CHILDREN'S TRAVEL TO SCHOOL:
THE INFLUENCE OF BUILT FORM AND PERCEPTIONS OF SAFETY

by

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B.ES, University of Waterloo, 2000

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTERS OF ARTS in PLANNING

in

THE FACULTY OF GRADUATE STUDIES

THE UNIVERSITY OF BRITISH COLUMBIA

August 2006

ABSTRACT

Background:
Children in developed nations are spending more time in cars and fewer are walking to school than 40 years ago. This trend has important implications for children's physical activity and health, pollution and traffic congestion in the vicinity of schools, and children's opportunities to practice independent decision-making.

Objective:
To examine the relationship between children's mode of travel to school and factors of demographics, micro-scale built form, and perceptions of safety. To compare micro-scale built environment conditions with parental perceptions of safety.

Methods:
Gender, age, income, distance, household vehicle ownership, mode of travel to school, and perceptions of safety while walking to school were obtained from travel surveys distributed to grade 4 and 5 children and their parents at 7 elementary schools in the Lower Mainland of B.C. Built environment features were evaluated at the street-segment and intersection scale using a standardized survey. Each child was assigned a unique "pedestrian friendliness" score based on an estimated route between their home and school. A binary logistic regression model was developed to statistically examine relationships.

Results:
Distance between home and school had the strongest influence on travel mode choice with vehicle ownership and parental perceptions of safety from traffic and from strangers or bullies being significant but less influential. Contrary to accepted norms in the literature, household income was not significant even after removing distance and vehicle ownership from the model. Indexed scores of micro-scale pedestrian environment variables were found to be highly influential for children living within a 500 metre radius of school, but not for the overall sample. Parental perceptions of safety from traffic were significantly associated with the "worst case" street segment and intersection scores on a child's route to school, but other measures of perception of safety were not. The influence of distance is confounded by its close relationships with perception of safety from traffic and pedestrian friendliness scores. The lack of significance of the built environment measures is likely affected by the relatively low level of variation in measured characteristics in the neighbourhoods selected for study.

Conclusion:
ome to school distance had the strongest influence on whether children would be active or not on the way to school. The index of micro-scale measures of the pedestrian environment examined in this study were highly influential for children living less than half a kilometre from school even after controlling for vehicle ownership and parental perceptions of safety. The pedestrian environment was not significant for the entire sample, although the influence of distance may mask this relationship. Household vehicle ownership and parental perceptions of safety from traffic and strangers were significant across the entire sample. Further research should include a broader diversity of street characteristics to more completely understand the influence of the micro-scale built environment. The factors influencing parental perception of safety, and the role of convenience in decision-making should also be studied in more detail.

TABLE OF CONTENTS

List of Tables:

Chapter 3

Chapter 4

Chapter 5

List of Figures:

List of Photos:

Chapter 3

Chapter 4

Chapter 6

ACKNOWLEDGEMENTS

There are many people who deserve thanks and recognition for their contributions to this research project. Without their guidance and hard work, this thesis would not have been possible.

Dr. Lawrence Frank, *Associate Professor and J. Armand Bombardier Chair in Sustainable Transportation, UBC School of Community and Regional Planning w*as the academic supervisor of this project. Thank you for your guidance throughout the process and for pushing me to stretch my limits.

Dr. Stephanie Chang, *Associate Professor and Canada Research Chair in Disaster Management and Urban Sustainability, UBC School of Community and Regional Planning* was the second academic advisor on this thesis and provided valuable statistical advice.

Dr. Heather McKay, *Associate Professor of Family Practice, Department of Orthopaedics, UBC Faculty of Medicine* and **Dr. P.J. Naylor** are the co-investigators on the Action Schools! BC research program who provided the research opportunity. Dr. McKay also acted as the external examiner for this thesis.

The Canadian Institutes of Health Research for funding the Action Schools! BC research program, including distribution of the children's travel surveys.

Dr. Jim Sallis, *Professor of Psychology, San Diego State University* for providing feedback on the travel survey and access to the computerized Micro-Scale Survey through the Neighbourhood Quality of Life Study (NQLS).

Ms. Sharon Storoschuck, Research Coordinator and **Ms. Deetria Egeli**, Research Assistant at the UBC Bone Health Research Group for their extensive work coordinating administration of the travel surveys.

Ms. Kelli Cain, Project Manager, Neighbourhood Quality of Life Study for assistance in installing and using the Micro-Scale Survey and GPS equipment.

Ms. Karen Zeller, Administrator, UBC Centre for Human Settlements for her assistance with numerous administrative tasks.

Dr. Kathleen Kern, Community Planner, City of Vancouver for training the evaluators on the use of the Micro-Scale Survey.

The SCARP students in **PLAN 581** the many days spent evaluating the built environment at each of the elementary schools; **Eric Doherty, Peter Giles, Eric Grant, Ugo Lachappelle, Haley Mousseau, Ren Thomas, and Lee Chan**

All of the **elementary school students, their parents, teachers, and school administrators** for agreeing to participate in the research program.

Ms. Juxin Liu, PhD. Candidate, UBC Department of Statistics for providing advice on the data analysis.

Financial support was provided by the Government of Canada through the Social Sciences and Humanities Research Council (SSHRC) and by the University of British Columbia.

Special thanks to my parents for a lifetime of love and support,
for encouraging me to follow my dreams, and for letting me walk to school.

And to Vic - thank you for listening, and for the photos of Mississauga!

CHAPTER 1: INTRODUCTION

"If we can build a successful city for children we will have
a successful city for all people."

Enrique Peñalosa, former mayor of Bogotá, Colombia

Gilbert and O'Brien, 2005, p.5

1.1 Current Trends

How children travel to school is an issue of increasing interest to researchers, educators, parents, health professionals, and policy-makers. This interest parallels concern over the negative impacts of traffic congestion, air pollution, and declining levels of physical activity among people of all ages. But there are many reasons why children's travel, and travel to places where children congregate (such as schools and community centres) deserves specific attention. This study focuses on how children travel to school, and explores various factors that influence their mode choice decisions.

Evidence suggests that children across the developed world are spending more time in cars and fewer are walking to school than 30 to 40 years ago.[1] Although national travel data are scarce in Canada, figures from some regional surveys corroborate this trend. In the Greater Toronto Area (GTA) between 1986 and 2001, the number of week-day car trips taken per child increased by 83%, while their parents' trips only increased by 11%.[2] The 2004 Trip Diary Survey in Greater Vancouver confirms that children between the ages of 5 and 12 travel as automobile passengers nearly 70% of the time, with walking and cycling accounting for 30% of their trips.[3] (Note that both these studies account for *all* children's trips, not just the journey to school). A national study conducted by Go for Green in 1998 indicated that nearly one in three children walks to school, although the survey of 1501 adults included only 429 with school-aged children.[4] The same study found that 43% of children use a school bus; since school boards generally set a minimum threshold distance for providing bus service this suggests that large school catchment areas[a] are

a A school catchment area is a geographic boundary drawn around a school and from within which most students attending the school are drawn.

contributing to decreased walking to school.

Specific data on walking to school are more readily available outside of Canada. In the United States the proportion of children walking to school decreased from 48% in 1969[5] to only 15% in 2000.[6] In Great Britain, the proportion of children being driven to school increased from 16% to 29% between 1989 and 1999.[7] In Melbourne and Perth, Australia, 60% of children travel to school by private car.[8] Part of this trend is influenced by the increasing size of school catchment areas, which mean longer average distances to school and thus greater difficulty for children to walk.[9] However American children living close to school are also walking less. In 1969, 90% of children living less than 1 mile from school walked to school - by 2000 this number had dropped to only 30%.[10] Statistics grouped by distance to school in Canada are somewhat more promising; the Go for Green study estimated that 86% of Canadian children living within 1 kilometre, and 50% of those within 1-3 kilometres of their school will walk “most of the time”.[11]

1.2 Why Walk?

Physical Activity and Health: Sedentary lifestyles[12] - and in particular time spent in cars[13] – are closely linked to increased risks of becoming overweight or obese. Excess body weight and physical inactivity (regardless of body weight) are both associated with health risks such as chronic heart disease, hypertension, diabetes, osteoporosis, and some forms of cancer.[14] Obese children are more likely than their average-weight peers to develop hypertension, glucose intolerance, and orthopedic complications; they face greater challenges of social acceptance, and are likely to remain obese as adults.[15] Physical activity is decreasing among Canadians of all ages[16] and observed rates of overweight and obesity doubled among Canadian children between 1981 and1996.[17] In response, encouraging children to exercise more has become a major public health concern and walking to school is an important source and regular source of this exercise.

Research has demonstrated that children who walk to school accumulate higher levels of physical activity than their counterparts who are driven.[18] It is unclear whether walking to school by itself is enough to attenuate body weight,[19] but after excluding the journey to school as a source of exercise, children who walk to school are found to remain more active throughout the day than their peers who are driven.[20] Measured with accelerometers,[b] children expend nearly as much energy while walking as while playing team sports; moreover, walking to school accumulates significantly more minutes of exercise per week than typically scheduled physical education periods.[21] The early establishment of an active lifestyle helps children to maintain healthy body weights, and avoid chronic health problems associated with obesity and sedentary lifestyles later in life.[22]

Traffic and Pollution: As more parents choose to drive their children to school, school zones are becoming high-traffic areas with increased probability of accidents. The Insurance Corporation of British Columbia (ICBC) estimates that 20-25% of traffic in morning peak-periods are related to travel to and from schools.[23] Parked cars reduce visibility for and of children, making it hazardous for them to cross at intersections and increasing the chance they will not be seen running between parked cars.[24] School administrators have cited reducing the number of vehicles around schools as the most important reason to encourage students to walk or cycle to school.[25]

Pollution is also problematic and idling vehicles increase concentrations of priority pollutants such as particulate matter and ground level ozone within the immediate vicinity of the school yards. Concentrations of benzene and carbon monoxide inside cars can be many times higher than those on the sidewalk.[26] The Canadian Institute of Health highlights children's special vulnerability because they inhale more air per unit of body weight than adults, have narrower airways, and because environmental toxicants can interfere with the chemical messengers involved in growth.[27] Elevated levels of air pollution are significant contributors to both acute and chronic respiratory problems such as asthma that result in lost days of school for children and significant costs to Canada's public health care system.[28] Trips to school are generally "short trips", which are considered to produce more pollution per travel distance than longer ones;[29] short trips are prime candidates for non-

b An accelerometer is a small device worn on a belt that monitors the intensity of an individual's physical activity (except for swimming) on a minute by minute basis.

motorized transportation modes and thus are an important target for reducing overall traffic demand.

