Ottawa, Canada. *BMC Public Health*, *14*(1), 497. https://doi.org/10.1186/1471-2458-14-497

Larouche, R., Eryuzlu, S., Livock, H., Leduc, G., Faulkner, G., Trudeau, F. & Tremblay, M. S. (2017). Test-retest reliability and convergent validity of measures of children's travel behaviours and independent mobility. *Journal of Transport and Health*, *6*(May), 105–118.

https://doi.org/10.1016/j.jth.2017.05.360

Larouche, R., Faulkner, G. E. J., Fortier, M. & Tremblay, M. S. (2014). Active transportation and adolescents' health: The Canadian Health Measures survey. *American Journal of Preventive Medicine*, *46*(5), 507–515. https://doi.org/10.1016/j.amepre.2013.12.009

Larouche, R., Saunders, T. J., Faulkner, G. E. J., Colley, R. & Tremblay, M. (2014). Associations between active school transport and physical activity, body composition, and cardiovascular fitness: A systematic review of 68 studies. *Journal of Physical Activity and Health*, *11*(1), 206–227. https://doi.org/10.1123/jpah.2011-0345

Larsen, K., Larouche, R., Buliung, R. N. & Faulkner, G. E. J. (2018). A matched pairs approach to assessing parental perceptions and preferences for mode of travel to school. *Journal of Transport & Health*, *11*, 56–63. https://doi.org/10.1016/j.jth.2018.09.004

Lubans, D. R., Boreham, C. A., Kelly, P. & Foster, C. E. (2011). The relationship between active travel to school and health-related fitness in children and adolescents: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *8*, 5. https://doi.org/10.1186/1479-5868-8-5

Mammen, G., Faulkner, G., Buliung, R. & Lay, J. (2012). Understanding the drive to escort: a cross-sectional analysis examining parental attitudes towards children's school travel and independent mobility. *BMC Public Health*, *12*, 862). https://doi.org/10.1186/1471-2458-12-862

Martínez-Gómez, D., Ruiz, J. R., Gómez-Martínez, S., Chillón, P., Rey-López, J. P., Díaz, L. E., Castillo, R., Veiga, O. L. & Marcos, A. (2011). Active commuting to school and cognitive performance in adolescents: The AVENA study. *Archives of Pediatrics and Adolescent Medicine*, *165*(4), 300–305. https://doi.org/10.1001/archpediatrics.2010.244

McDonald, N. C. (2007). Active transportation to school. Trends among U.S. Schoolchildren, 1969-2001. *American Journal of Preventive Medicine*, *32*(6), 509–516. https://doi.org/10.1016/j.amepre.2007.02.022

McMillan, T., Day, K., Boarnet, M., Alfonzo, M. & Anderson, C. (2006). Johnny walks to school-does Jane? Sex differences in children's active travel to school. *Children, Youth and Environments*, *16*(1), 75–89. http://ideas.repec.org/p/cdl/uctcwp/qt22f7k6z8.html

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

Ottawa Student Transportation Authority. (n.d.). *Frequently Asked Questions (FAQs)*. Retrieved January 9, 2023, from http://www.ottawaschoolbus.ca/school-bus-routes/frequently-asked-questions-faqs/

Page, A. S., Cooper, A. R., Griew, P., Davis, L. & Hillsdon, M. (2009). Independent mobility in relation to weekday and weekend physical activity in children aged 10-11 years: The PEACH Project. *International Journal of Behavioral Nutrition and Physical Activity*, *6*, 2. https://doi.org/10.1186/1479-5868-6-2

Panter, J. R., Jones, A. P. & van Sluijs, E. M. F. (2008). Environmental determinants of active travel in youth: A review and framework for future research. *International Journal of Behavioral Nutrition and Physical Activity*, *5*, 34. https://doi.org/10.1186/1479-5868-5-34

Pont, K., Ziviani, J., Wadley, D. & Abbott, R. (2011). The Model of Children's Active Travel (M-CAT): A conceptual framework for examining factors influencing children's active travel: a model of children's active travel. *Australian Occupational Therapy Journal*, *58*(3),

138–144. https://doi.org/10.1111/j.1440-1630.2010.00865.x

R Core Team. (2022). *R: A language and environment for statistical computing.* (4.2.1). R Foundation for Statistical Computing. https://www.r-project.org/

Rainham, D. G., Bates, C. J., Blanchard, C. M., Dummer, T. J., Kirk, S. F. & Shearer, C. L. (2012). Spatial classification of youth physical activity patterns. *American Journal of Preventive Medicine*, *42*(5), e87–e96. https://doi.org/10.1016/j.amepre.2012.02.011

Riazi, N. A., Blanchette, S., Trudeau, F., Larouche, R., Tremblay, M. S. & Faulkner, G. (2019). Correlates of children's independent mobility in canada: A multi-site study. *International Journal of Environmental Research and Public Health*, *16*(16), 2862. https://doi.org/10.3390/ijerph16162862

Saelens, B. E., Moudon, A. V., Kang, B., Hurvitz, P. M. & Zhou, C. (2014). Relation between higher physical activity and public transit use. *American Journal of Public Health*, *104*(5), 854–859. https://doi.org/10.2105/AJPH.2013.301696

Schoeppe, S., Duncan, M. J., Badland, H. M., Oliver, M. & Browne, M. (2014). Associations between children's independent mobility and physical activity. *BMC Public Health*, *14*, 91. https://doi.org/10.1186/1471-2458-14-91

Shaw, B., Bicket, M., Elliott, B., Fagan-Watson, B., Mocca, E. & Hillman, M. (2015). Children's Independent Mobility: an international comparison and recommendations for action. In *Policy Studies Institute* (Issue July). http://www.psi.org.uk/docs/7350_PSI_Report_CIM_final.pdf

Sterne, J. A. C., White, I. R., Carlin, J. B., Spratt, M., Royston, P., Kenward, M. G., Wood, A. M. & Carpenter, J. R. (2009). Multiple imputation for missing data in epidemiological and clinical research: Potential and pitfalls. *BMJ (Online)*, *339*(7713), 157–160.

https://doi.org/10.1136/bmj.b2393

Trapp, G. S. A., Giles-Corti, B., Christian, H. E., Bulsara, M., Timperio, A. F., McCormack, G. R. & Villaneuva, K. P. (2011). On your bike! a cross-sectional study of the individual, social and environmental correlates of cycling to school. *International Journal of Behavioral Nutrition and Physical Activity*, *8*, 123. https://doi.org/10.1186/1479-5868-8-123

VanKann, D. H. H., Kremers, S. P. J., de Vries, S. I., de Vries, N. K. & Jansen, M. W. J. (2016). Parental Active Transportation Routines (PATRns) as a moderator of the association between neighborhood characteristics and parental influences and active school transportation. *Environment and Behavior*, *48*(7), 946–965. https://doi.org/10.1177/0013916515574548

Wong, B. Y.-M., Faulkner, G., Buliung, R. & Irving, H. (2011). Mode shifting in school travel mode: examining the prevalence and correlates of active school transport in Ontario, Canada. *BMC Public Health*, *11*, 618. https://doi.org/10.1186/1471-2458-11-618

Woodcock, J., Edwards, P., Tonne, C., Armstrong, B. G., Ashiru, O., Banister, D., Beevers, S., Chalabi, Z., Chowdhury, Z., Cohen, A., Franco, O. H., Haines, A., Hickman, R., Lindsay, G., Mittal, I., Mohan, D., Tiwari, G., Woodward, A. & Roberts, I. (2009). Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport. *The Lancet*, *374*(9705), 1930–1943. https://doi.org/10.1016/S0140-6736(09)61714-1

CHAPTER 5: DISCUSSION & CONCLUSIONS

5.1 PURPOSE

In this study we aimed to investigate the multi-generational associations between parental mobility on children's active transportation (AT) and independent mobility (IM). We found that the older a parent was allowed to travel alone as a child, the less IM their child was allowed. We also found that older children, girls who lived in Trois-Rivières vs. other sites, and girls whose parents biked to work had higher IM. In our study on AT, we found that children participated in 7% less active trips for each day a parent accompanied them home from school. We also found that boys in Vancouver and Trois-Rivières reported more active trips when compared to Ottawa.

A child's ability to travel actively and independently is an important milestone for growth and development. Independent travel allows children different social opportunities than when adults are present, and it allows them to forge emotional bonds with their peers and with their environment (Brown et al., 2008). This is also an opportunity to develop their sense of responsibility and wayfinding skills (Brown et al., 2008; Rissotto & Tonucci, 2002). In this way, independent travel can be the means that satisfies a child's need for autonomy and their ability to navigate the world independently.

5.2 PARENTAL MOBILITY DURING CHILDHOOD

Parenting and caregiving practices are informed by a number of factors, which can include parental life events, the child's individual characteristics, stress, and available sources of support (Abidin, 1992). Parents interpret parenting practices in the context of their own life experiences and can perpetuate the restrictions that their own parents enforced. It is therefore not surprising that those who did not have freedom to roam might interpret their child's capabilities differently than some who did. This illustrates the potential for a generational 'carry-over' effect,

which has implications for future interventions to promote IM. We cannot assume that all parents had the same freedom to roam as children, and this can in turn affect their parenting practices.

Our study found no associations between parents' school travel mode as a child and the number of active trips reported by their children. It is worth mentioning that the questions asked to children covered AT to/from a broader range of destinations. The lack of association between parents' AT in childhood and their child's AT could also be linked to the intergenerational decline in AT to/from school (Buliung et al., 2009). Buliung et al.'s work (2009) showed that the proportion of adolescents using active modes on their trip to school declined significantly between 1986 to 2006, while Gray et al (2014) showed a significant increase in the percentage of children using inactive modes. Thus, one may expect that many parents who engaged in AT during childhood have children who travel by car or bus. Given the lack of previous studies examining the association between parents' school travel mode as child and their children's AT, there is a clear need for more research in this area.

5.3 PARENTS' CURRENT MOBILITY

Children are less autonomous than adults in regards to PA behaviours (Giles-Corti et al., 2009), especially since parents act as the "gatekeepers" of children's travel mode decisions (Carver et al., 2013; Hume et al., 2009; Mah et al., 2017; Panter et al., 2008; Pont et al., 2011). In our study on children's IM, we found that girls whose parents biked to work had higher IM. This is consistent with another recent cross-sectional study in Canada on IM during the coronavirus pandemic (COVID-19) which found that children whose parent respondent actively commuted to work had higher IM compared to those who used motorized transport (Larouche et al., 2023).

In the bivariate analysis, parents who traveled to school by bus as a child and those who commute to work by walking and driving a car were found to have children with higher AT trips.