Child Development: Finally, walking is an important part of the intellectual and psychological development of children.[30] Walking in their neighbourhood, including to school, is a key opportunity for children to explore and learn confidence, to practice learned safety skills, to develop cognitive mapping skills, and to experience independence.[31] In one example, children who traveled primarily by car demonstrated a poorer perception of distances and the placement of key destinations relative to one another than their peers who walked to school.[32] Walking to school may contribute to a stronger sense of community which has been associated with lower rates of drug use and petty crime.[33] Moreover, walking to school is a good start to developing life-long habits of physical activity and transportation choice.[34] If our society wishes to reduce traffic congestion, foster a healthy population, and address issues of air pollution and climate change, it is essential that our children be exposed to transportation alternatives at an early age.[35] If walking to school develops into life-long walking habits, even a 10-20% shift in modal split for home to school trips could have significant benefit for society in both the short and long-term.

Recognizing the importance of children being able to walk to school, school districts in both Canada and the United States have adopted programs such as “Active and Safe Routes to School” (Ontario), “Way to Go!” (British Columbia), and “Safe Routes to School” (US). In Canada the programs receive little to no funding from government and are facilitated primarily by non-profit organizations in partnership with school boards and community associations. Programs focus on social-marketing strategies - providing curriculum-related materials to teach traffic safety and appropriate route selection. Programs also include intra- and inter-school competitions to see which group can accumulate the most distance walked, “walking school buses” led by parent chaperones, neighbourhood mapping exercises, and restrictions on parking within a certain radius surrounding the school.[36] Programs in the United States receive state and federal funding for a combination of social-marketing strategies (such as those used in Canada) and improvements to the physical pedestrian infrastructure in the vicinity of schools. In 2005 the U.S. Congress passed legislation called SAFET-LU that includes $612 million over 4 years. Seventy to ninety percent of these funds are allocated to infrastructure with the remaining going to student education, public awareness campaigns, traffic law enforcement, and related programs to encourage cycling and walking.[37]

There appear to be two potentially complimentary policy approaches to consider; investment in infrastructure improvements, and/or in social-marketing strategies. Unfortunately, although there is an extensive and growing body of knowledge on adult travel choices,[38] less is understood about the factors that influence children's travel choices[39] which could positively inform such policy decisions. Research has demonstrated that adults tend to walk more in neighbourhoods with high population densities, interconnected street networks, a diverse mix of land uses, and more commerical destinations overall.[40] The small existing body of research on children's travel suggests that these factors are *not* influential on the journey to school, but results are somewhat contradictory and explorations of alternative influencing factors are limited.[41] In addition, the studies on children are concentrated in the southern United States and no empirical research has been conducted on the topic in Canada. It is hoped that an improved understanding of these influences will contribute to more informed policy decisions and better program design to achieve desired walk to school objectives.

1.3 Research Objectives and Hypotheses

The primary objective of this study is to better understand the factors influencing a child's mode of travel to school. Existing research on urban form associations with children's travel, and travel to school in particular, is inconclusive. Some studies show that macro-scale built environment features of density, street connectivity, and land use mix are important predictors of the total amount that children will walk. Others focusing specifically on the trip to school find these predictors *not* to be significant. The current study focuses on the child's trip to school by examining the influence of micro-scale pedestrian environment. Micro-scale characteristics are those measured at the street-scale such as number of lanes, presence of sidewalks, intersection and crosswalk controls, and traffic calming measures. Recognizing the importance of non-infrastructural issues, this study also explores personal perceptions of safety while walking to school, distance between home and school, and demographic factors such as income and vehicle ownership.

Specifically, this study asks the following four questions:

1) To what degree does an index of selected micro-scale features of the pedestrian environment influence whether or not a child regularly uses a non-motorized form of travel to get to school?

2) To what degree does parental perception of neighbourhood safety (from traffic and crime) influence whether or not a child regularly uses a non-motorized form of travel to get to school?

3) To what degree are measures of the pedestrian environment associated with the distance between a child's home and their school?

4) To what degree do micro-scale features of the pedestrian environment and distance between home and school influence parental perceptions of safety for their child walking to school?

Based on previous studies, it is hypothesized that children with high-quality pedestrian environments on their route to school will be significantly more likely to walk than those with low-quality pedestrian environments along their route to school. However, it is suspected that this positive relationship between walking and pedestrian environments will be moderated by the influences of:

a) travel distance (with the likelihood of walking decreasing as distance increases);

b) household income (with the likelihood of walking decreasing as household income increases);

c) household vehicle ownership (with the likelihood of walking decreasing as the number of household vehicles increases), and

d) parental perception of safety (with increased perception of risk associated with decreased likelihood of walking).

The perceived relative convenience of different travel modes is likely also an influence, although this was not measured directly in this study. It was also suspected that pedestrian environment scores would be associated with distance between home and school, with children living closer to school having higher (better) pedestrian environment scores than those living farther away.

Finally, it was hypothesized that there would be an inverse relationship between parental perceptions of safety and the pedestrian environment scores, with higher (better) pedestrian environment scores associated with lower levels of concern over safety risks.

Methodological Approach

This study applies a cross-sectional reasearch design to evaluate the influence of the pedestrian environment and perceptions of safety on children's walking to school while controlling for socio-economic factors and distance between home and school. The micro-scale pedestrian environment was measured using a standardized tool designed for the Neighbourhood Quality of Life Study (NQLS), a collaborative research project based at San Diego University.[42] It has been used only once for surveys in Washington State and the results of the NQLS micro-scale evaluation have not yet been published. This research is unique in the tactic of assigning a specific assumed route between home and school for each child participating the study, and then quantitatively evaluating the pedestrian-friendliness of each unique route. Previous research has focused on the attributes across the area in which the trip takes place but none have isolated specific trip routes for analysis. Thus two methodological questions became integral to the purpose of the research:

1) Is this micro-scale pedestrian environment survey an effective tool for measurement in the Greater Vancouver area?

2) Can the data collected using this measurement tool provide sufficient detail to integrate with the route-specific methodology applied in this study?

It is hypothesized that the measurement tool would provide a quality of data sufficient to answer the primary research questions but that the study would produce recommendations for improvements and refinements in subsequent applications of the methodology.

1.4 Project Outline

This thesis contains 6 chapters. Chapter 1, which you have just read, provided background on international trends in children's travel to school patterns, highlighted the benefits of increasing the number of children walking to school, and presented the research objectives and hypotheses. Subsequent chapters are each described briefly below:

Chapter 2 outlines current theoretical models of travel choice among adults, and highlights specific factors known to influence modal choice decisions. Validation is provided for the selection of each of the pedestrian environment, demographic, and perceptual factors selected for detailed analysis in this study.

Chapter 3 details the methods used in the data collection and statistical analysis of data. Methods are described within the theoretical and practical context of current best practices for data collection.

Chapter 4 describes each of the schools selected for participation in the study, based on data obtained through surveys of children and their parents, and surveys of pedestrian environment characteristics surrounding the schools.

Chapter 5 describes the inferential statistical analysis undertaken to answer the four primary quantitative questions posed in section 1.3.

Chapter 6 discusses this author's interpretation of the study results including possible explanations for unexpected outcomes, a review of how the outcomes may have been affected by the study methodology, and recommendations are made for further research. This chapter concludes with a discussion of the policy implications arising from this study.

CHAPTER 2: REVIEW OF CURRENT LITERATURE

"...the large number of variables (almost 200) used in the instruments to capture environmental factors...indicates a lack of knowledge about the effect of single variables on walking and bicycling."

Moudon and Lee, 2003

2.1 Theoretical Context

It is widely recognized that transportation is a derived demand; people travel to accomplish tasks and participate in activities, rarely for the sake of travel itself.[1] Models explaining personal transportation choices are traditionally based in micro-economic theory that assumes individuals seek to maximize their own personal utility for any particular trip.[2] Personal utility is defined through a cost-benefit equation where pecuniary (monetary) costs and non-monetary costs such as time and effort are balanced against the anticipated benefits of the activity at the intended destination.[3] Such costs are perceived by the individual decision-maker in different ways. For example, the decision to make a trip may be heavily influenced by that specific trip's (relatively low) marginal monetary costs (e.g. the cost of gas and parking), even though the true cost of the trip is actually much higher after considering the fixed or sunken costs of vehicle purchase and maintenance.[4] In this way travel decision-making is also hierarchical; the decision to accept the sunken costs of car ownership is made only once compared to numerous daily decisions over marginal costs.[5] Once the vehicle purchase cost is accepted, an individual is predisposed to accept the comparatively small marginal costs associated with each trip. Transportation decisions also inherently include both sunken and marginal social costs such as the waste associated with vehicle production, traffic congestion and air pollution but these are generally externalized in both theoretical and practical applications.

Non-monetary costs of transportation include travel time, comfort, and convenience (relative to not taking the trip). Difference in trip time is thought to be one of the most important factors in mode choice, with longer trip times representing lost opportunities to engage in other activities.[6] Benefits include the pleasure or utility derived from the destination activity, particularly in contrast to the (assumed lesser) benefit of alternatives to the journey, or not taking a trip at all. Utility theory assumes that individuals make rational decisions based on an awareness of and access to the full range of alternatives,[7] although this may not actually be the case.

In the context of utility theory, a child's trip to school is particularly complex because of its interrelationship with travel demands of their parent. The perceived relative costs of different travel modes must consider the schedules and destinations of at least two individuals. Travel to school frequently becomes part of a complex trip-chain of sequential origins and destinations. Higher order hierarchical decisions such as how (or if) the parents travel to work will in turn influence the available mode choice options for the child's trip. For example, the incremental cost of driving a child to school en route to work is negligible after accepting the sunken costs of vehicle ownership and the incremental costs of the parent's trip to work. In contrast a multi-modal trip chain of walking with a child to school, then returning home (by foot) before driving to work incurs significant decreases in utility due to the additional time costs (which will vary depending on the home to school distance).

The nature of the transportation system acts as a mediator between destinations by increasing or decreasing the net utility of various trips and their associated mode choices.[8] For example, transit systems providing frequent and rapid service may increase the perceived utility of public transit, whereas infrequent, poorly connected services will increase the attractiveness of the personal automobile. Similarly, elements of the built environment such as population density or the presence of sidewalks may alter the utility of non-motorized forms of travel (as discussed further in this chapter).