However, these associations became non-significant once controlling for covariates. Nevertheless, other studies in the Netherlands and the USA have indicated that parental active commuting is a positive correlate of children's AT (Kwon et al., 2022; VanKann et al., 2016). The high number of children reporting zero active trips in our sample suggests that the majority of trips children take are completed using inactive modes of transport. This aligns with another study showing that over 65% of trips children made and time spent travelling occurred in a vehicle (Williams et al., 2018).

We also found that for each day a parent accompanied their child home from school, girls and boys participated in 6% and 7% less active trips respectively. This aligns with other research showing that children with higher IM do more active trips and engage in more physical activity (Carver et al., 2014; Larouche, Barnes, et al., 2020; Mammen et al., 2012). Our finding also appears consistent with previous research showing that the perceived convenience of driving children to school on the way to work is one of the key barriers to AT (McDonald & Aalborg, 2009). Yet, McDonald and Aalborg (2009) highlighted that interventions that promote AT to school (e.g., Safe Routes to School) fail to address perceived convenience, which could undermine their effectiveness.

The trip home from school is of particular interest, as some studies have found a higher prevalence of walking/biking found in the afternoon than for the morning (Wong et al., 2011). Often a parent's workday extends beyond school hours, and it may be difficult for some parents to return to accompany their child home. Within the Canadian context, the trip home from school may be viewed as safer due to increased daylight, better visibility, and less traffic from other commuting parents. Since parents often choose the mode of transport that's quickest and easiest (Faulkner et al., 2010), it's possible that they can be encouraged to allow their child

independence on their trip home by framing AT in the afternoon as a way of addressing their own time constraints (McDonald, 2008). However, future studies should investigate accompaniment on the trip to school as well as to other locations beyond school travel. For example, Hjorthol and Fyhri (2009) reported that children's engagement in organized leisure activities was associated with greater car use.

5.4 CORRELATES OF CHILDREN'S MOBILITY AND ACTIVE TRANSPORTATION

In our study on children's IM, we found that girls in Trois-Rivières had a higher IM by almost 0.8 licenses compared to the other sites, which represents a medium effect size (Cohen's d = 0.53 for Trois-Rivières vs. Ottawa) given that the pooled standard deviation of the IM index was 1.55 (Riazi et al., 2019). However, this finding was not statistically significant in boys. The smaller population in the Trois-Rivières census metropolitan area (CMA = 161,489) compared to other sites could be a factor, as Ottawa and Vancouver are over 9 times (Ottawa/Gatineau CMA = 1,488,307) and 16 times more populous respectively (Vancouver CMA = 2,642,825) (Statistics Canada, 2023). However, a lower population does not guarantee that parents perceive the community to be safer. Using the same dataset, Riazi et al. found no differences between sites in regards to parent-perceived informal social control and safety concerns (Riazi et al., 2019). There may be other social-ecological factors that contribute to the higher IM among girls in Trois-Rivières.

We also found that boys living in Vancouver had 55% more active trips compared to Ottawa as a reference site (95% CI 1.18-2.04) and boys in Trois Rivières had 33% more active trips compared to Ottawa (95% CI 1.00-1.77). Higher population density in Vancouver (918 persons per square km) compared to Ottawa (185 persons per square km) (Statistics Canada, 2023) may encourage AT as it is associated with access to a greater variety of destinations within

walking/cycling distance (Herrmann et al, 2019; Statistics Canada, 2016). However, this does not explain the higher AT in Trois Rivieres (156 persons per square km) (Statistics Canada, 2023) as AT did not differ significantly compared to Vancouver. The lack of subsidized bus provision by school boards in the City of Vancouver limits travel mode choice and may contribute to the higher number of active trips compared to Ottawa (Larouche, Barnes, et al., 2020). The differences seen in Trois Rivières and Vancouver suggest that the broader social-ecological context can affect children's active and independent mobility, illustrating the value of our multi-site design.

Health equity is an important factor to consider in the design of AT research and interventions (Hansmann et al., 2023). For example, in some affluent suburbs, some mothers have been found to encourage their children to walk to school (Lang et al., 2011) or switch readily between mobilities as in Copenhagen (Denmark) (Jensen et al., 2015). In contrast, low-income mothers in Midlands, UK (Bostock, 2001) and California (Cubbin et al., 2017) may be carless and using active modes, but not necessarily by choice. This may explain why studies on area-level socioeconomic status with IM and AT are mixed (Ikeda et al., 2019; Mammen et al., 2012; Nystrom et al., 2019; Riazi et al., 2022; Veitch et al., 2017). What might be a viable and appropriate option in one city might be subject to different barriers and social norms in another.

Like many other studies, we also found that IM increased with each year of age. This is consistent with most other studies that considered individual correlates of IM (Larouche et al., 2023; Riazi et al., 2022). While there is variance in what is considered a good age to allow a child more independence, global trends show that that the age a child is allowed to travel alone has increased over time (Dodd et al., 2021; Hillman et al., 1990; Shaw et al., 2015). A reason for this could be a collective change in social norms, as a previous study found that fear of

judgement from other parents led them to restrict their child's IM (Francis et al., 2017). For example, a father in Vancouver who had taught four of his five children to ride the bus alone and equipped them with mobile phones was reported to child protection services (Brend, 2017). While this father was eventually cleared of any wrongdoing (Judd, 2020), negative attention such as this could deter some from doing the same. Some parents have also expressed that driving their child to school may be a reflection of "good parenting" (Larouche, 2018). These social norms are pervasive, and may also be changing with other political contexts. A recent study in the context of the COVID-19 pandemic indicated that parents were restricting their child's IM due to concerns they may not follow COVID-19 guidelines when unaccompanied (Larouche et al., 2023). While the right age for a child to go places alone is debatable, there is consistent evidence that parental confidence in their child competence to safely travel in their neighbourhood is consistently associated with higher IM (Riazi et al., 2022). Thus, interventions aiming to develop traffic skills could help increase IM at a given age.

While many studies show boys engaging in more AT than girls on the trip to school (Larouche et al., 2014; McDonald et al., 2011; Panter et al., 2008; Trapp et al., 2011), this study found no significant difference between the number of active trips between genders (boys: 11.9, girls: 11.2, $p=0.368$). This could be due to the inclusion of a broader range of locations where children could travel, including the homes of friends, relatives, and places of commerce and worship. We observed that boys had higher levels of IM than girls, consistent with some previous literature (Carver et al., 2014; Christian et al., 2015; Fyhri et al., 2011; Mitra et al., 2014; Riazi et al., 2019). However, a more recent systematic review found mixed associations between gender and IM with some studies showing no difference between boys and girls (Riazi et al., 2022). Girls are socialized differently than boys from a young age as a result of traditional

gender norms (Morrongiello & Dawber, 1999), and they are often viewed as being more at-risk of harm in public than boys (Valentine, 1997). Interestingly, Brown et al. (2008) reported that, while boys were granted more IM on their own, girls could achieve comparable levels of mobility by traveling in groups, a strategy that could mitigate the perception of vulnerability. For example, 98% of Japanese children attending public schools engage in AT to school and they commonly walk in groups from a very young age (Mori et al., 2012).

5.5 FUTURE DIRECTIONS FOR RESEARCH AND POLICY

5.5.1 Research

Collectively, findings from this study suggests that parents can play an important role in influencing their child's AT and IM, indicating a need for future longitudinal research in this area. Future studies should use more similar questions to assess children's and parents' AT and IM while focussing on a broad range of destinations. Given that mobility licenses capture permissions to do certain activities, future studies should consider employing different measures of IM such as roaming allowance or territorial range (Badland et al., 2011; Loebach & Gilliland, 2016; Vlaar et al., 2019). The trip to school and work are usually studied separately, but often are interrelated (McDonald & Aalborg, 2009; Mitra & Buliung, 2014). Future AT interventions should consider addressing both parent and child transportation to work and school respectively. Considering the AT behaviours of children and parents together could allow for better opportunities to address the barriers that families might experience in planning for active trips and IM.

While there is significant heterogeneity among interventions to increase AT for the trip to school, most interventions have achieved "trivial-to-small" effects (Larouche et al., 2018). Therefore, intervention studies should explore novel methods of increasing AT and IM. Family-

based PA interventions may be a promising approach to what is a family-based problem (Rhodes et al., 2023). The "Family Systems Theory" is a popular model used to conceptualize the management of childhood obesity, emphasizing the family environment for healthy practices and de-emphasizing a child's personal responsibility for health behaviour (Golan & Weizman, 2001). Family-based interventions can be tailored to target a specific cultural context, the family's level of motivation, and their specific time-constraints and barriers (Brown et al., 2016). The "Healthy Dads, Healthy Kids" program is an award-winning example of a family-based program out of Australia that recruited fathers or father-figures and young children (Morgan et al., 2014). The program has been adapted for several other geographical and cultural settings, including the "Papás Saludables, Niños Saludables" program in targeting Hispanic parents and children in Houston (Perez et al., 2021) and for incarcerated fathers in the Scottish prison service (University of Newcastle, n.d.). Learnings from these interventions could be applied to the travel behaviours of parents and children as well.

In a national survey, parental tolerance to risk has been found to be associated with higher IM independent of a child's age (Larouche et al., 2023). Research on risky play may also provide some guidance as to how to approach parents to improve risk tolerance for IM. Protocols have been developed for increasing risky play, including a digital risk-reframing tool and accompanying workshop for both mothers and early childhood educators to improve risk tolerance (Brussoni et al., 2018, 2021). It may be possible to design a similar risk tool to educate parents on the benefits of IM and improve parent's tolerance of their children's IM. This re-framing could emphasize the risks of not allowing a child to engage in IM and educate parents on the experiences that may be otherwise eliminated from their child's life.

Designing interventions that foster social connection could be another avenue to explore to increase parental tolerance of risk. Neighborhood relations has been shown to influence parental perceptions of danger, and appears to be mediated by parental sense of community (Alparone & Pacilli, 2012). Facilitating neighborhood or parent groups that encourage and support their children to travel actively and independently may help to combat the social norms that prevent children's IM. An example of this is walking school buses (WSB), which involve an adult on foot accompanying children picked up along the way to school (Engwicht, 1992). While WSB's have received criticism as being highly structured and supervised approach to increasing AT, they can free up time for parents by sharing the responsibility of leading children to school each day (Kearns et al., 2003). This is important because perceived lack of time may lead parents to drive their children on the way to/from school (Faulkner et al., 2010). While there is a lack of research on long-term sustainability of WSBs, they can be explored as a viable compromise to allow children more AT opportunities (Collins & Kearns, 2010). Other possible interventions include the "Friendly Paths Project" which encourages children to walk to school together (Berasategi et al., 2021). This approach appears to increase IM for participating children, and may mitigate parental safety concerns without increasing adult supervision (Berasategi et al., 2021).

5.5.2 Policy and Practice

Our study adds to the consistent evidence that IM increases with age (Riazi et al., 2022). While age is not a modifiable variable, it is likely associated with parents' perceived confidence in their child's traffic skills. It may be helpful to develop policies and programs that provide training to children on how to navigate their neighborhoods, or that facilitate communication between parents and children to negotiate more lenient IM licenses (Riazi et al., 2021). Parenting

that engages in autonomy support within Self-Determination Theory involves consideration of children's perspectives and initiatives, providing choice, allowing input into decision-making, and encouraging open discussion (Grolnick et al., 2021). Parents and children can be supported in using autonomy support to negotiate IM licenses with their children, and to facilitate a child's autonomy. They can also walk behind their children, gradually increasing the distance, when they observe that their children behave appropriately.

Japan has had a very high rate of young children walking to school as a result of policies that have been in place since 1953 (Mori et al., 2012). A large part of their success is due to ensuring a network of schools is built that are within 2-4 km of children's homes to mitigate the effect of distance (Mori et al., 2012). However, policies implemented at the school level can also have a great impact on AT and IM (Mori et al., 2012). Drop-off spots that children can walk to school from is another approach that can increase AT to school for children that live farther from school (Vanwolleghem et al., 2014). School staff, parent-teacher associations, and local government can also collaborate to establish safety measures such as group-walking, inspection of school routes, and information sharing to ensure safe routes to school (Mori et al., 2012).

Workplaces are a key setting at the organizational or community-level that can promote or discourage AT (Petrunoff et al., 2015). A scoping review on major life events showed that entry into the labour market was generally associated with increased car use and declines in walking and cycling (Larouche, Rodriguez, et al., 2020). Some workplaces have demonstrated multi-faceted approaches that limit the availability of free parking to discourage driving to work, while also offering public transit assistance, shower facilities, and safe bicycle parking to incentivize other methods of transportation (Larouche, Rodriguez, et al., 2020; Petrunoff et al., 2015). These can be considered as part of the toolkit for developing workplace wellness

programs that could help reduce the incidence of chronic disease in employees. If such interventions can increase the uptake of active commuting to work, there could be downstream benefits for children's IM and AT. However, to our knowledge no previous studies have examined this hypothesis, underscoring a need for future research.

5.6 STRENGTHS & LIMITATIONS

The two studies included in this thesis are strengthened by the large sample size, inclusion of three different regions of Canada, and stratification by socioeconomic status and urbanization. Likewise, the use of a well-recognized and validated IM index as a dependent variable allows for clear interpretation of these results. While most studies in this area consider only active travel to school (Larouche, 2018), this study was also inclusive of several other locations that children may travel to such as the homes of friends or relatives, parks or playgrounds, shops or markets, restaurants, places of faith, etc.

There are also several limitations that should be considered when interpreting the results. The testing of multiple hypotheses in one study can increase the risk of type 1 error and residual confounding. However, the low p-value (<0.01) of many of the associations provides some reassurance about these findings. This study is also cross-sectional, making any inference of causality unviable. While some insight about temporal sequence can be gleaned by comparing parents' mobility as a child to their children's current mobility, the retrospective approach is vulnerable to recall bias. For instance, a parent's school-age years may have occurred 30 or more years ago. The survey questions on parent's travel to school as a child as well as the age they could go places alone relies heavily on the precision of their memories. The question on parents' IM as a child was assessed with a single item that did not include examples of where children may have travelled alone. Likewise, the question on parent AT as a child focused exclusively on

the trip to school. It is possible that parent respondents used AT to get to other locations which may also affect their children's travel behaviours, potentially biasing the results towards the null hypothesis.

Social desirability bias may also have increased the reporting of AT trips, though it is unclear how this effect may take place for IM. It is possible that some families may want to present themselves as being supportive of both IM and AT. Alternatively, Francis et al. (2017) found that judgement from other parents was a potential reason for parents engaging in more protective behaviours. Parents may therefore perceive a higher level of supervision to be more socially acceptable, potentially artificially lowering their child's IM score.

Lastly, it is also important to reiterate that the data is based on the responding parent, almost 80% of which identified as women. The underrepresentation of fathers limits our ability to discuss their influence on children's IM and AT. Systematic reviews have consistently reported greater participation of mothers than fathers in studies related to child health (Davison et al., 2016; Eiser & Morse, 2001). This study did not specifically recruit parent participants of each gender, but the responses suggest a need for future studies to make deliberate efforts to recruit fathers.

5.7 CONCLUSION

Our findings suggest that children may have more opportunities for AT if parents allow them to come home from school unaccompanied. This further supports the need for mitigating parents' perceptions of risk and finding ways to increase children's IM. While we found that parents who experienced IM later may be more restrictive of their sons' and daughters' IM, longitudinal research is required to confirm this association. It is worth considering a parent's own experiences as a child when planning IM interventions as it could influence their

willingness to grant IM licenses. Given that parents may drive their child to/from school on the way to work, interventions to promote children's AT should address the perceived convenience of driving and encourage active commuting to work among parents and assess parents' and children's travel behaviours simultaneously. Future studies may consider a family-based approach to addressing AT and IM. This could help to bridge the inter-generational gap in IM and AT by considering a parents' lived experience and addressing parental barriers.

5.8 REFERENCES

Abidin, R. R. (1992). The Determinants of Parenting Behavior. In *Journal of Clinical Child Psychology* (Vol. 21, Issue 4, pp. 407–412). https://doi.org/10.1207/s15374424jccp2104_12

Alparone, F. R. & Pacilli, M. G. (2012). On children's independent mobility: The interplay of demographic, environmental, and psychosocial factors. *Children's Geographies*, *10*(1), 109–122. https://doi.org/10.1080/14733285.2011.638173

Andersen, L. B. (2017). Active commuting is beneficial for health. *BMJ (Clinical Research Ed.)*, *357*, j1740. https://doi.org/10.1136/bmj.j1740

Badland, H. M., Oliver, M., Duncan, M. J. & Schantz, P. (2011). Measuring children's independent mobility: comparing objective and self-report approaches. In *Children's geographies* (Vol. 9, Issue 2, pp. 263–271). Routledge. https://doi.org/10.1080/14733285.2011.562386

Berasategi, N., Legorburu, I., Aliri, J. & Alonso, I. (2021). The 'walking with friends to school' project and its contribution to independent mobility, self-esteem and happiness. *Children and Society*, *November*, 1–11. https://doi.org/10.1111/chso.12532

Besser, L. M. & Dannenberg, A. L. (2005). Walking to public transit: Steps to help meet physical activity recommendations. *American Journal of Preventive Medicine*, *29*(4), 273–280. https://doi.org/10.1016/j.amepre.2005.06.010

Bostock, L. (2001). Pathways of disadvantage? Walking as a mode of transport among low-income mothers. *Health and Social Care in the Community*, *9*(1), 11–18. https://doi.org/10.1046/j.1365-2524.2001.00275.x

Brend, Y. (2017). Here are the rules about putting kids on a bus alone: there aren't any. *CBC News*. https://www.cbc.ca/news/canada/british-columbia/5-children-ride-bus-alone-debate-

vancouver-adrian-crook-free-range-helicopter-parenting-1.4280001

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, H. E., Atkin, A. J., Panter, J., Wong, G., Chinapaw, M. J. M. & van Sluijs, E. M. F. (2016). Family-based interventions to increase physical activity in children: A systematic review, meta-analysis and realist synthesis. *Obesity Reviews*, *17*(4), 345–360. https://doi.org/10.1111/obr.12362

Brussoni, M., Han, C. S., Jacob, J., Munday, F., Zeni, M., Walters, M., Cheng, T., Schneeberg, A., Fox, E. & Oberle, E. (2021). A Web-Based Risk-Reframing Intervention to Influence Early Childhood Educators' Attitudes and Supportive Behaviors Toward Outdoor Play: Protocol for the OutsidePlay Study Randomized Controlled Trial . In *JMIR research protocols* (Vol. 10, Issue 11, pp. e31041–e31041). JMIR Publications . https://doi.org/10.2196/31041

Brussoni, M., Ishikawa, T., Han, C., Pike, I., Bundy, A., Faulkner, G. & Mâsse, L. C. (2018). Go Play Outside! Effects of a risk-reframing tool on mothers' tolerance for, and parenting practices associated with, children's risky play: Study protocol for a randomized controlled trial. *Trials*, *19*(1), 1–9. https://doi.org/10.1186/s13063-018-2552-4

Buliung, R. N., Mitra, R. & Faulkner, G. (2009). Active school transportation in the Greater Toronto Area, Canada: An exploration of trends in space and time (1986–2006). *Preventive Medicine*, *48*(6), 507–512. https://doi.org/10.1016/j.ypmed.2009.03.001

Carver, A, Panter, J. R., Jones, A. P. & van Sluijs, E. M. F. (2014). Independent mobility on the journey to school: A joint cross-sectional and prospective exploration of social and physical

environmental influences. *Journal of Transport & Health*, *1*(1), 25–32. https://doi.org/10.1016/j.jth.2013.12.003

Carver, Alison, 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

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. *Journal of Physical Activity & Health*, *12*(Suppl 1), S84–S93. https://doi.org/10.1123/jpah.2014-0271

Collins, D. & Kearns, R. A. (2010). Walking school buses in the Auckland region: A longitudinal assessment. *Transport Policy*, *17*(1), 1–8. https://doi.org/10.1016/j.tranpol.2009.06.003

Cubbin, C., Kim, Y. & Lee, R. E. (2017). California Women with Young Children Use Active Transportation Most Often in Very Unsafe Neighborhoods Regardless of SES. *Journal of Transport & Health*, *5*, S8. https://doi.org/10.1016/j.jth.2017.05.285

Davison, K. K., Gicevic, S., Aftosmes-Tobio, A., Ganter, C., Simon, C. L., Newlan, S. & Manganello, J. A. (2016). Fathers' Representation in Observational Studies on Parenting and Childhood Obesity: A Systematic Review and Content Analysis. *American Journal of Public Health*, *106*(11), e14–e21. https://doi.org/10.2105/AJPH.2016.303391

Dodd, H. F., Fitzgibbon, L., Watson, B. E. & Nesbit, R. J. (2021). Children's play and independent mobility in 2020: Results from the british children's play survey. *International Journal of Environmental Research and Public Health*, *18*(8). https://doi.org/10.3390/ijerph18084334

Eiser, C. & Morse, R. (2001). Can Parents Rate Their Child's Health-Related Quality of Life? Results of a Systematic Review. In *Quality of life research* (Vol. 10, Issue 4, pp. 347–357). Kluwer Academic Publishers. https://doi.org/10.1023/A:1012253723272

Engwicht, D. (1992). *Towards an eco-city: calming the traffic.* Envirobook.