In contrast to utility theory, ecological models of behaviour[9] or behavioural models of the environment[10] do not explain behaviour as rational cost-benefit comparison among alternatives. Instead, they recognize choices in terms of individuals' internal influencing factors, social environments, and external influences such as the built and natural environments and institutional/ organizational structures.[11] Ecological models recognize a complex set of interacting influences beyond explicit costs and benefits. They recognize that behavioural influences are multi-layered, composed of physical settings (weather and built form), organizations, socio-demographic and socio-cultural environments, and the availability of social supports[12] and that effecting change requires multi-disciplinary strategies customized to each layer.[13]

A segue between transportation theorists and ecological models of behaviour has come via the discipline of public health (where ecological models are commonly used), and shared desires to increase walking and cycling for physical activity and community transportation benefits.[14] The link with transportation planning has increased the emphasis on built-environment aspects of physical activity, while the behavioural models have expanded how transportation researchers view travel choice. Moudon and Lee[15] define three categories of determinants in choosing non-motorized forms of travel. Described in the context of children's travel to school, these are:

1. **Intra- and inter-personal factors.** It is widely recognized that socio-demographic factors of income and vehicle ownership have the strongest influence on travel mode choice.[15] Other factors are wide-ranging and include the child's level of cognitive development and their ability to deal with risks, accepted norms among the peer groups of the child and parent, the physical fitness level of the child, preferred travel modes, perceived convenience of alternative travel modes, the degree to which the school administration encourages walking and cycling, local and provincial restrictions on vehicular activity in school zones, and school board policies on providing bussing.

2. **Environmental factors** are sub-divided into three components of a trip.
   - *Origin and Destination*: availability of bike racks, changing areas, parking and/or drop-off facilities, school-yard supervision before and after school,
   - *Route*: distance and directness of route, street type and design, proximity between pedestrian/cyclist space and vehicular space, traffic controls within

school zones, presence of other children walking, presence of other road users (all modes)

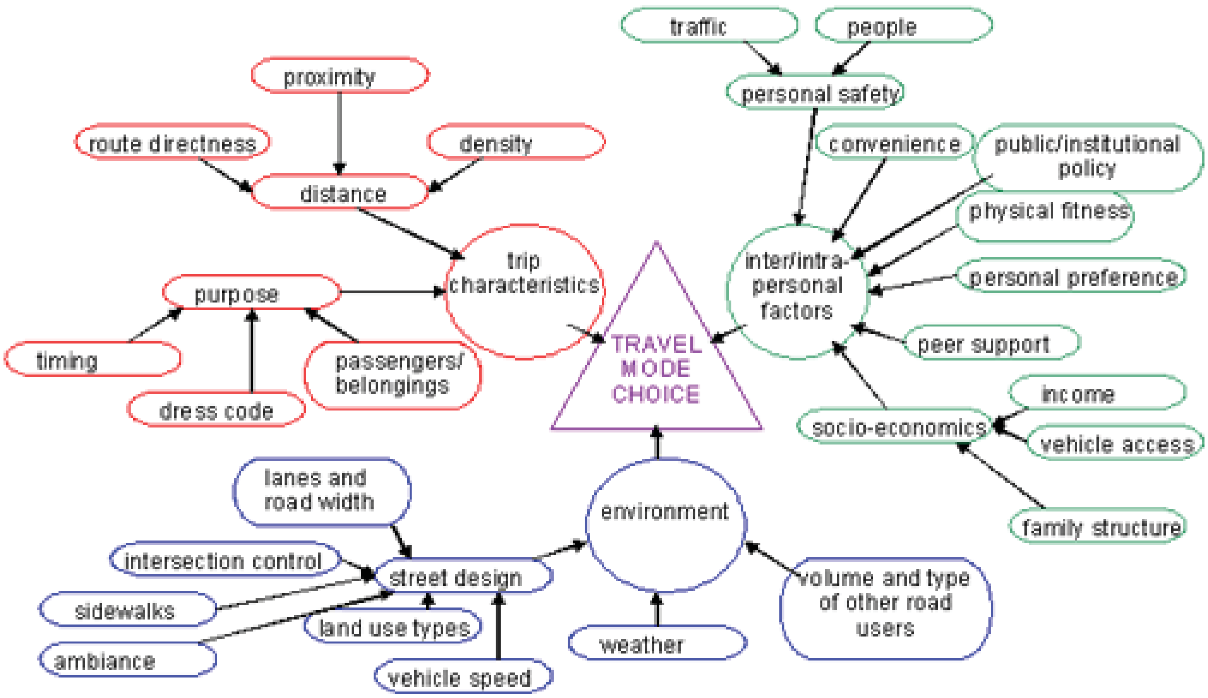
- *Overall Area*: density, land-use and street connectivity (which combine to heavily influence distance), climate and weather, the number of other road users of different modes

3. **Trip characteristics** including single-purpose trip versus a trip chain, purpose and timing of other trips within the same trip-chain, the distance between home and school, activities taking place at the school influencing equipment to be taken (special sports days, large school projects, field trips), requirements for transportation and/or equipment at other parts of the trip chain.

It should be noted that the environmental factors in this model are extremely disaggregate; in a review of 31 pedestrian environment audit instruments, Moudon and Lee[16] found over 200 discrete measures considered to influence the use of non-motorized travel. More evidence is clearly needed to understand the built environment component of the ecological model.

The three components of a journey (described under "environmental factors" above) are not only useful in considering environmental variables, but are also a valid way to categorize the inter-/intra-personal factors and trip characteristics. Any trip's origin and destination are fundamentally affected by personal preferences which determine the purpose of the trip, the best location for that purpose (e.g. the grocery store with the lowest prices), and whether the trip will be taken at all. The trip destination and trip purpose interact to influence the type of clothing to be worn, belongings or other people who must be transported, and the length of stay at the destination. Moreover, recent evidence in the literature makes it clear that personal preferences influence residential location choice which underpins travel behaviour.[17] All elements of a trip's route or the area in which it takes place are viewed through the individual's personal perceptions and threshold tolerances for safety, enjoyment, weather, and convenience. Figure 2.1 illustrates this author's conception of an ecological model of travel choice with specific reference to the variables considered in the current study.

Figure 2.1 Ecological Model of Travel Choice



It is important to remember that these theories of travel behaviour are based on adult-centric research. However, parents do play a strong role in travel choices of their children, particularly younger children still in elementary school[18], thus the categories of factors in the ecological model are likely also applicable to children's travel. Children's particular vulnerabilities of age, physical size, and cognitive skills, their differing range of desirable destinations, and comparatively low levels of independence give reason to believe there will be differing degrees of influence from the multiple variables within the model.

Ecological models of behaviour are beneficial in recognizing the multiplicity of interacting influences that contribute to travel behaviour and transportation mode choice. Although it is important to recognize this diversity of factors it is next to impossible to measure and analyze them all within one research project. The remainder of this chapter identifies specific factors selected for consideration in the current study and reviews the existing literature on relationships between them, travel choice in general, and the travel choices of children in particular.

2.2 Exploring Existing Evidence

An extensive literature review revealed 12 studies that specifically examined mode of travel to school, although several others examined other aspects of the journey to school such as physical activity benefits[19] and school age and catchment area size.[20] The growing interest in this topic is evidenced by the fact that more than half of these were published within the past 2 years.

Of the identified studies, 7 were conducted in the United States (South and North Carolina, Florida, and California); 3 are from Australia and 1 from the U.K. The majority of these utilized cross-sectional travel mode data provided at one point in time through parent and child surveys administered through schools.[21] In one case researchers drew data from local and federal trip diary data,[22] another visually observed the mode by which children arrived at participating schools[23], and a third relied on hand-count data provided by teachers.[24] Most studies used the school as the unit of analysis and used local averages for demographic data. At least three studies were able to link travel mode choice and independent variables on a case by case basis.

Independent variable data were obtained from a variety of sources including:

- U.S. Census (density and intersections per street mile[25]);
- State department of education or local school board data (school size, percent of students on public welfare, and ethnic background[26]; school urbanization levels and percent students with lunch subsidies[27]; school enrollment data[28]);
- Local and state transportation modeling systems (density of residents and jobs, population-employment balance, job mix[29]);
- Local property assessment databases (commercial floor-area ratio[30]);
- County bicycle and pedestrian level of service database (proportion of street miles with street trees, bike lanes/paved shoulders, and/or sidewalks, average sidewalk width[31]);
- Responses from direct surveys or state/local travel survey data (reasons for travel mode

and reasons not to walk[32]; socioeconomic data[33]), and

- Direct observation (pedestrian counts, vehicle flows, and micro-scale urban form[34]).

Two of these studies are of sufficient importance to describe their research methods in further detail at this time. The first, conducted in Gainsville, Florida by Ewing, Schroeer and Green,[35] examined the most comprehensive set of independent variables of any children's travel study published to date. It is also the only study that utilized behavioural data from regional travel surveys instead of relying on school-based study populations, thus obtaining data from a more random and representative sample of neighbourhoods. Seven hundred and nine journeys to school by children Kindergarten to grade 12 were identified from a combined database of the Florida Department of Transportation (FDOT) and Gainsville Metropolitan Transportation Planning Organization (MTPO) trip diary surveys. Survey responses indicated the transportation analysis zone (TAZ)[a] of their origin and destination locations, from which trip time and trip distance were estimated. Respondents also indicated the size of their household, number of household motor vehicles, annual household income, and whether the student had a driver's license. Macro-scale built environment data included density of people and jobs, jobs-housing balance, and the mix of available jobs (industrial, commercial, or service). Property assessment data provided intensity of pedestrian-oriented commercial development, and county roads data indicated the presence of street trees, bikes lanes/paved shoulders, and sidewalks – all averaged by TAZ. Analysis was conducted using multi-nomial and nested logit mode choice models. An important limitation of this study was that only a very small proportion of trips to school were by active mode (4.5% walked and 3.4% bicycled).

The second significant study evaluated infrastructure improvements made under the Safe Routes to School program in California and has been analyzed from two different perspectives.[36] Student participants were recruited from 10 schools across the state where changes had been made to pedestrian infrastructure over the past year. In the first

a TAZ's are regionally designated polygons roughly equivalent to census tracts and are commonly used in transportation demand modeling in the United States. TAZ' in urban centres are often quite small such as city block due to the concentration of trip-ends in these locations. Trips are characterized by the TAZ's in which they begin and end; the system implicitly excludes trips that originate and end within the same TAZ.

analysis[37], researchers conducted direct observations of site-specific traffic conditions before and after installation of infrastructure improvements. The analysis found that children walking to school were likely to use the improved infrastructure, and that pedestrian risk was decreased due to separation from traffic and increased driver courtesy at crosswalks. The second analysis[38] used cross-sectional survey data on children's mode of travel to school, comparing children whose routes to school were or were not affected by the new infrastructure. Retrospective questions asked parents whether their children walked or biked to school more often after the improvements than before. This study could not conduct a regression analysis to determine the relative impact of specific factors because the type of improvements varied from school to school; projects included replacing stop signs with lights, closing gaps in sidewalk networks, and installing pedestrian/bicycle crossing lights. The outcomes of this study actually showed a net decrease in the number of children walking. Eighteen percent of parents stated their child walked or bicycled less after the project while only 10% indicated their child walked more; 71.5% stated their child's walking or cycling remained the same. However, 15.4% of children whose route to school had been affected by the new infrastructure reported an increase in walking while only 4.3% of those not affected by the improvements increased how much they walked. The proportion of children who reported walking or bicycling less was equally divided between the two groups, suggesting that decreases in walking were unrelated to the infrastructure improvements.

The remainder of this chapter describes current knowledge of the factors influencing mode choice. Results from all 12 children's travel studies are described as relevant to the individual variables discussed. Following the ecological model of behaviour, intra- and inter-personal variables are presented first, followed by environmental factors and trip characteristics.

2.3 Intra- and Inter-Personal Factors

2.3.1 Socioeconomic Status and Access to Vehicles

Numerous studies have demonstrated a significant link between household income and travel choices to the extent that income is the most common variable to be controlled for in travel behaviour studies. Adults living in lower income households tend to walk and use public transit more than those with higher incomes,[39] and children in such households follow the same trend.[40] Household income is not always available but higher rates of walking have also been found at schools with a higher proportion of students on welfare,[41] and at public schools compared to private schools.[42] (The relationship to private schools may be confounded by larger average travel distances.)

This income-travel choice relationship is largely due to the high cost of owning and operating a private vehicle. Lower income households own fewer vehicles (on average) than those of higher income and thus their transportation choices are more often restricted to alternatives other than single-occupant vehicles. Vehicle ownership rates can be influenced by factors other than than income, for example the number of licensed drivers or personal preferences for other travel modes. Regardless of the reason, less vehicle access is likely to increase rates of walking. In the literature, children's travel modes are more strongly connected to household vehicle ownership than to income, and many studies have found this to be the strongest influence on mode of travel to school.[43] In Melbourne, Australia 5-6 year old girls in households with 2 or more cars were 70% less likely to walk or cycle regularly (3 or more times per week) than their counterparts in families with one or no cars.[44] In Gainsville, Florida, Ewing et al. found that the probability of walking decreased by a factor of -1.16 with additional vehicles per member of household, while the change with respect to household income was only -0.84 regardless of vehicle ownership.[45] That study's authors suggest that the variables of household income and per person vehicle ownership "individually and together may have a strong enough influence on mode choice to overwhelm other factors favouring walking trips, such as short distance to and from school".[46]

Although children of low-income parents may be more likely to walk overall, a British study found that mothers without the pressure of paid work are more likely to walk to school with their child rather than drive.[47] This suggests that the presence of non-working adults in the household may be a more important predictor of walking to school, at least among higher-income groups.

2.3.2 Perceptions of Safety from Traffic and Safety from Strangers

Parents' concerns about the physical safety of their children are not without reason. It is thought that children younger than 10 or 11 lack the cognitive abilities to anticipate risk and make complex decisions – particularly those involving vehicle speed and distance, but also potentially regarding other risks.[48] Children have shorter attention spans than adults, are easily distracted, and are less able to follow instructions consistently. Finally, children travel to school during peak traffic periods and the growing number of children being driven has increased traffic volumes and congestion in the immediate vicinity of elementary schools. This combination of factors contributes to making pedestrian and cycling accidents a leading cause of death and hospitalization among school-age children in North America, the U.K., and Australia.[49] It is not a coincidence that a high proportion of these deaths occur on the way to and from school. Safety from traffic is associated with the nature of the pedestrian environment (as discussed in section 2.4), but pedestrian injuries have also been linked to neighbourhoods with higher unemployment, fewer high-income households (perhaps because there are fewer cars per person), and higher traffic volumes.[50]

Whether a real or perceived threat, it is generally believed that children are less likely to walk if their parents perceive the nature and volume of traffic to be dangerous on the child's route to school.[51] Although most of a route may be reasonably safe, the presence of one or more major street crossings can be enough to discourage walking or cycling.[52] In one cognitive mapping exercise, children's understanding and perceptions of their surroundings were negatively affected by the presence of high-volume, high-speed traffic which may increase the barriers to walking safely.[53]

Although the likelihood of child abduction is much lower than traffic injury, safety from strangers is an important and growing concern, with parents perceiving the outcome of abduction or assault as being “vastly more hideous” than the consequences of a car accident.[54] In some surveys, fear of abduction ranked as the most or second-most (after traffic) frequently cited reason for parents driving their children to school.[55] The U.S. Centre for Disease Control (CDC) found that fear of traffic or abduction was much higher among parents of elementary school children than of high school children, although other barriers ranked about the same between the two groups.[56] A few studies have referenced safety from bullies as a parental concern regarding walking to school, but no relationship has been quantified.[57]

A multi-disciplinary literature review found a diverse body of research linking fears of personal safety to decreased physical activity levels and prevalence of obesity.[58] However, the same review revealed research with contradictory conclusions, and a diversity of metrics to measure response variables and define safety that make it difficult to draw definitive conclusions. Finally, most (but not all) of the studies reviewed focused on adults.

The most comprehensive study found examining perceptions of safety and children’s travel choices was conducted by Timperio et al. in Melbourne, Australia.[59] “Stranger danger” was found to be a significant influence on both boys and girls walking to destinations in their neighbourhoods, with slightly more concern indicated from parents of girls (compared to boys) and parents of 5-6 year olds (compared to 10-12 year olds). A lack of signalized crossings was a significant influence for boys while having to cross “several roads” to access play areas was significant for girls. A more general statement regarding road safety in the area was not significant for either. Fewer than half as many children indicated concern about strangers and traffic than adults, although perceptions of personal safety, and opinions about their parents’ perceptions were both found to be significant influences.

2.4 Environmental Factors

The built environment or urban form component of travel behaviour models is the subject of a significant and growing body of research. The subjects of these studies are individual people who have pre-selected a place to live for a variety of reasons, making it more difficult to demonstrate causality between urban form and travel behaviour.[60] It is nonetheless possible to quantify the strength and direction of relationships and to identify trends across neighbourhoods of similar design. The majority of studies have examined macro-scale elements of the built environment (measured on an area-wide basis), while others have focused on micro-scale elements that influence the safety and ambiance of specific routes. Clusters of characteristics have emerged as contributing to increased levels of walking and cycling; neighbourhoods that exhibit these characteristics are labeled “walkable” and the measured degree to which the characteristics are present is called “walkability”.[61] While rates for walking for exercise are similar in walkable and unwalkable communities, overall physical activity has been found to be higher due to walking for transportation purposes.[62] The following paragraphs describe which attributes at the macro- and micro-scales of measurement contribute to enhancing walkability and increasing walking activity.

2.4.1 Macro-Scale Elements

A significant body of evidence links *adult* travel and physical activity to macro-scale elements of the built environment. It has been found that even after controlling for income, individuals living in higher-density communities with well-connected street networks and a diverse mix of land uses are more likely to choose non-motorized forms of transportation for their daily trips.[63] Although levels of physical activity for exercise are often similar between walkable and unwalkable communities, walking for transportation significantly increases the total amount of exercise of people living in walkable neighbourhoods.[64] The primary reason for this relationship is thought to be the effect on distance. Distance (discussed further in section 2.4.2), is perhaps the most important limiting factor in the choice to use non-motorized forms of travel. A diversity of land uses in close proximity increases the potential number of destinations within a reasonable walking radius. The viability of retail services for day to day needs is linked to the population in close proximity, thus higher population densities are required to support land use diversity.

The third macro-scale aspect of walkability is street connectivity. Highly interconnected street networks with short blocks and grid-pattern design enable more direct routes between origins and destinations. This minimizes the difference between straight-line distance and the street network (walking path) distance.[65] Grid street networks also increase route choice, giving pedestrians and cyclists the opportunity to travel on lower-traffic streets without appreciably increasing the distance of their trip.

Figure 2.2 illustrates the difference between street network and straight line distances in two of the school catchment areas used in this study.

Figure 2.2 Street Network Versus Straight Line Distances

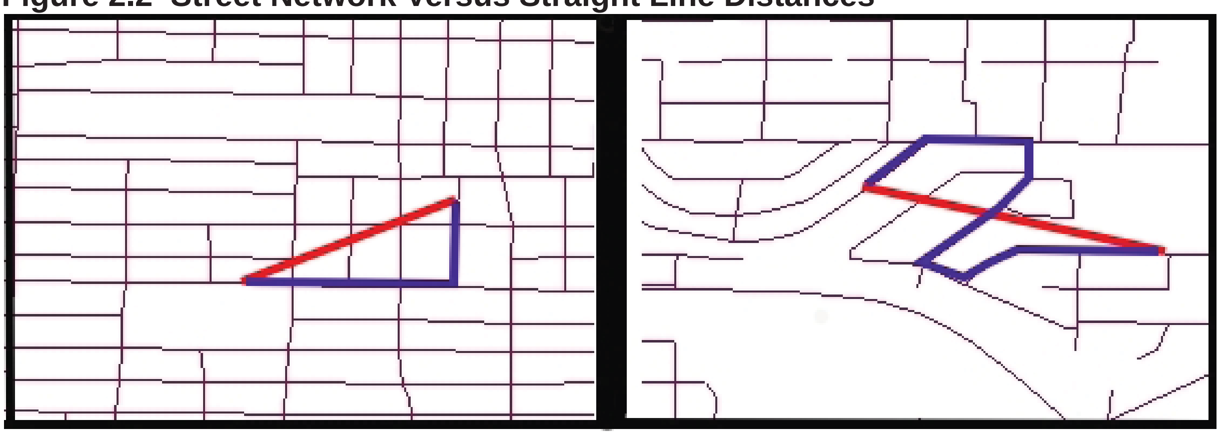


Image A: Grid Pattern (Walter Moberly)
Straight Line (red): 500 metres
Street Network (blue): 700 metres
Distance Ratio: 1.4