Faulkner, G. E. J., Richichi, V., Buliung, R. N., Fusco, C. & Moola, F. (2010). What's quickest and easiest Parental decision making about school trip mode. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 1–11. https://doi.org/10.1186/1479-5868-7-62

Francis, J., Martin, K., Wood, L. & Foster, S. (2017). 'I'll be driving you to school for the rest of your life': A qualitative study of parents' fear of stranger danger. *Journal of Environmental Psychology*, *53*, 112–120. https://doi.org/10.1016/j.jenvp.2017.07.004

Frank, L. D., Hong, A. & Ngo, V. D. (2021). Build it and they will cycle: Causal evidence from the downtown Vancouver Comox Greenway. *Transport Policy*, *105*(February), 1–11. https://doi.org/10.1016/j.tranpol.2021.02.003

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*(5), 703–710. https://doi.org/10.1016/j.tranpol.2011.01.005

Giles-Corti, B., Kelty, S. F., Zubrick, S. R. & Villanueva, K. P. (2009). Encouraging walking for transport and physical activity in children and adolescents: How important is the built environment? *Sports Medicine*, *39*(12), 995–1009. https://doi.org/10.2165/11319620-000000000-00000

Golan, M. & Weizman, A. (2001). Familial approach to the treatment of childhood obesity: Conceptual model. *Journal of Nutrition Education and Behavior*, *33*(2), 102–107.

http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed5&NEWS=N&AN=12031190

Gray, C. E., Larouche, R., Barnes, J. D., Colley, R. C., Bonne, J. C., Arthur, M., Cameron, C., Chaput, J.-P., Faulkner, G., Janssen, I., Kolen, A. M., Manske, S. R., Salmon, A., Spence, J. C., Timmons, B. W. & Tremblay, M. S. (2014). Are we driving our kids to unhealthy habits? Results of the active healthy kids Canada 2013 report card on physical activity for children and youth. *International Journal of Environmental Research and Public Health*, *11*(6), 6009–6020. https://doi.org/10.3390/ijerph110606009

Grolnick, W. S., Levitt, M. R., Caruso, A. J. & Lerner, R. E. (2021). Effectiveness of a Brief Preventive Parenting Intervention Based in Self-Determination Theory. *Journal of Child and Family Studies*, *30*(4), 905–920. https://doi.org/10.1007/s10826-021-01908-4

Hansmann, K., Grabow, M. & McAndrews, C. (2023). Health Equity and Active Transportation: a scoping review of active transportation interventions' impact on health equity. In *Annals of family medicine* (Vol. 21, Issue S1). Annals of Family Medicine. https://doi.org/10.1016/j.jth.2022.101346

Herrmann, T., Gleckner, W., Wasfi, R. A., Thierry, B., Kestens, Y. & Ross, N. A. (2019). A pan-Canadian measure of active living environments using open data. Health Reports, 30(5), 16–25. https://doi.org/https://doi.org/10.25318/82-003-x201900500002-eng

Hillman, M., Adams, J. & Whitelegg, J. (1990). One false move: A study of children's independent mobility. *Policy Studies Unit*, *January*. https://ci.nii.ac.jp/naid/10004535145/en/

Hjorthol, R. & Fyhri, A. (2009). Do organized leisure activities for children encourage car-use? Transportation Research Part A: Policy and Practice, 43(2), 209–218.

https://doi.org/10.1016/j.tra.2008.11.005

Huertas-Delgado, F. J., Molina-García, J., Van Dyck, D. & Chillon, P. (2019). A questionnaire to assess parental perception of barriers towards active commuting to school (PABACS): Reliability and validity. *Journal of Transport and Health*, *12*(November 2018), 97–104. https://doi.org/10.1016/j.jth.2018.12.004

Hume, C, Salmon, J. & Ball, K. (2005). Children's perceptions of their home and neighborhood environments, and their association with objectively measured physical activity: a qualitative and quantitative study. In *Health education research* (Vol. 20, Issue 1, pp. 1–13). Oxford University Press. https://doi.org/10.1093/her/cyg095

Hume, Clare, Timperio, A., Salmon, J., Carver, A., Giles-Corti, B. & Crawford, D. (2009). Walking and Cycling to School. Predictors of Increases Among Children and Adolescents. *American Journal of Preventive Medicine*, *36*(3), 195–200. https://doi.org/10.1016/j.amepre.2008.10.011

Ikeda, E., Hinckson, E., Witten, K. & Smith, M. (2019). Assessment of direct and indirect associations between children active school travel and environmental, household and child factors using structural equation modelling. *International Journal of Behavioral Nutrition and Physical Activity*, *16*(1), 1–17. https://doi.org/10.1186/s12966-019-0794-5

Jensen, O. B., Sheller, M. & Wind, S. (2015). Together and Apart: Affective Ambiences and Negotiation in Families' Everyday Life and Mobility. *Mobilities*, *10*(3), 363–382. https://doi.org/10.1080/17450101.2013.868158

Judd, A. (2020). Vancouver dad wins court case in fight to let his kids ride the bus on their own. Global News. https://globalnews.ca/news/7145065/vancouver-dad-appeal-kids-bus-alone/

Kearns, R. A., Collins, D. C. A. & Neuwelt, P. M. (2003). The walking school bus: Extending

children's geographies? *Area*, *35*(3), 285–292. https://doi.org/10.1111/1475-4762.00177

Lang, D., Collins, D. & Kearns, R. (2011). Understanding modal choice for the trip to school. *Journal of Transport Geography*, *19*(4), 509–514. https://doi.org/10.1016/j.jtrangeo.2010.05.005

Larouche, R. (2018). *Last Child Walking?—Prevalence and Trends in Active Transportation* (R. Larouche (ed.); pp. 53–75). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-12-811931-0.00004-1

Larouche, R., Barnes, J. D., Blanchette, S., Faulkner, G., Riazi, N. A., Trudeau, F. & Tremblay, M. S. (2020). Relationships among children's independent mobility, active transportation, and physical activity: A multisite cross-sectional study. *Pediatric Exercise Science*, *32*(4), 189–196. https://doi.org/10.1123/PES.2019-0238

Larouche, R., Bélanger, M., Brussoni, M., Faulkner, G., Gunnell, K. & Tremblay, M. S. (2023). Canadian children's independent mobility during the COVID-19 pandemic: A national survey. *Health and Place*, *81*(March), 1–8. https://doi.org/10.1016/j.healthplace.2023.103019

Larouche, R., Chaput, J.-P., Leduc, G., Boyer, C., Bélanger, P., LeBlanc, A. G., Borghese, M. M. & Tremblay, M. S. (2014). A cross-sectional examination of socio-demographic and school-level correlates of children's school travel mode in Ottawa, Canada. *BMC Public Health*, *14*(1), 497. https://doi.org/10.1186/1471-2458-14-497

Larouche, R., Mammen, G., Rowe, D. A. & Faulkner, G. (2018). Effectiveness of active school transport interventions: a systematic review and update. *BMC Public Health*, *18*(1), 206. https://doi.org/10.1186/s12889-017-5005-1

Larouche, R., Rodriguez, U. C., Nayakarathna, R. & Scott, D. R. (2020). Effect of major life

events on travel behaviours: A scoping review. *Sustainability (Switzerland)*, *12*(24), 1–21. https://doi.org/10.3390/su122410392

Larouche, R., Bélanger, M., Brussoni, M., Faulkner, G., Gunnell, K. & Tremblay, M. S. (2023). Canadian children's independent mobility during the COVID-19 pandemic: A national survey. Health and Place, 81(March), 1–8. https://doi.org/10.1016/j.healthplace.2023.103019

Lloyd, A. B., Lubans, D. R., Plotnikoff, R. C. & Morgan, P. J. (2014). Impact of the "Healthy Dads, Healthy Kids" lifestyle programme on the activity- and diet-related parenting practices of fathers and mothers. *Pediatric Obesity*, *9*(6), e149–e155. https://doi.org/10.1111/ijpo.248

Loebach, J. E. & Gilliland, J. A. (2016). 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

Mah, S. K., Nettlefold, L., Macdonald, H. M., Winters, M., Race, D., Voss, C. & McKay, H. A. (2017). Does parental support influence children's active school travel? *Preventive Medicine Reports*, *6*(C), 346–351. https://doi.org/10.1016/j.pmedr.2017.04.008

Mammen, G., Faulkner, G., Buliung, R. & Lay, J. (2012). Understanding the drive to escort: a cross-sectional analysis examining parental attitudes towards children's school travel and independent mobility. In *BMC public health* (Vol. 12, Issue 1, p. 862). BioMed Central Ltd. https://doi.org/10.1186/1471-2458-12-862

McDonald, N. C. (2008). Household interactions and children's school travel: the effect of parental work patterns on walking and biking to school. *Journal of Transport Geography*, *16*(5), 324–331. https://doi.org/10.1016/j.jtrangeo.2008.01.002

McDonald, N. C. & Aalborg, A. E. (2009). Why parents drive children to school. *Journal of the American Planning Association*, 75(3), 331–342. https://doi.org/10.1080/01944360902988794

McDonald, N. C., Brown, A. L., Marchetti, L. M. & Pedroso, M. S. (2011). U.S. school travel, 2009 an assessment of trends. In *American journal of preventive medicine* (Vol. 41, Issue 2, pp. 146–151). https://doi.org/10.1016/j.amepre.2011.04.006

Mehdi, T. & Morissette, R. (2021). Working from home in Canada: What have we learned so far? *Statistics Canada*, *36*. https://www150.statcan.gc.ca/n1/pub/36-28-0001/2021010/article/00001-eng.htm

Mitra, R. & Buliung, R. N. (2014). The influence of neighborhood environment and household travel interactions on school travel behavior: an exploration using geographically-weighted models. In *Journal of transport geography* (Vol. 36, pp. 69–78). Elsevier Ltd. https://doi.org/10.1016/j.jtrangeo.2014.03.002

Mitra, R., Faulkner, G. E., 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

Morgan, P. J., Collins, C. E., Plotnikoff, R. C., Callister, R., Burrows, T., Fletcher, R., Okely, A., Young, M. D., Miller, A., Lloyd, A. B., Cook, A. T., Cruickshank, J., Saunders, K. L. & Lubans, D. R. (2014). The "Healthy Dads, Healthy Kids" community randomized controlled trial: A community-based healthy lifestyle program for fathers and their children. *Preventative Medicine*, *116*, 90–99. https://doi.org/https://doi.org/10.1016/j.ypmed.2013.12.019