Image B: Curvilinear Street Pattern (Boundary)
Straight Line (red): 500 metres
Street Network (blue): 1200 metres
Distance Ratio: 2.4

The body of literature on children's travel patterns is much less conclusive regarding the influence of the macro-scale built environment. Three studies have examined population density; two of these in relation to children's travel to school[66] and one in relation to walking for all travel purposes.[67] A California study using data aggregated by schools found density was found to be significant.[68] However the Gainsville, Florida study that used unique data for each child found density was not significant at all.[69] The California study also examined intersection density but found it was only significant in pairwise correlations but not in the multiple regression analysis.[70] A third study found that short blocks and mixed land uses had a negative influence on children walking to school, although there was little variance between school sites which reduced the significance of these findings.[71] Evidence on mixed-use is contradictory as other authors (with non-empirical studies) suggest diversity of uses provides important "eyes on the street" and points of refuge for children.[72]

The Gainsville study analyzed macro-scale variables of land use mix, population density, and school size and found none to be influential after controlling for distance.[73] This suggests that population density has an indirect influence on walking rates because of its affect on catchment size as discussed in Section 2.4.2. However, a study in the Atlanta region did find these macro-scale variables to be significant. The study analyzed travel for all purposes among children and youth based on trip-diaries collected through the SMARTRAQ program.[74] Participants fell into one of 4 age-based groups ranging between 5 and 20 years; children living in neighbourhoods with the highest tertiles of intersection density and population density were respectively 1.3 to 2.0 and 1.8 to 3.7 times more likely to report walking at least once during the 2-day survey than those in the lowest tertiles (likelihood varied by age group). The presence of mixed land uses (versus single-use), at least one commercial land use (versus none), and at least one public recreation/open space nearby (versus none) also increased the likelihood that the child would walk.

The Gainsville study's authors speculate that children's journeys to school do not fit typical (i.e. adult) travel choice models because they are mandatory and thus may be less sensitive to variation in the walking environment than discretionary travel. Trips to school, especially for young children, are also less likely to be linked to other errands compared to their parents' trips, reducing the impact of mixed-use development. Although the Atlanta study did find macro-scale variables to be significant, the trip diaries included both discretionary and mandatory trips. Thus the outcome does not refute the hypothesis that school-trips are not significantly affected by macro-scale urban form variables.

A third hypothesis is that the mandatory trips to school are more influenced by micro-scale characteristics measured at the street-scale rather than the neighbourhood scale. It may also be that non-infrastructure factors such as perceived safety (as discussed in section 2.3) are more influential, and/or that urban form's influence on perception of safety indirectly affects travel choice. It is these hypotheses that the current study is designed to test.

2.4.2 Distance

In the ecological model of behaviour, absolute travel distance is considered a "trip characteristic" rather than a component of the built environment. However, the clear relationship between distance and macro-scale variables just described makes it appropriate to discuss distance at this point. Distance is frequently cited among the most important barriers to walking for transportation for all trips and all ages.[75] In a Canadian survey, 47% of respondents cited distance as a barrier to walking, with time (directly related to distance) being the second-most frequently cited at 19%.[76] National studies in Canada[77] and the US[78] found distance to be the most frequently cited barrier to children walking to school (mentioned by 55% and 53% of parents respectively). Second most common were weather (11% among Canadian parents) and traffic danger (40% among American parents). The Canadian study found that 86% of children living within 1 km from school walked "most of the time", compared to only 36% among all children. Only 5% of those living greater than 3 km walk to school.[79] Results of empirical studies also indicate that distance is a significant predictor of whether or not children will walk to school.[80]

Density and connectivity interact with the policy decisions of local school boards that determine the size of schools (i.e. number of students) and the school catchment area

– the geographic boundary from within which most students are drawn. Holding school populations equal, catchment areas are smaller in high-density than in low-density neighbourhoods. Special programs such as French immersion draw students from outside the standard catchment area and increase the average travel distance for children at that school. There is an emerging trend, at least in the United States, of systematic increases in school sizes[81], and increasing school size has been correlated with fewer children walking.[82] However, school enrollment does not seem to be significant after controlling for distance.[83]

Opinion is varied on a clear threshold distance above which walking to school drops dramatically. Gilbert and O'Brien[84] suggest that children's common destinations (schools, parks, etc.) should be located within 2 km of their homes. Go for Green found 86% of Canadian children living less than 1km from school walked, a statistic that dropped to only 50% for those within 1-3km, and only 5% of those living greater than 3km away.[85] Finally, a study of compact urban areas in Britain found that the probability of being driven to school by automobile was 20% for children living less than half a mile (800 metres) from school, increasing to 50% for those living 1.25 miles (2km), and 80% at 2 miles (3.2km).[86]

However, it seems that if a threshold distance does exist, it has decreased significantly in recent decades. It is estimated that in 2001, 31% of American children aged 5 to 15 years living within 1 mile of school walked or biked[87], while the equivalent figure in 1969 was 90%.[88] A South Carolina study indicates an increase in the use of hazard busing – i.e. school bus transportation provided to students living close to the school but who encounter barriers such as highways en route.[89] It is probable that other factors such as two income households (fewer parents available to walk with children to school), heavier traffic volumes, a less pedestrian-friendly environment, and increased perceptions of risk from strangers are mitigating the maximum acceptable distance.

2.4.3 Micro-Scale Elements

Micro-scale elements of the pedestrian environment include features for safety and comfort (e.g. sidewalks, cross-walks, traffic calming), and contributors to ambiance (street trees and landscaping, street furniture). There is a small base of evidence that such elements influence rates of non-motorized travel,[90] although they have not been incorporated into empirical travel models to the same degree. Demonstrating links independent from macro-scale elements is difficult because built environment features tend to co-vary in space; for example sidewalks and street trees are often found in high-density neighbourhoods with street-oriented retail.[91] Nonetheless, urban micro-scale features are frequently cited in reference to children's travel and pedestrian safety[92]. In the absence of any clear relationships between children's travel and macro-scale measures, it is useful to explore the micro-scale in greater detail.

This study has chosen to focus on a specific sub-set of micro-scale elements, detailed below. These elements were selected based on the frequency with which they are referenced in the literature on children's travel and this author's perception of their association with the safety and attractiveness of walking to school. The primary focus on safety elements follows Ewing, Schroeer and Greene's observation that school trips are non-discretionary and that the presence of street trees is not a significant influence.[93]

Sidewalks

Sidewalks provide a clearly designated space for pedestrians within the road right-of-way. They are frequently (although not always) grade-separated from the road, providing slight added protection from wayward vehicles, and may even be buffered from the road with a planting strip or other landscaped area. It is recommended that a sidewalk or pathway network be continuous between homes and schools, and that the sidewalk be 3-4 metres wide to accommodate young cyclists, and parents with strollers.[94] The presence of sidewalks near homes and schools was the most significant built-environment (macro- or micro-) factor for children walking to school in Gainsville, Florida. Sidewalk construction and closing of gaps were undertaken for 4 of the schools in the California Safe Routes to School evaluation. Observations at 3 of the 4 indicated increased levels of safety (children no longer walking on the road) and slight increases in the numbers of children walking to school.[95] After project construction, the children whose route included improvements were significantly more likely to have increased walking than those children whose route did not.[96]

Intersections

Pedestrian risks from motorized vehicles increase at intersections when they must leave sidewalks and cross vehicular paths. This is particularly true for children whose abilities to judge the speed and intentions of motorized vehicles are not as well developed as adults, whose attention is more easily distracted, and for whom seeing and being seen are more difficult.[97] Ideal cross-walk conditions are described as having minimal width, being well marked on road and with high-visibility signage, preferably with specific pedestrian crossing signals; cross-walks should accommodate all physical abilities by raising the crosswalk to sidewalk level (with a speed table), or providing ramps for strollers and wheeled mobility aids.[98] Barring timed signals, 4-way stops are preferable to 2-way stops or yield signs, marked crosswalk lines or textured pavement preferable to no pavement markings.[99] Cross walk improvements were installed in the Safe Routes to School project described under *sidewalks* (above), but otherwise little empirical data has recorded the efficacy of cross walks in encouraging walking.

Traffic Calming

Vehicle speed is a significant factor in the severity of traffic accidents and influences the probability of accidents through reduced time to see and respond to people or vehicles unexpectedly entering the road.[100] Incremental increases in vehicle speed at the time of crash dramatically increase the severity of pedestrian injuries. Most pedestrians will survive a crash at 15 miles (24 km) per hour with only minor injuries. Severe injuries and a 50% chance of fatality are associated with collisions at 25 miles (40km) per hour; at 40 miles (64km) per hour 90% of crashes are fatal.[101] In British Columbia, the legal speed limit in a school zone is 30km per hour. On residential streets immediately adjacent to such zones (where many children must walk), the statutory speed limit is 50 km per hour.[102]

Measures to reduce speed or “calm” traffic can reduce the chance and severity of accidents[103], while producing the qualitative benefits of reduced traffic volumes and associated traffic noise. A study in New Jersey conducted a comparison of driver behaviour before and after the installation of a raised median, curbs, and sidewalks on a 4-lane suburban arterial. It was found that the 85th percentile speed decreased by 2 miles (3.6 km) per hour, and pedestrian risk was lowered by 28%.[104] Bradshaw[105] refers to a British longitudinal study involving 185 traffic calming projects implemented near schools in the early 1980’s; accidents dropped by 85% in slow speed zones and severity of accidents also decreased. There is no empirical evidence that increased safety from traffic calming induces more walking, but it is nonetheless an important consideration for protecting those who already choose to walk or cycle.

Buffer

Buffers are the strips of land that separate the sidewalk from the road. They increase pedestrian comfort and safety by creating a separation from moving cars, providing an overflow space when the sidewalk is too narrow, preventing utility poles from blocking the sidewalk, and can include landscaping such as street trees and benches. Buffers affect the proximity between pedestrians and motorized traffic which is a critical factor in determining utility and perceived safety. Additional elements in the buffer such as shade trees or street furniture can affect the perception of enjoyment along the route. A buffer is recommended for streets where traffic is moving faster than 30 kilometres per hour and it is suggested that a 3 metre (9 foot) width may reduce children’s exposure to pollution from idling vehicles.[106] There is no evidence on the relationship between rates of walking and the presence of buffers.

Road Width

Increased road width increases the volume and speed of vehicular traffic and reduces visibility of pedestrians waiting to cross at intersections. Wide roads increase pedestrian crossing distances and times, increasing their length of exposure in the intersection, and decreasing their chances of crossing during one light or one break in traffic. Vanderslice advocates a “4S” approach to creating safe pedestrian environments, all of which are affected by road width: i)Slow the traffic, ii) Shorten the crossing distance, iii) Put pedestrians where they can See and be Seen, and iv) Slash the number of lanes to cross at once.[107] Gilbert and O’Brien corroborate this, recommending that wide roads should have a median island for refuge so the road can be crossed in two stages.[108] However, there is no empirical evidence demonstrating a clear relationship between road width and rates of walking.

2.4.4 Residential self-selection

Research relating the built environment to travel mode choice and physical activity makes a significant assumption that has been subject to vocal critique; that is the assumption that residential location decisions are exogenous to employment status, vehicle ownership, personal travel preferences, and other related factors. In many cases this simplification is accepted because available data is insufficient to test relationships one way or another and would make predictive models significantly more complex.[109] Critics argue that personal values such as a desire to be physically active or to use less polluting travel modes lead individuals to select neighbourhoods that support those values – a theory called residential self-selection.[110] Thus evidence appears to support a relationship between urban form and travel behavoiur when the real relationship is between travel behaviour and personal values. This assumption can lead to overestimating the significance of the built environment influence in this equation.

Self-selection theory presents a valid argument, and is complimentary to the ecological model of behaviour with respect to intra-personal influences. It is known that travel choice is affected by personal values to some degree[111], but researchers disagree about whether these values outweigh the influence of built form. A study using longitudinal data of families before and after moving neighbourhoods found no change in total vehicle kilometres traveled despite changes in built form.[112] This study did not examine changes in physical activity patterns.

It is reasonable to believe that school proximity and opportunity to walk contribute to housing decisions. However self-selection theory makes it own assumptions - primarily that individuals and families are always able to live in the neighbourhood of their choice. This reality was demonstrated by a study in the Atlanta region that evaluated walking for transportation and recreation, while controlling for the participants' stated preferences of neighbourhood type.[113] Twenty-five percent of participants indicated they were not living in their preferred neighbourhood type; of these, 81% preferred a high walkability area but were residing in a car-oriented one, indicating a significant unfilled demand for high-density, mixed-use neighbourhoods. This study did confirm that rates of walking were strongly associated with personal preferences. It also demonstrated that among individuals preferring car-oriented areas, those living in walkable neighbourhoods walked more than those in the neighbourhood type of their choice. Likewise, individuals preferring walkable neighbourhoods but living in car-oriented areas walked much less than those who were living in their preferred neighbourhood type.

High relative housing costs in downtown Vancouver and Toronto suggest there is high unfilled demand for mixed-use, walkable neighbourhoods in those Canadian regions (thereby increasing market prices). A latent demand for walking was also expressed in two Canadian studies. Eighty percent of adults in the first survey indicated they would prefer to walk more, and 60% would like to cycle more than they currently do.[114] In southern-Ontario, 75% of elementary school students indicated a preference for walking to school while only 62% actually did.[115] However these studies did not indicate specifically if the built environment was a significant deterrent to walking more.

2.5 Conclusion

Understanding travel choice is obviously complicated. As mentioned previously, over 200 distinct variables of the pedestrian environment have been evaluated for their influence on walking for transportation and recreation.[116] These include vehicle speed, street lighting, building setbacks, on-street parking, and the presence of street trees and street furniture to name a few. Inter- and intra-personal influences on children's travel to school include convenience, parent's workplace location, availability of an adult to walk with the child, extra-curricular activities before and after school, and whether siblings attend the same school. A limited number of variables have been selected for analysis in this study, the known influence of which was described in this chapter. Chapter 3 details how each of these variables was measured for the current analysis and the route-specific methodology used to collate them into the final analysis.

CHAPTER 3 - METHODS

"Few studies have simultaneously assessed perceptions and objectively measured environmental factors and their relative association with transport or recreational physical activity."

Hoehner et al., 2005

3.1 Introduction

This study utilizes cross-sectional primary data from two sources collected as part of a larger school-based intervention study funded by the Canadian Institutes of Health Research. The primary objective was to statistically compare responses on children's modes of travel to school against demographics, perceptions of safety, and a specific subset of characteristics of the pedestrian environment. These two data sources are:

1) Self-reported cross-sectional data obtained from paired parent and child surveys distributed to grade 4 and 5 students in selected schools in British Columbia's lower mainland. (In this text, these are hereafter referred to as "travel surveys".) These surveys provided both travel mode data for the child's trip to school and data on how parents and children perceive the child's safety while walking in the neighbourhood of the school. Full text of the two surveys can be found in Appendix A.

2) A database of field observations that enumerated micro-scale features of the pedestrian environment such as those described in Chapter 2. The field data collection was conducted by trained student evaluators from the University of British Columbia's (UBC's) School of Community and Regional Planning (SCARP) using a standardized survey first developed for the Neighbourhood Quality of Life Study.[1] Full text of the pedestrian environment survey can be found in Appendix B. In this text, this is referred to as the Micro-Scale Survey.

The study focuses on the child's trip to school - a very specific journey that is non-discretionary and is common to all participants. Knowledge of the home addresses and location of the schools was used to estimate a unique route for each child's trip from home to school. Micro-scale data were combined to create a simple index that rated the pedestrian friendliness of each child's route against others in the sample. A combination of inferential statistical methods was used to test the influence of the pedestrian environment and perceptions of safety on children's choices in travel mode to school. The efficacy of the micro-scale survey tool was evaluated based on qualitative observations during data collection and insights gained through subjecting the data to rigorous statistical analysis.

Action Schools! B.C.

Action Schools! BC (AS! BC) is a public school-based program designed to increase physical activity levels and healthy eating among children. In 2005 a research program was launched to assess the efficacy of the AS!BC model in promoting healthy school environments, and the program's effects on children's health. The primary investigator in the study is Dr. P.J. Naylor, Professor at the University of Victoria's Department of Physical Education. Funding was provided by the Canadian Institutes of Health Research. The study involves grade 4 and 5 students at elementary schools across the province, providing a valuable opportunity to collect information from children and their parents on several other health-related issues. Dr. Lawrence Frank, Associate Professor in UBC's School of Community and Regional Planning was invited to conduct a sub-survey on children's travel patterns, and thus the travel survey became one of several adjunct surveys distributed to students at a subset of participating schools. The ethics review, participant recruitment (schools and individuals), and administration of the travel survey were conducted by the main *AS!BC* research team and are discussed in more detail later in this chapter.

As required by UBC's Office of Research Services, the study's objectives, recruitment strategies, research methods, and surveys were reviewed and approved by UBC's Behavioural Research Ethics Board. The ethics review process was managed by Dr.

McKay and the core *AS!BC* research team. A copy of the Behavioural Research Ethics Board Certificate of Approval can be found in Appendix C.

The remainder of this chapter details the key stages of data collection, data cleaning and compilation – first for the behavioural and perceptual data and second for the micro-scale survey data. The data analysis is described including development of a pedestrian friendliness index from the micro-scale data, and the inferential statistical analysis.

3.2 Behavioural and Perceptual Data

3.2.1 Survey Design

Two multiple-choice surveys were based in part on previous survey instruments developed and tested as part of the Neighbourhood Quality of Life Study funded by the National Institutes of Health (U.S.). Survey development was also based on the review of children's travel literature (see Chapter 2), and adapting specific questions posed in the Neighbourhood Quality of Life Study[2], and the Ontario Walkability Survey.[3] Surveys were amended based on feedback provided by thesis supervisor Dr. Lawrence Frank and Dr. James Sallis of San Diego University[4]. (The full text of both student and parent surveys are found in Appendix A.)

The first survey was designed to be completed by the participating students. It questioned the children's current mode of travel to and from school, how often (if ever) they use a non-motorized travel mode to get to school, whether they ever travel by a non-motorized mode for non-school trips, if they have been encouraged to walk to school by their teachers, and asked them to rank on a Likert scale how safe they feel when walking in their neighbourhood.

The second survey was designed for parents of the participating children. It requested demographic information such as gender and age of the child, household vehicle ownership, and household income. It questioned how the child travels to and from school, how the parent travels to work, and how often (if ever) the family uses non-motorized travel modes for non-school trips. Parents responded on a Likert scale to a diversity of statements relating to their perceptions of neighbourhood safety and barriers that may prevent their child from walking to school. Each also indicated which two of a broad list of factors are the most influential in their decision of how their child travels to school. The parental survey included an open-ended question to give parents the opportunity to explain more complex decision-making factors that may not have been captured in the multiple-choice survey questions.

3.2.2 Participant Recruitment

The *AS!BC* research team recruited school principals to become involved in the study by introducing the *AS!BC* program and the intended research at seminars and conferences across the province, followed by a formal letter of invitation. Confirmation of participation was made after discussion with principals and teachers with a goal of participation by approximately 128 grade 4 and 5 teachers from 50 schools throughout the province, representing a total student sample of approximately 2000 students. Schools were selected through a stratified random sample to ensure geographic representation across all 5 BC Health Regions. In addition, efforts were made to include both large and small schools, and those located in both large and small urban areas. Half the schools in each region were randomly assigned to implement the *AS!BC* program (the intervention), so by agreeing to participate, teachers and school administrators at these schools had to commit to implementing the program for a year.

The challenge of establishing working relationships with individual schools and gaining consent of school administrators, classroom teachers, and parent placed some limits on the choice of schools. This challenge was exacerbated due to a strike by the B.C. Teacher’s Federation in October 2005 which compressed the time frame for the overall study, and reduced the willingness of some teachers to take on extracurricular projects. Ultimately 13 schools in the lower mainland were selected to receive the travel survey.

Following the *AS!BC* study design, all grade 4 and 5 students at the 13 schools were invited to participate, except those children who were unable to participate in physical education classes. This excluded any students who have to be driven to school as a result of a physical disability. The survey was distributed to all children that returned a consent form signed by a parent or guardian. While this sample eliminated the opportunity to assess travel patterns at different ages, it did provide a large sample of children in the same age range that can be compared to one another. As discussed in section 2.3, this is the age near or at which most children are developmentally capable of the decision-making skills required for walking trips in their neighbourhood.