Mori, N., Armada, F. & Craig Willcox, D. (2012). Walking to School in Japan and Childhood Obesity Prevention: New Lessons From an Old Policy. In *American journal of public health (1971)* (Vol. 102, Issue 11, pp. 2068–2073). American Public Health Association. https://doi.org/10.2105/AJPH.2012.300913

Morrongiello, B. A. & Dawber, T. (1999). Parental Influences on Toddlers' Injury-Risk Behaviors: Are Sons and Daughters Socialized Differently? In *Journal of applied developmental psychology* (Vol. 20, Issue 2, pp. 227–251). Elsevier Inc. https://doi.org/10.1016/S0193-3973(99)00015-5

Nystrom, C. D., Barnes, J. D., Blanchette, S., Faulkner, G., Leduc, G., Riazi, N. A., Tremblay, M. S., Trudeau, F. & Larouche, R. (2019). Relationships between area-level socioeconomic status and urbanization with active transportation, independent mobility, outdoor time, and physical activity among Canadian children. *BMC Public Health*, *19*(1). https://doi.org/10.1186/s12889-019-7420-y

Ottawa Student Transportation Authority. (n.d.). *Frequently Asked Questions (FAQs)*. Retrieved January 9, 2023, from http://www.ottawaschoolbus.ca/school-bus-routes/frequently-asked-questions-faqs/

Panter, J. R., Jones, A. P. & van Sluijs, E. M. F. (2008). Environmental determinants of active travel in youth: A review and framework for future research. *International Journal of Behavioral Nutrition and Physical Activity*, *5*, 1–14. https://doi.org/10.1186/1479-5868-5-34

Perez, O., Beltran, A., Isbell, T., Galdamez-Calderon, E., Baranowski, T., Morgan, P. J. & O'Connor, T. M. (2021). Papás Saludables, Niños Saludables: Perspectives From Hispanic Parents and Children in a Culturally Adapted Father-Focused Obesity Program. *Journal of*

Nutrition Education and Behavior, *53*(3), 246–253. https://doi.org/10.1016/j.jneb.2020.11.006

Petrunoff, N., Rissel, C., Wen, L. M. & Martin, J. (2015). Carrots and sticks vs carrots: Comparing approaches to workplace travel plans using disincentives for driving and incentives for active travel. *Journal of Transport and Health*, *2*(4), 563–567. https://doi.org/10.1016/j.jth.2015.06.007

Pont, K., Ziviani, J., Wadley, D. & Abbott, R. (2011). The Model of Children's Active Travel (M-CAT): A conceptual framework for examining factors influencing children's active travel: a model of children's active travel. *Australian Occupational Therapy Journal*, *58*(3), 138–144. https://doi.org/10.1111/j.1440-1630.2010.00865.x

Rapisarda, V., Loreto, C., De Angelis, L., Simoncelli, G., Lombardo, C., Resina, R., Mucci, N., Matarazzo, A., Vimercati, L. & Ledda, C. (2021). Home working and physical activity during SARS-CoV-2 pandemic: A longitudinal cohort study. *International Journal of Environmental Research and Public Health*, *18*(24). https://doi.org/10.3390/ijerph182413021

Rhodes, R. E., Hollman, H. & Sui, W. (2023). Family-based physical activity interventions and family functioning: A systematic review. *Family Process*, *May 2022*, 1–22. https://doi.org/10.1111/famp.12864

Riazi, N. A., Blanchette, S., Trudeau, F., Larouche, R., Tremblay, M. S. & Faulkner, G. (2019). Correlates of children's independent mobility in canada: A multi-site study. *International Journal of Environmental Research and Public Health*, *16*(16), 1–14. https://doi.org/10.3390/ijerph16162862

Riazi, N. A., Brussoni, M., Vertinsky, P. & Faulkner, G. (2021). "Well, You Feel More

Responsible When You're Unsupervised": Exploring Family Perspectives on Children's Independent Mobility. *Children*, *8*(3), 1–18. https://doi.org/10.3390/children8030225

Riazi, N. A., Wunderlich, K., Yun, L., Paterson, D. C. & Faulkner, G. (2022). Social-Ecological Correlates of Children's Independent Mobility: A Systematic Review. *International Journal of Environmental Research and Public Health*, *19*(3). https://doi.org/10.3390/ijerph19031604

Rissotto, A. & Tonucci, F. (2002). Freedom of movement and environmental knowledge in elementary school children. *Journal of Environmental Psychology*, *22*(1–2), 65–77. https://doi.org/10.1006/jevp.2002.0243

Saelens, B. E., Moudon, A. V., Kang, B., Hurvitz, P. M. & Zhou, C. (2014). Relation between higher physical activity and public transit use. *American Journal of Public Health*, *104*(5), 854–859. https://doi.org/10.2105/AJPH.2013.301696

Shaw, B., Bicket, M., Elliott, B., Fagan-Watson, B., Mocca, E. & Hillman, M. (2015). Children's Independent Mobility: an international comparison and recommendations for action. In *Policy Studies Institute* (Issue July). http://www.psi.org.uk/docs/7350_PSI_Report_CIM_final.pdf

Statistics Canada. (2021). Working from home during the COVID-19 pandemic Working from home: a new experiment for many Canadian workers and employers. *The Daily*, *August 4, 2021*. https://www150.statcan.gc.ca/n1/en/daily-quotidien/210804/dq210804b-eng.pdf?st=tjMwG711

Statistics Canada. (2017). Commuters using sustainable transportation in census metropolitan areas : Census of population, 2016. 98, 10. https://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016029/98-200-x2016029-eng.cfm

Statistics Canada (2023). Census Profile. 2021 Census of Population. Statistics Canada Catalogue number 98-316-X2021001. Ottawa. Released March 29, 2023.
https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/index.cfm?Lang=E

Trapp, G. S. A., Giles-Corti, B., Christian, H. E., Bulsara, M., Timperio, A. F., McCormack, G. R. & Villaneuva, K. P. (2011). On your bike! a cross-sectional study of the individual, social and environmental correlates of cycling to school. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 123. https://doi.org/10.1186/1479-5868-8-123

University of Newcastle. (n.d.). *Targeting Dads To Improve Health and Family Relationships*. https://www.newcastle.edu.au/research/stories/research-impact/healthy-dads-healthy-kids

Valentine, G. (1997). "Oh yes I can." "oh no you can't": Children and parents' understandings of kids' competence to negotiate public space safely. *Antipode*, *29*(1), 65–89. https://doi.org/10.1111/1467-8330.00035

Vanwolleghem, G., D'Haese, S., Dyck, D. Van, Bourdeaudhuij, I. De & Cardon, G. (2014). Feasibility and effectiveness of drop-off spots to promote walking to school. *International Journal of Behavioral Nutrition and Physical Activity*, *11*(1), 1–11. https://doi.org/10.1186/s12966-014-0136-6

Veitch, J., Carver, A., Salmon, J., Abbott, G., Ball, K., Crawford, D., Cleland, V. & Timperio, A. (2017). What predicts children's active transport and independent mobility in disadvantaged neighborhoods? *Health and Place*, *44*(February), 103–109. https://doi.org/10.1016/j.healthplace.2017.02.003

Vlaar, J., Brussoni, M., Janssen, I. & Mâsse, L. C. (2019). Roaming the neighbourhood: Influences of independent mobility parenting practices and parental perceived environment

on children's territorial range. *International Journal of Environmental Research and Public Health*, *16*(17), 8–14. https://doi.org/10.3390/ijerph16173129

Whitzman, C. & Mizrachi, D. (2012). Creating Child-Friendly High-Rise Environments: Beyond Wastelands and Glasshouses. *Urban Policy and Research*, *30*(3), 233–249. https://doi.org/10.1080/08111146.2012.663729

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), 11–15. https://doi.org/10.1186/s12966-017-0634-4

Wong, B. Y.-M., Faulkner, G., Buliung, R. & Irving, H. (2011). Mode shifting in school travel mode: examining the prevalence and correlates of active school transport in Ontario, Canada. *BMC Public Health*, *11*(1), 618. https://doi.org/10.1186/1471-2458-11-618

APPENDIX A

Thursday, 21 May 2020

PI:	Richard Larouche, Faculty of Health Sciences
Study Title:	Active transportation, independent mobility, and physical activity among school children: A multi-site study
Action:	Approved
HPRC Protocol Number:	2020-050
Approval Date:	May 21, 2020
Term Date:	May 20, 2021

Dear Richard,

Thank you for submitting the documentation for the study titled "Active transportation, independent mobility, and physical activity among school children: A multi-site study"; the documents have been reviewed and approved on behalf of the University of Lethbridge Human Participant Research Committee (HPRC) for the **approval period May 21, 2020 to May 20, 2021**. The HPRC conducts its reviews in accord with University policy and the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (2018).

Please note that a final report for closeout of the protocol will be due to the Office of Research Ethics on or before **May 20, 2021**.

We wish you and your students the best with the data analysis.

Sincerely,

Susan Entz, M.Sc., Ethics Officer
Office of Research Ethics
University of Lethbridge
4401 University Drive
Lethbridge, Alberta, Canada
T1K 3M4

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

Children Mobility Questionnaire

Please answer the questions as best you can.
There are no right or wrong answers.

1) You are a: ☐ girl ☐ boy

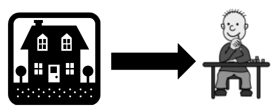
2) a) How old are you? _______ years

b) What grade are you in? ☐ 4th grade ☐ 5th grade ☐ 6th grade

---

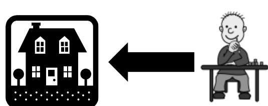
YOUR TRAVELLING JOURNAL

3) Please draw an X in the table below to indicate <u>how you travelled to school</u> on each day of the week. (If you missed school, please don't put an X)



	Monday	Tuesday	Wednesday	Thursday	Friday
Walk					
Bike					
Skateboard					
Rollerblade					
Car					
Bus					
Other: ___________					

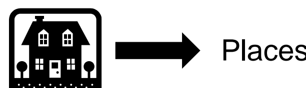
4) Please draw an X in the table below to indicate <u>how you travelled back home</u> on each day of the week. (If you missed school, please don't put an X)



	Monday	Tuesday	Wednesday	Thursday	Friday
Walk					
Bike					
Skateboard					
Rollerblade					
Car					
Bus					
Other: ___________					

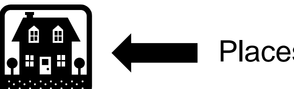
ID:					Date:		/			/				

5) How many times did you go from home to the following places using active modes of travel (such as walking, running, biking)?
Please respond for each day of the week.