3.2.3 Survey Administration

Travel survey packages contained a cover letter, one survey each for child and parent on differently coloured paper, and a stamped self-addressed envelope for the return of the completed surveys. Survey packages were initially distributed to 839 children at their school by an *AS!BC* research assistant between December 2005 and February 2006. When returned, the paired parent and child surveys were coded with a four-digit identifier by the *AS!BC* research team, and then hand-delivered to Dr. Frank's research lab for data entry and analysis. A copy of the initial cover letter is included in Appendix D. In February 2006, participants who had not returned their surveys received a duplicate package by mail with a cover letter encouraging them to submit a completed survey.

A response rate per school of 60% was considered feasible because participating students had previously consented to participate, would have the surveys hand-delivered, and would be receiving multiple prompts related to their participation in the larger study. To achieve a desired sample of 200 cases it was hoped that each school would return at least 30 surveys; this anticipated level of response was a primary factor in school selection (discussed in Section 3.3).

By the end of March 2006, a total of 498 children's surveys and 500 parental surveys (representing 504 individual participants) were returned from the 13 schools. This represents an overall response rate of just over 59%. Eight more completed survey pairs were subsequently submitted but these were not received in time to include in the current analysis.

3.2.4 Data Compilation

As with any large data set the travel survey data had to be cleaned to remove unusable data. The dataset was then culled to confine the analysis to a manageable number of variables. Cases with missing data among this subset of variables were identified and where possible, variables were imputed to create the complete dataset required for regression analysis.

Entering Data and Establishing the Study Sample

A scan of the returned surveys revealed that the multiple choice options to questions relating to the child's mode of travel to and from school[a] were not interpreted as intended. The options "driven to school by myself or with brothers/sisters" (child survey) and "driven to school by him/herself or with brothers/sisters" (parents survey) were intended for any child driven to school by an adult when the only passengers in that car are the child and his/her siblings. This differentiated them from children in a carpool when the parents of two families share the driving. However, responses suggested these options were interpreted as the child driving him/herself – which is obviously impossible for 9 and 10 year olds. Respondents who misinterpreted this question checked "other" and indicated the child was driven by their parents. "Other" responses of this nature were categorized as "driven to school by myself or with my brothers/sisters" since to treat them otherwise would have significantly skewed the results of the travel mode data toward "other" and made valid analysis impossible.

In addition, some questions requested a single response but multiple responses were entered. In order to retain as much information as possible all checked responses were entered. In the case of travel mode to or from school, multiple answers were later treated

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a Questions 2 and 3 on the child's survey; questions 8 and 9 on the parent's survey.

as such and assumed to mean that no one mode of travel was predominant for that child. A sub-sample of the data was then drawn to include only respondents from the 7 schools selected for the additional Micro-Scale Survey described in section 3.1. (See section 3.3.1 for the school selection process.) Sub-sampling the dataset at this time reduced work required at later stages of data cleaning and imputation (see section 3.2.5).

Verifying Accuracy

Data entry accuracy was checked by selecting a stratified random sample that represented 10% of the surveys from each of the 7 schools, always rounding up to the nearest complete survey. Entered responses in the database were checked against the original surveys for all questions in the survey. An error was considered to be any question, or part of a question, where the response entered differed from the response on the original survey. The number of data entry errors was tallied for each school and for the total sample, as well as how many surveys were involved; results are displayed in Table 3.1. The error rate was determined by dividing the number of errors by the total number of question responses entered for that survey. (See example in Table 3.1 below for Walter Moberly Elementary School.) The overall error rate of only 0.38% was considered low enough to assume the accuracy of all surveys in the series.

Table 3.1: Travel Survey Data Entry Error Checking Record

School Name	Number survey pairs	Number checked	Number of Errors	Error Rate
Boundary	42	5	1	0.3%
Brentwood Park	45	5	0	0%
Brooksbank	39	4	0	0%
Hatzic	27	3	0	0%
Marlborough Elementary	101	11	3 (on 2 surveys)	0.4%
Mission Central	38	4	0	0%
Walter Moberly	52	6	6 (on 2 surveys)	6 errors / [6 survey pairs x 70 questions per pair] = 1.4% error
Total	**344**	**38**	**10**	**0.38%**

Selecting Study Variables

The travel survey pairs provided data on 70 separate variables related to children walking to school. It was clearly necessary to select a subset of key variables for the purposes of the current analysis. This step was conducted before the data cleaning and imputation in order to minimize the work required at that stage. Variables were selected from three separate categories: demographics and geographic location (control variables), travel behaviour (dependent variable), and perception of neighbourhood safety (target independent variable). Table 3.2 summarizes each of the variables selected from both the parent and child surveys. To simplify the analysis, demographic and travel behaviour data were all selected from the parent surveys even though some questions were answered by both parent and child. For exact wording of questions, please see Appendix A.

Table 3.2: List of Variables Selected from Parent and Child Travel Surveys

Demographics	
Parent Survey: Postal Code (Q1) Gender (Q2) and Age (Q3) of child Household Income (Q17) Number of Household Vehicles (Q5) Distance between home and school (Q4)	**Child Survey:** N/A
Travel Behaviour	
Parent Survey: Mode of travel TO school (Q8) Mode of travel FROM school (Q9) Two reasons for travel choice (Q10) Non-motorized travel for non-school trips (Q13)	**Child Survey:** Favourite way to get to school? (Q8) Teachers encouraging active transport? (Q10)
Perception of Safety	
Parent Survey: Likert scale of agreement with statements about child (Q15) • Safe walking in the neighbourhood • Safe from traffic while walking to school • Safe from strangers/bullies while walking to school • Driving child to school is an important parental responsibility • Distance is too far to walk or bicycle	**Child Survey:** Likert scale of agreement with statements about walking or biking in neighbourhood: • Feel safe from cars • Feel safe from strangers/bullies • Easy and fun to walk • Feel safe walking alone

3.2.5 Cleaning and Imputing Data

Among the 7 schools, 354 families had returned some part of the travel survey; 6 families submitted only parental response and 3 only the child's response. These responses were removed so that only matched pairs of surveys remained, leaving a total of 345 matched surveys. This produced a practical response rate of 61.2%. Table 3.3 indicates the actual response rate per school.

Table 3.3. Response Rate Per School

School	Consent Forms	Complete Survey Pairs Returned	Response Rate
Boundary Community	57	42	73.68%
Brentwood Park	53	45	84.91%
Brooksbank	65	39	60.00%
Hatzic	47	27	57.45%
Marlborough	158	101	63.92%
Mission Central	63	38	60.32%
Walter Moberly	119	52	43.70%
TOTAL	**562**	**344**	**61.21%**

In addition to missing complete surveys, many of the respondents omitted responses to selected questions. Gender was the only variable for which there were no gaps in the data. Of the 19 remaining variables, 10 were missing data for fewer than 5 cases. Eight ranged from 10 to 30 cases with missing data, and household income was missing from 52 out of 345 cases. Removing all these surveys would have reduced the sample to below a size practical for significant analysis. Instead, a process of imputation was used to create the most "likely" value for the missing case. Recommended imputation methods vary depending on the nature of the variable in question, the original source of the data set, and other information known to the researcher.[5] The process requires a systematic method to infer data based on known values and relationships between values.

The most reliable method of imputing is deduction – determining the most likely true value based on responses to other questions in the same survey.[6] In this case, the process of deduction was facilitated by the paired surveys since some questions were asked on both the parent and child surveys. In the cases where the parent had not responded (for example travel mode choice), the child's answer was used. For the variable of distance from school, children's addresses were known so the route distance from home to school could be measured using G-map pedometer (an on-line service using the Google Maps feature that measures point-to-point distances).[7] Ultimately this technique was used to determine the actual travel distance to school for all children because the survey response choices were not equally spaced which would have decreased the rigor of the final analysis. Routes to school were based on those described in section 3.4.2.

When it was not possible to deduce a variable based on information already in the survey, a random numbers table was used to select a response from another respondent in a relevant sub-sample of the data. For example, perceptions of neighbourhood safety were randomly selected from the sub-sample of all respondents from the same school (i.e. living in the same or immediately adjacent neighbourhood). Table 3.4 contains a list of each variable, the number of missing cases, and the method used to impute data. Kalton and Kasprzyk[8] refer to random imputation as a "hot-deck" method; while this is not the most ideal approach it was the only one feasible for the variables with which it was used. Where possible, a sub-set of the data was selected based on a correlation analysis as described in Table 3.4 on the following pages. It should be noted that data points imputed through random selection represent a very small portion of the data set, with no one variable having greater than 7.5% of data points randomly imputed.

Table 3.4. Imputation Methods for Parent and Child Travel Survey Data

Survey Question	Number of Missing Values	Method of Imputation
Gender	0	Not required
Age	2	Average of the school, rounded to nearest full year.
Distance from school	30	Used address and postal code information provided to locate residence and measured distance from school using the Google Maps based G-map pedometer tool.
Household income	52	Household income was imputed by determining the median household income for the census dissemination area (CDA) in which each child lived (based on postal address). The CDA is the smallest census area for which income data is available without obtaining special access to information through Statistics Canada.
Number of household vehicles	2	Random selection of one vehicle ownership value from a sub-sample of respondents in the same income group. (Pearson's Correlation p=0.000 between income and vehicle ownership)
Mode of Travel to School (as reported by the parent)	2	The child's response to the same question was used to impute.
Mode of Travel from School (as reported by the parent)	1	The child's response to the same question was used to impute.
Reasons cited for travel choice.	13	Not applicable – this data was used only in the descriptive section of the analysis which did not require a complete data set.
Active Travel for non-school trips (as reported by the parent)	10	The child's response to the same question was used to impute. In one case, the child had not answered this question either and so a random response was drawn from the entire sample.