Places	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
School							
Friend's home							
Relative's home							
Parks or playgrounds							
Shops, markets, or restaurants							
Sport venues (e.g., soccer field, swimming pool)							
Faith places (e.g., church, mosque)							
Other: ______________							

6) How many times did you go to home from the following places using active modes of travel (such as walking, running, biking)?
Please respond for each day of the week.



Places	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
School							
Friend's home							
Relative's home							
Parks or playgrounds							
Shops, markets, or restaurants							
Sport venues (e.g., soccer field, swimming pool)							
Faith places (e.g., church, mosque)							
Other: ______________							

7) For each day of the week, please write "yes" if you have worn the activity monitor (pedometer) for most of the day or "no" if you did not.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Did you wear the pedometer for most of the day?							

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

QUESTIONNAIRE

8) Are you allowed to walk or bike to school on you own?

☐ Yes ☐ No

9) How long does it usually take you to travel to school?(Only tick one box)

☐ Less than 5 minutes ☐ 5 to 15 minutes ☐ 16 to 30 minutes

☐ 31 to 45 minutes ☐ 46 minutes or more

10) Are you allowed to walk or bike to go back home after school on your own?

☐ Yes ☐ No

11) How would you like to be able to travel to and from school? (Only tick one box)

☐ Walk most or all the way

☐ Cycle

☐ School bus

☐ Local bus or train or underground

☐ Car

☐ Other, please write in: ________________________

12) How many times a week do you usually go home for lunch during school days?

☐ 0 time (Please go to Question 14) ☐ 1 time ☐ 2 times

☐ 3 times ☐ 4 times ☐ 5 times

13) How do you usually go home for lunch? (Please tick only one box)

☐ I walk ☐ I bike ☐ I run

☐ By car or van ☐ By bus or train ☐ By motorcycle

☐ By another way. Please write it down: ________________________

☐ I do not go home for lunch

WALKING

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

14) a) Are you allowed to cross main roads on your own?

☐ YES (Please go to Question **14c**)

☐ NO

b) If you are not allowed to cross main roads on your own, would you like to be allowed to?

☐ YES ☐ NO

c) How old were you when you first crossed main roads on your own?
(Please estimate if you are not sure)

☐ Age

☐ Not allowed to cross roads on my own

d) When going to places other than school that are within walking distance, are you allowed to go on your own?

☐ I usually go on my own ☐ I am usually taken ☐ Varies

CYCLING

15) a) Do you have a bicycle?

☐ YES ☐ NO (Please go to Question **16**)

b) Are you allowed to cycle on main roads on your own?

☐ YES; At what age were you first allowed? _______ years

☐ NO

☐ Don't have a bicycle

c) If you have a bicycle, are you allowed to ride it to go to places (like the park or friend's houses) on your own?

☐ YES ☐ NO ☐ Don't have a bicycle

d) **How many times do you cycle in a typical week (both with and without parents) including the weekend?** (Please answer for the current season)

☐ Less than once a week ☐ One or two days a week

☐ Three or more days a week ☐ Don't have a bicycle

ID: [ ][ ][ ][ ] Date: [ ][ ] / [ ][ ][ ] / [ ][ ][ ][ ]

BUSES

16) Are you allowed to go on local buses on your own (other than a school bus)?

☐ YES ☐ NO

AFTER DARK

17) Are you usually allowed to go out on your own after dark?

☐ YES ☐ NO

ON THE WEEKEND

18) Which of these activities did you do this weekend?
Tick the 1st column if you did these things on your own or with another young person.
Tick the 2nd column if you did them with a parent or other adult.

		On your own or with another young person	With a parent or other adult
	Visited a friend's home		
	Visited relatives or grown-ups		
	Went to a youth club (including Scouts, Guides, Cadets, Sunday school etc.)		
	Went to the shops		
	Went to a library		
	Went to a cinema		
	Spent time with friends outside after dark		
	Went to a playground, park or playing fields		
	Played sport or went swimming (individual or team sports or lessons)		
	Went for a walk or cycled around		
	Went to a concert or nightclub		
	Visited a place of worship		
	Other *(please write in)*:		

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

WHERE YOU LIVE

19) a) How safe do you feel <u>on your own</u> in your local neighborhood?(Only tick <u>one box</u>)

☐ Very safe ☐ Fairly safe ☐ Not very safe

☐ Not at all safe ☐ Not allowed out on my own

b) When you are outside <u>on your own or with friends</u> are you worried by any of the following?

	Yes	No	Don't know
Traffic			
Getting lost			
Bullying			
Strangers			
Do not feel that I am old enough to go about on my own			
Not knowing what to do if someone speaks to me			

c) Is there anything else you are worried about when you are outside <u>on your own or with friends</u>?

Please write in:…………………………………………………………………………..

………………………………………………………………………………………….

20) How far from home are you allowed to roam on your own? (Only tick <u>one box</u>)

☐ I am not allowed out on my own

☐ Within my street

☐ Within 2-3 streets away from home

☐ Within a 15 minute walk from home

☐ More than a 15 minute walk from home

21) How far from home are you allowed to roam on your own with friends? (Only tick <u>one box</u>)

☐ I am not allowed out on my own with friends

☐ Within my street

☐ Within 2-3 streets away from home

☐ Within a 15 minute walk from home

☐ More than a 15 minute walk from home

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

22) Please indicate your level of agreement with the statements written in the first column of the table. Please check (√) one number only.

STATEMENTS It is **difficult** for me to walk or bike to school because…	1 Strongly disagree	2 Somewhat disagree	3 Somewhat agree	4 Strongly agree
• there are too many hills along the way				
• there are no sidewalks or bike lanes				
• the route is boring				
• the route does not have good lighting				
• there is too much traffic *along the route*				
• there is too much traffic *around our home*				
• there is too much traffic *around the school*				
• there is one or more dangerous crossing				
• I get too hot and sweaty				
• no other children walk or bike to school				
• it's not considered cool to walk or bike				
• I have too much stuff to carry				
• it is easier for my parents to drive me on the way to something else				
• it involves too much planning ahead				
• it is unsafe because of crime (strangers, gangs, drugs)				
• I get bullied, teased, harassed				
• there is nowhere to leave a bike safely				
• there are stray dogs				
• it is too far				

Data Entry Staff Initials: ______________________ Date: ______ /________ / _______

APPENDIX C

ID: ☐☐☐☐	Date: ☐☐ / ☐☐☐ / ☐☐☐☐

Parent Questionnaire on Children's Mobility

The following questions are about your child:

- This questionnaire should take about 15 minutes to complete.
- Please only answer in relation to the child who gave you this form – do not answer about any other children in your household.
- Please answer the questions as accurately as possible to the best of your knowledge.
- Your answers will be made anonymous and will be kept confidential.

---

1. Is your child allowed to walk or bike home from school on their own?

☐ Yes – When did you first allow your child to walk or bike home from school on their own?

☐ years old

☐ No – At what age will you be likely to allow your child to walk or bike home from school on their own?

☐ years old

2. How many days a week is your child typically collected from school by an adult?
(Please insert number)

☐ times each week

3. What are your *main* reasons for picking your child up from school (even if you no longer do)?
(Please tick no more than three boxes)

☐	**1.** Opportunity to spend time with my child	☐	**6.** Fear of bullying by other children
☐	**2.** Opportunity for exercise or to get out of house	☐	**7.** Opportunity to meet people (teachers, other parents, etc.)
☐	**3.** Concern about traffic danger	☐	**8.** On the way to an activity for you or the child (e.g. shopping, visiting a relative, after school club, etc.)
☐	**4.** Child unreliable or too young	☐	**9.** School too far away
☐	**5.** Danger from adults	☐	**10.** Other, please write in:

Version #3, March 15, 2016

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

4. How long would it typically take you to get to your child's school?
(Insert a time however large or small, or tick "Don't know / Not applicable")

On foot	*minutes*	or	☐ Don't know / Not applicable
By car	*minutes*	or	☐ Don't know / Not applicable
Public transport	*minutes*	or	☐ Don't know / Not applicable

5. Is the school the nearest one your child can attend?

☐ YES *(Please go to Question 7)*

☐ NO

6. What is the main reason for your child attending this school?
(Tick as many as you need)

☐	1. No places available at nearest school
☐	2. Did not want to send child to local school or preferred a specific school elsewhere
☐	3. Wanted a specific type of school (faith school, private, performing arts, etc.)
☐	4. Moved home after child started at school
☐	5. Travel is easier
☐	6. Other, *please write in:*

7. Please draw an **X** in the table below to indicate how your child travelled **to school on each day** of the week when wearing the pedometer. (*If your child missed school, please don't put an X*)

	Walk	Bike	Skateboard	Roller-blade	Car	Bus	Other
Monday							
Tuesday							
Wednesday							
Thursday							
Friday							

8. Please draw an **X** in the table below to indicate how your child travelled **back home on each day** of the week when wearing the pedometer. (*If your child missed school, please don't put an X*)

	Walk	Bike	Skateboard	Roller-blade	Car	Bus	Other
Monday							
Tuesday							
Wednesday							
Thursday							
Friday							

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

9. Does your child go home for lunch during school days?

☐ Yes ☐ No *(Please go to Question 12)*

10. How many times during the week?

☐ 0 time *(Please go to Question 12)* ☐ 1 time ☐ 2 times

☐ 3 times ☐ 4 times ☐ 5 times or more

11. How does your child usually go home for lunch? Please tick only one box.

☐ He/she walks ☐ He/she bikes ☐ He/she runs

☐ By car or van ☐ By bus or train ☐ By motorcycle

☐ By another way. Please write it down: ______________________

☐ He/she does not go home for lunch

12. When going to places other than school that are *within walking distance*, is your child taken there or allowed to go on their own?

☐ Usually goes on their own

☐ Usually taken

☐ Varies

13. What is the approximate number of round trips made *each week* to accompany your child, *excluding the journey to school?*

(For example, travelling to the swimming pool and then home again would count as one round trip)

☐ Round trips each week

14. What is the method of travel most frequently used on these trips?

(Tick as many as you need)

☐ Walk most or all the way

☐ Cycle

☐ Local bus or train or underground

☐ Car

☐ Other method, *please write in*: ……………………………………………

ID: [ ][ ][ ][ ] Date: [ ][ ] / [ ][ ][ ] / [ ][ ][ ][ ]

15. When wearing the pedometer, how many times did your child go **from home to the following destinations** using active modes of travel (for example, walking, running, biking)? Please respond for each day of the week.

Destination	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
School							
Friend's home							
Relative's home							
Parks or playgrounds							
Shops or markets, or restaurants							
Sport venues (e.g., soccer field, swimming pool)							
Faith places (e.g., church, mosque)							
Other							

** If you have written "other", please specify which destination it is: ____________________

16. When wearing the pedometer, how many times did your child go **to home from the following destinations** using active modes of travel (for example, walking, running, biking)? Please respond for each day of the week.

Destinations	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
School							
Friend's home							
Relative's home							
Parks or playgrounds							
Shops or markets, or restaurants							
Sport venues (e.g., soccer field, swimming pool)							
Faith places (e.g., church, mosque)							
Other							

** If you have written "other", please specify which destination it is: ____________________

ID: [ ][ ][ ][ ] Date: [ ][ ] / [ ][ ][ ] / [ ][ ][ ][ ]

17. Please indicate your level of agreement with the statements written in the table below. *Please CHECK (√) ONE number only*.

Statements (It is difficult for my child to walk or bike to school because…)	1 Strongly disagree	2 Somewhat disagree	3 Somewhat agree	4 Strongly agree
There are too many hills along the way				
There are no sidewalks or bike lanes				
The route is boring				
The route does not have good lighting				
There is too much traffic *along the route*				
There is too much traffic *around our home*				
There is too much traffic *around the school*				
There is one or more dangerous crossing				
My child gets too hot and sweaty				
No other children walk or bike to school				
It's not considered cool to walk or bike				
My child has too much stuff to carry				
It is easier for me to drive my child here on the way to something else				
It involves too much planning ahead				
It is unsafe because of crime (strangers, gangs, drugs)				
My child gets bullied, teased, harassed				
There is nowhere to leave a bike safely				
There are stray dogs				
It is too far				

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

18. Is your child allowed to cross main roads on their own?
Please note: *This question is included for all parents of children aged between 7 and 15 years old. Please answer even if the answer seems obvious.*

☐ YES At what age was your child first allowed to do so?
☐ years old

☐ NO At what age do you think you will allow your child to do so?
☐ years old

19. Is your child usually allowed to go out *on their own* after dark?

☐ YES *(Please go to Question* 21)

☐ NO

20. If NO, what is the main reason your child is not allowed to go out *on their own* after dark?

Please write in:……………………………………………………………………………

……………………………………………………………………………….

21. Is your child allowed to cycle on main roads on their own?

☐ Does not own a bicycle

☐ YES - At what age was your child first allowed to cycle on main roads on their own?
☐ years old

☐ NO - At what age do you think you will allow your child to cycle on main roads on their own?
☐ years old

22. Is your child usually allowed to travel on local buses on their own (other than a school bus)?

☐ YES At what age was your child first allowed to travel on buses on their own?
☐ years old

☐ NO At what age do you think you will allow your child to travel on buses on their own?
☐ years old

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

23. Does your child have a mobile phone?

☐ YES

☐ NO (*Please go to Question **25***)

24. If YES, does this give you more confidence about letting your child go out on their own?

☐ YES

☐ NO

☐ Child does not go out on their own

25. How worried are you about the risk of your child being injured in a traffic accident when crossing a road?

☐ Very

☐ Quite

☐ Not very

☐ Not at all

☐ Don't know / not sure

26. How far from home is your child allowed to roam on their own? *(Only tick <u>one box</u>)*

☐ He/she is not allowed out on their own

☐ Within my street

☐ Within 2-3 streets away from home

☐ Within a 15 minute walk from home

☐ More than a 15 minute walk from home

27. How far from home is your child allowed to roam on their own with friends (unaccompanied by an adult)? *(Only tick <u>one box</u>)*

☐ He/she is not allowed out on their own with friends

☐ Within my street

☐ Within 2-3 streets away from home

☐ Within a 15 minute walk from home

☐ More than a 15 minute walk from home

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

28. On a typical **weekday**, how much time does your child spend playing outdoors at the moment (choose only one answer):

☐ None at all

☐ Less than 1 hour

☐ 1 to 2 hours

☐ 2 to 3 hours

☐ More than 3 hours

29. On a typical **weekend day**, how much time does your child spend playing outdoors at the moment (choose only one answer):

☐ None at all

☐ Less than 1 hour

☐ 1 to 2 hours

☐ 2 to 3 hours

☐ More than 3 hours

30. Does your child have a long-standing illness, disability or infirmity?

☐ YES - *Please give brief details (optional)*………………………………………

☐ NO

The following questions are about you:

31. When you were a child aged 10 to 12, how did you usually travel to school? *(Only tick one box)*

☐ Walked most or all the way

☐ Cycled

☐ School bus

☐ Local bus or train or underground

☐ Car

☐ Other. *Please write in:* ……………………………………………………

32. At about what age were you allowed to get about on your own?

☐ years old

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

33. Was **<u>your</u>** primary school closer or further away from your home than your child's primary school?

Much closer	Closer	About the same	Further	Much further
☐	☐	☐	☐	☐

34. How do **<u>you</u>** usually travel to and from work? (*Tick as many as you need*)

☐ I walk

☐ I bike

☐ I use public transit (i.e., bus, train)

☐ I drive (i.e., car, van, motorcycle)

☐ By another way. Please write it down: ________________________

☐ I work at home (or don't work)

35. To what extent do you agree or disagree with the following two statements?
Tick the box which best matches your opinion.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a) Most adults who live in the neighbourhood look out for other people's children in the area	☐	☐	☐	☐	☐
b) Some young people and adults in the area make you afraid to let your children play outdoors	☐	☐	☐	☐	☐

36. Does your household have regular use of a car (including car share)?

☐ No ☐ Yes, 1 car ☐ Yes, 2 or more cars

37. How many adults in your household, *<u>including yourself</u>*, have a full driving license?

☐ Number

38. How many people live in your home, *<u>including yourself</u>?*

	Children aged 10 years or less
	Children aged 11 to 15 years
	Everyone else aged 16 or more
	TOTAL

ID:					Date:		/			/				

39. Does your family own your home or is it rented?

- ☐ Own home (with or without mortgage)
- ☐ Rented home from Council or Housing Association
- ☐ Private rented
- ☐ Live in a relative's home
- ☐ Temporary accommodation
- ☐ Other ……………………..

40. Do you have access to outside space(s) where your children can play?
(Please tick all the relevant boxes)

☐	1. Garden
☐	2. Park which you can reach without crossing a main road
☐	3. Park you reach by crossing a main road
☐	4. Quiet residential road

☐	5. Shared communal space
☐	6. Other *please write in:*
☐	7. No suitable outside space available

41. Please write in your postal code

For the following questions, please tick the boxes for you and (if applicable) your partner

42. How old are you?

	You	Your husband, wife or partner (if applicable)
Under 30	☐	☐
30 to 44	☐	☐
45 or over	☐	☐

43. What gender are you?

	You	Your husband, wife or partner (if applicable)
Male	☐	☐
Female	☐	☐

ID: ☐☐☐☐ Date: ☐☐ / ☐☐☐ / ☐☐☐☐

44. Are you in paid work?

	You	Your husband, wife or partner (if applicable)
Yes, full-time	☐	☐
Yes, part-time	☐	☐
No	☐	☐

45. If you are in paid work, do you work at home or elsewhere?

	You	Your husband, wife or partner (if applicable)
Home	☐	☐
Elsewhere	☐	☐

46. Do you speak a language other than English or French at home?

☐ Yes, please specify: ___________________

☐ No

47. What is the highest level of education that the child's father has completed?

☐ Elementary school (grade 8)

☐ Secondary school (grade 12)

☐ College

☐ University

☐ Graduate school

☐ Not applicable / don't know

48. What is the highest level of education that the child's mother has completed?

☐ Elementary school (grade 8)

☐ Secondary school (grade 12)

☐ College

☐ University

☐ Graduate school

☐ Not applicable / don't know

Thank you very much for your help ☺

Data Entry Staff Initials: _______________________ Date: ______ /________ / _______

APPENDIX D

Table D1. *Variables included in the multiple imputation model*

Variable	Role in model	Constraints
School_ID	Predictor	N/A
Site_ID	Predictor	N/A
Urban_Type (type of urbanization)	Predictor	N/A
SchoolSES	Predictor	N/A
CQ_gender	Predictor/imputed	N/A
CQ_age	Predictor/imputed	No decimals
CQ_grade	Imputed only (to avoid collinearity with age)	N/A
CQ9_ToSchoolLong (school travel time; categorical variable)	Predictor/imputed	N/A
CQ11_LikeTravel (preferred travel mode)	Predictor/imputed	N/A
CQ15_Bike (child has a bicycle)	Predictor/imputed	N/A
CQ19a_Safe (child feels safe in their neighbourhood)	Predictor/imputed	N/A
CQ20_Far_Own (home range alone)	Predictor/imputed	N/A
CQ20_Far_Friends (home range with friends)	Imputed only to avoid collinearity	N/A
PQ2_Days_Collected (number of days child is picked up by an adult at school)	Predictor/imputed	Integer between 0 and 7
PQ23_Phone (child has a mobile phone)	Predictor/imputed	N/A
PQ25_WorriedTraffic (parent worried about traffic)	Predictor/imputed	N/A
PQ26_Far_Own (home range alone)	Imputed only to avoid collinearity	N/A
PQ27_Far_Friends (home range with friends)	Imputed only to avoid collinearity	N/A
PQ28_WeekOut (time spent outdoors on weekdays)	Predictor/imputed	N/A
PQ29_WeekendOut (time spent outdoors on weekend days)	Predictor/imputed	N/A
PQ30_Ill (child has illness, disability, infirmity)	Predictor/imputed	N/A
PQ31_ParentTravel (parent's primary school travel mode)	Predictor/imputed	N/A

PQ32_ParentOwn (age at which parent was allowed to get around on their own	Predictor/imputed	Integer between 3 and 20
PQ34_ParentWorkWalk (parent walks to work)	Imputed only to avoid collinearity	N/A
PQ34_ParentWorkBike (parent bikes to work)	Imputed only to avoid collinearity	N/A
PQ34_ParentWorkPub (parent uses public transit to get to work)	Imputed only to avoid collinearity	N/A
PQ34_ParentWorkCar (parent drives to work)	Predictor/imputed	N/A
PQ35_AdultLookout (most adults in the neighbourhood look out for other children)	Predictor/imputed	N/A
PQ35_Afraid (some people in the area make you afraid to let your child play outside)	Predictor/imputed	N/A
PQ36_Cars (car ownership)	Predictor/imputed	N/A
PQ42_AgeYou (age of parent; categorical variable)	Predictor/imputed	N/A
PQ43_GenderYou (gender of parent)	Predictor/imputed	N/A
PQ44_WorkYou (work of the parent)	Predictor/imputed	N/A
PQ46_Language (whether family speaks a language other than French or English at home)	Predictor/imputed	N/A
Steps_day (average steps per day)	Predictor/imputed	Integer between 1000 and 29 999 (following Rowe's rules*)
MVPA_day (average minutes spent in MVPA)	Imputed only to avoid collinearity	≥ 1
CQ_ActiveT (number of trips to/from all destinations, child report)	Imputed only – this variable includes a lot of zeros and is highly skewed to the right	Integer between 0 and 175
HighEdu (highest level of education in household, 3-level)	Predictor/imputed	N/A
CQ_IM_Index (independent mobility index)	Predictor/imputed	Integer between 0 and 6
PQ_IM_Index (independent mobility index)	Imputed only to avoid collinearity	Integer between 0 and 6
OwnHome (whether parents own their home)	Predictor/imputed	N/A

Distance AM (in meters)	Predictor/imputed	≥ 1
Distance PM (in meters)	Imputed only to avoid collinearity	≥ 1
Walkability400 (walkability index within 400m buffer)	Predictor/imputed	N/A
Walkability1600 (walkability index within 1600m buffer)	Imputed only to avoid collinearity	N/A
AST_volume (volume of AT to/from school, child report – in km/week)	Imputed only – this variable includes a lot of zeros and is highly skewed to the right	0 ≤ AST volume ≤ 100
PQ_all_trips (number of trips to/from all destinations, parent report)	Imputed only to avoid collinearity	Integer between 0 and 175
MVPA_weekdays (average minutes in MVPA on weekdays)	Imputed only to avoid collinearity	≥ 1
MVPA_weekends (average minutes of MVPA on weekend days)	Imputed only to avoid collinearity	≥ 1
Steps_weekdays (average steps on weekdays)	Imputed only to avoid collinearity	Integer between 1000 and 29 999 (following Rowe's rules*)
Steps_weekends (average steps on weekend days)	Imputed only to avoid collinearity	Integer between 1000 and 29 999 (following Rowe's rules*)
PQ_AST_volume	Imputed only to avoid collinearity	0 ≤ AST volume ≤ 100
CQ_AST_trips (categorical variable for the number of AT trips to/from school)	Predictor/imputed	N/A
PQ_AST_trips (categorical variable for the number of AT trips to/from school)	Imputed only to avoid collinearity	N/A

Note: variables that start with CQ are from the child questionnaire and those that start with PQ are from the parent questionnaire.

NA, Not applicable; SES, Socioeconomic status; MVPA, Moderate-to-vigorous physical activity; IM, Independent mobility; AST, Active school transport; AT, Active transport

*Rowe, D. A., Mahar, M. T., Raedeke, T. D., & Lore, J. (2004). Measuring physical activity in children with pedometers: Reliability, reactivity, and replacement of missing data. *Pediatric Exercise Science*, *16*(4), 343-354.

APPENDIX E

Table E1. *Complete case analysis of independent mobility models*

Variable	β, Both genders (n=1699)	β, Girls (n=936)	β, Boys (n=763)
Site			
Ottawa (reference)	0	0	0
Vancouver	-0.25 (-0.63, 0.12)	-0.22 (-0.62, 0.17)	-0.30 (-0.80, 0.20)
Trois-Rivières	**0.70 (0.30, 1.09)****	**0.81 (0.40, 1.22)****	0.41 (-0.13, 0.92)
Urbanization			
Urban (reference)	0	0	0
Suburban	-0.05 (-0.41, 0.32)	0.03 (-0.35, 0.41)	-0.12 (-0.60, 0.35)
Rural	0.14 (-0.24, 0.52)	0.15 (-0.24, 0.54)	0.09 (-0.41, 0.60)
School SES			
High (reference)	0	0	0
Low	-0.01 (-0.30, 0.32)	-0.18 (-0.50, 0.14)	0.18 (-0.22, 0.59)
Child age (year)	**0.41 (0.33, 0.49)****	**0.39 (0.28, 0.50)****	**0.51 (0.37, 0.64)****
Age Parent was allowed to go places alone (each additional year)	**-0.09 (-0.12, -0.06)****	**-0.09 (-0.12, -0.05)****	**-0.09 (-0.13, -0.05)****
Parent gender			
Man (reference)	0	0	0
Woman	-0.13 (-0.32, 0.06)	-0.06 (-0.30, 0.19)	-0.09 (-0.13, 0.05)
Parent travel to school as a child			
Active (reference)	0	0	0
Bus	0.10 (-0.09, 0.29)	0.24 (0.00, 0.48)	-0.05 (-0.35, 0.24)
Inactive	0.18 (-0.18, 0.54)	0.32 (-0.15, 0.80)	-0.02 (-0.56, 0.52)
Parent travel mode to work‡			
Walk	-0.01 (-0.26, 0.23)	0.01 (-0.30, 0.19)	0.04 (-0.35, 0.44)
Bike	0.23 (-0.10, 0.55)	0.38 (-0.04, 0.80)	0.11 (-0.41, 0.63)
Public Transit	-0.09 (-0.33, 0.16)	-0.24 (-0.56, 0.08)	-0.05 (-0.33, 0.43)
Car	-0.09 (-0.28, 0.09)	-0.09 (-0.33, 0.14)	-0.06 (-0.35, 0.23)

Note: β = unstandardized regression coefficients; SES = socioeconomic status. **p*-value <0.05; ***p*-value <0.01; School-level intraclass correlation coefficient 0.07 for Both, 0.07 for Girls and 0.10 for Boys
‡Parent could select multiple modes and, for each mode, the reference is "no".

APPENDIX F

Table F1. *Complete case analysis of winsorized active transportation models*

Variable	IRR, Both (n=1699)	IRR, Girls (n=936)	IRR, Boys (n=763)
Site			
Ottawa (reference)	0	0	0
Vancouver	**1.27 (1.00 – 1.61)***	1.10 (0.85 – 1.41)	**1.66 (1.23 – 2.24)****
Trois-Rivières	1.17 (0.92 – 1.49)	1.06 (0.82 – 1.38)	**1.40 (1.03 – 1.90)***
Urbanization			
Urban (reference)	0	0	0
Suburban	0.99 (0.79 – 1.24)	0.80 (0.63 – 1.02)	1.31 (1.00 – 1.72)
Rural	0.93 (0.73 – 1.17)	0.85 (0.66 – 1.09)	1.10 (0.82 – 1.49)
School-level Socioeconomic Status(SES)			
High (reference)	0	0	0
Low	1.01 (0.84 – 1.22)	1.07 (0.87 – 1.31)	0.93 (0.74 – 1.18)
Child age (years)	0.95 (0.89 – 1.00)	0.94 (0.87 – 1.01)	0.96 (0.88 – 1.04)
Days a parent accompanied child home from school	**0.94 (0.91 – 0.96)****	**0.94 (0.91 – 0.98)****	**0.93 (0.89 – 0.96)****
Parent Gender			
Man (reference)	0	0	0
Woman	1.05 (0.92 – 1.19)	1.00 (0.84 – 1.19)	1.10 (0.90 – 1.34)
Parent travel mode to school as a child			
Active (reference)	0	0	0
Public transit	0.88 (0.78 – 1.00)	0.87 (0.73 – 1.02)	0.87 (0.72 – 1.04)
Inactive	1.01 (0.79 – 1.29)	1.03 (0.72 – 1.47)	0.95 (0.67 – 1.34)
Parent travel mode to work			
Walk	1.12 (0.96 – 1.32)	1.16 (0.94 – 1.44)	1.17 (0.91 – 1.50)
Bike	0.98 (0.79 – 1.21)	1.02 (0.77 – 1.36)	0.84 (0.61 – 1.16)
Public transit	1.11 (0.94 – 1.31)	1.08 (0.86 – 1.35)	1.14 (0.89 – 1.46)
Car	0.94 (0.81 – 1.03)	0.97 (0.82 – 1.15)	0.84 (0.70 – 1.01)

Note: School-level intraclass correlation coefficient 0.08 for Both, 0.07 for Girls and 0.09 for Boys

**p-value <0.05; **p-value <0.01*

APPENDIX G

Table G1. *Uncensored multiply imputed active transportation models stratified by gender.*

Variable	IRR, Both (n=1699)	IRR, Girls (n=936)	IRR, Boys (n=763)
Site			
Ottawa (reference)	0	0	0
Vancouver	1.25 (0.98 – 1.58)	1.12 (0.85 – 1.47)	**1.51 (1.13 – 2.04)****
Trois-Rivières	1.14 (0.89 – 1.46)	1.02 (0.77 – 1.36)	1.34 (0.99 – 1.82)
Urbanization			
Urban (reference)	0	0	0
Suburban	1.01 (0.80 – 1.27)	0.85 (0.65 – 1.12)	1.23 (0.93 – 1.62)
Rural	0.93 (0.74 – 1.18)	0.83 (0.63 – 1.09)	1.08 (0.81 – 1.46)
School Socioeconomic Status			
High (reference)	0	0	0
Low	1.00 (0.82 – 1.21)	1.03 (0.82 – 1.29)	0.99 (0.78 – 1.25)
Child age (years)	0.95 (0.90 – 1.01)	0.95 (0.88 – 1.02)	0.96 (0.89 – 1.04)
Days a parent accompanied child home from school	**0.93 (0.91 – 0.96)****	**0.93 (0.90 – 0.97)****	**0.93 (0.90 – 0.96)****
Parent Gender			
Man (reference)	0	0	0
Woman	1.04 (0.92 – 1.17)	0.99 (0.84 – 1.16)	1.10 (0.91 – 1.32)
Parent travel mode to school as a child			
Active (reference)	0	0	0
Public transit	**0.88 (0.79 – 0.99)***	0.88 (0.75 – 1.03)	0.89 (0.75 – 1.05)
Inactive	0.96 (0.77 – 1.19)	0.99 (0.73 – 1.33)	0.92 (0.67 – 1.27)
Parent travel mode to work			
Walk	1.09 (0.94 – 1.27)	1.08 (0.89 – 1.32)	1.19 (0.94 – 1.50)
Bike	1.02 (0.83 – 1.24)	1.06 (0.81 – 1.39)	0.94 (0.70 – 1.27)
Public transit	1.13 (0.97 – 1.31)	1.09 (0.88 – 1.34)	1.16 (0.93 – 1.46)
Car	0.94 (0.84 – 0.96)	0.97 (0.83 – 1.13)	0.90 (0.76 – 1.07)

Note: School-level intraclass correlation coefficient 0.09 for Both, 0.10 for Girls and 0.10 for Boys
*p-value <0.05; **p-value <0.01