Table 3.4. (continued)
Imputation Methods for Parent and Child Travel Survey Data

Parent's Perception of the Neighbourhood:		
My neighbourhood is a safe place for my child to walk.	4	Imputed by drawing a random response from a sub-sample of respondents, based on the child's school.
My child is safe from traffic while walking to school or waiting for the school bus/public transit.	10	Imputed by drawing a random response from a sub-sample of respondents, based on the child's school.
My child is safe from strangers or bullies while walking to school or waiting for the school bus/public transit.	12	Imputed by drawing a random response from a sub-sample of respondents, based on the child's school.
Driving my child to school is an important part of my responsibility as a parent.	18	Imputed by drawing a random response from the entire sample of respondents.
Our house is too far away from school for my child to walk or ride their bicycle.	13	Imputed by drawing a random response from a sub-sample of respondents, based on the reported distance between home and school.
Child's Responses		
What is your favourite way to get to school?	10	Imputed by drawing a random response from a sub-sample of respondents, based on having the same travel to school mode. (Pearson's Correlation $p=0.022$ between actual and favourite travel mode)
Have the teachers at your school ever encouraged your to walk, bike, jog, roller blade, skateboard, or use a scooter to get to school?	3	Imputed by drawing a random response from a sub-sample of respondents, based on the child's school. (Assuming that they have the same teachers, the school sub-sample is more likely to produce a correct response).

Table 3.4. (continued)
Imputation Methods for Parent and Child Travel Survey Data

Child's perception of the neighbourhood: when I walk in my neighbourhood...		
I feel safe from cars.	2	Imputed by drawing a random response from a sub-sample of respondents, based on the child's school.
I feel safe from strangers and bullies.	2	Imputed by drawing a random response from a sub-sample of respondents, based on the child's school.
It is easy and fun to walk.	4	Imputed by drawing a random response from a sub-sample of respondents, based on the child's school.
I feel safe walking by myself.	4	Imputed by drawing a random response from a sub-sample of respondents, based on the child's school.

3.3 Micro-Scale Survey of the Pedestrian Environment

3.3.1 School Selection

The limited number of students recruited from any single school steered the collection of micro scale data towards the selection of a subset of 7 schools for inclusion in the micro-scale survey component of this study. Ideally travel survey participants would have been recruited from neighbourhoods that represent extremes in the range of neighbourhood types (walkable, not walkable) desired for the study. Given the strong correlation between income and travel choice (as discussed in Chapter 2), it is likewise essential to ensure that participants represent extremes of socioeconomic backgrounds. If applying this strategy, schools would be selected from neighbourhoods representing the four quadrants of income and walkability illustrated in Figure 3.1 (developed for the Neighbourhood Quality of LIfe Study noted above), with one or more schools being selected from each quadrant. Participants would then be recruited from schools in each quadrant until a sufficient number were obtained to achieve some statistical significance.

Figure 3.1. Ideal Categories of Neighbourhood for Participant Recruitment

High Walkability, High Income	Low Walkability, High Income
High Walkability, Low Income	Low Walkability, Low Income

However, objectives of the *AS!BC* research program took precedence in school selection so the available neighbourhoods were limited to those associated with only 13 schools in B.C.'s lower mainland which had not been selected based on these neighbourhood types. It was decided that a maximum of 7 schools could be evaluated given available data collection resources. The following considerations were used to better understand the choices available:

1. Income

Household income levels were assessed by finding the 2001 Canada Census Tract in which each school is located, and using the average household income as a proxy for the average income of the participating families. This analysis determined that average incomes ranged from a low of $33,223 to a high of $86,866.

2. Diversity of Neighbourhood Types

Before selecting the schools for the final analysis, it was necessary to compare the pedestrian environment in the neighbourhoods under consideration to ensure as diverse a sample of the pedestrian environment as possible. Since data on the micro-scale pedestrian environment are only available through direct observation, street network connectivity was chosen as a proxy measure. Street connectivity was selected because it is:

a) known to be a significant influence on adult travel patterns (as discussed in Section 2.4.1);

b) an important influence on travel distance which is the most frequently cited deterrent to walking (as discussed in Section 2.4.1); and

c) the only walkability variable that can be compared with reasonable accuracy from a simple visual analysis of a street map.

Admittedly there is no evidence of a relationship between street connectivity and micro-scale features of the pedestrian environment. Given that selection of neighbourhoods was already limited (and would be further by income and sample size considerations), connectivity was considered a reasonable proxy.

To estimate connectivity, street maps of the school catchment areas were obtained at 1:33333 scale (1.5cm=500m) using the on-line MapQuest® tool.[9] This allowed a simple visual comparison of the interconnectedness of the street network. More grid-like street patterns became the proxy for a more walkable community, and more curvilinear street patterns being a proxy for a less walkable one

3. Potential Sample Size

At the time of school selection many participants had already returned consent forms, providing an estimate of the maximum possible responses per school. The potential number of responses utimately became the primary decision factor in school selection, under the assumption that a response rate of 60% would be achieveable.

Final Selection

Of the 13 schools, one (Yarrow Elementary) was located in Chilliwack, a distance too far away to obtain reasonable pedestrian environment data under the circumstances. The 12 remaining schools were compared using Table 3.5. It was determined that Hatzic Elementary School has a street network pattern that is distinct among the 12 schools; it has longer blocks with more cul-de-sacs and curvilinear streets than the other neighbourhoods, and in addition it is geographically isolated from the core area of the Town of Mission. It was thus an important school to include in the sample, despite having only 47 signed consent forms (requiring a 64% response rate to meet the target of 30).

There were no other schools with small sample sizes with a street pattern unique enough to warrant inclusion. The final seven schools selected were 6 of the 7 with more than 50 participants, plus Hatzic Elementary with 47 students. Windebank Elementary was excluded so there would not be three schools all in Mission School District.

Table 3.5. School Selection Criteria

School Name (City)	*Walkability*	*Average Household Income (from Census 2001)*	*Number of Students Participating*	*Selected for Study?*
Boundary Elementary (North Vancouver)	High/connected	$76,770.00	57	**Yes**
Brentwood Park Elementary (Burnaby)	Low/disconnected	$56,299.00	53	**Yes**
Britannia Elementary (Vancouver)	High/connected	$43,063.00	15	No
Brooksbank Elementary (North Vancouver)	Moderately connected	$33,223.00	65	**Yes**
Florence Nightengale Elementary (Vancouver)	High/connected	$71,797.00	42	No
Hatzic Elementary (Mission)	Very low/disconnected	$71,623.00	47	**Yes**
Lakeview Elementary (Burnaby)	Moderately connected	$83,866.00	37	No
Marlborough Elementary (Burnaby)	Low/connected	$37,305.00	158	**Yes**
Mission Central Elementary (Mission)	Mix of connected and disconnected	$42,716.00	63	**Yes**
Walter Moberly Elementary (Vancouver)	High/connected	$57,184.00	119	**Yes**
West Heights Elementary (Mission)	Moderately connected	$47,116.00	35	No
Windebank Elementary (Mission)	High/connected	$67,280.00	74	No

3.3.2 Selection of a Survey Tool

Numerous audit instruments have been developed to inventory or otherwise quantify macro- and micro-scale elements of the built environment as related to non-motorized travel and physical activity.[10] It is recommended that any instrument address each of the origin/ destination, route, and area aspects of a journey as discussed in Chapter 2, but this is rarely done due to the expense of primary data collection.[11] Unfortunately there is little consistency between measuring tools. One review identified over 200 different variables across a sample of 31 tools, which makes it unlikely that any two tools look at the same combination of variables. In addition, those recording the same variables may quantify them in different ways. This makes it difficult to compare results between jurisdictions, even though each study contributes something to a broader understanding of the topic.

The route from home to school was chosen as the location from which micro-scale features would be evaluated and correlated with each student's travel choice to school. This does not completely discount the origin/destination and area elements. The focus on a specific trip common to all participants makes the destination component almost a constant. Although the micro-scale pedestrian environment in the immediate vicinity of each school may vary, there are several similarities. All elementary schools are all subject to provincially legislated vehicle speed restrictions (30 km per hour in school zones[12]). In addition, trip characteristics are similar with respect to time of day, belongings that a child must bring with them, the mandatory nature of the destination, and the presence of supervisory adults at each end of the trip (if not also along the route). Trip origins are more diverse, but are at least consistent in being the child's place of residence. Once they leave their driveway, variation in the pedestrian environment is accounted for through the route evaluation. The area component of the journey is not included because this study is predicated on previous research that discounted the influence of area-wide/macro-scale characteristics. Limitations on resources for data collection and analysis were also a factor.

The micro-scale survey selected for use in this study was developed for the Neighbourhood Quality of Life Study (NQLS) which is funded by the U.S. National Institutes for Health and operates out of San Diego State University.[13] The NQLS survey has been used once previously in the Seattle area but results from the data have not been published to date. This tool was selected due to Dr. Frank's association with the NQLS project. This association allowed Palm Pilot computes already programmed with the previously developed and tested survey instrument to be provided on-loan for use at UBC. The Palm Pilots were also programmed with a GPS device enabling the location of specific street segment start and end points as described below. The current study provided an opportunity to test the transferability of the NQLS survey to a different jurisdiction and test the application of the resulting data to a different research framework. From this perspective testing the utility of the survey tool in the Greater Vancouver context became a secondary research objective of this study.

Micro-Scale Survey Content

The micro-scale survey includes over 60 micro-scale measures that are thought to influence the safety and enjoyment of walking along the route of a trip. These measures fit into the broad categories outlined in Table 3.6, which together provide a comprehensive inventory of pedestrian environment features. A complete version of the micro-scale survey can be found in Appendix B. The survey is divided into two distinct components so that street segments and intersections can be evaluated as the units of analysis.

Street Segment = The block of street between two intersections

Intersection = The place where two or more officially designated streets meet or cross

The junctions of laneways or driveways are not considered intersections, although they can present similar risks for the purposes of pedestrian and some vehicular travel.

Enumeration of micro-scale variables on each street segment and intersection is conducted by responding to a series of multiple choice questions. A survey software was designed by GeoStats, LLP in Atlanta, Georgia, that enables the data to be entered directly onto a hand-held Palm Pilot computer and administered on-location. A global positioning system (GPS) device attaches to the Palm Pilot to provide geo-references to each of the street segments and intersections evaluated with the survey that enables data to later be entered into a geographic information system (GIS) database. However the GPS data were not used for the current analysis.

Table 3.6. Categories of Variables Included in the Micro-Scale Survey

BROAD CATEGORY	SPECIFIC ELEMENTS
Intersection	Traffic control signs and signals, crosswalk design, curb design
Roadway	Number of lanes, type of curb, on-street parking, roadway grade
Traffic Calming	Presence of speed humps, signs, traffic circles, or other infrastructure modifications to slow traffic
Buffer	Presence and width of a buffer-zone between the sidewalk and vehicular traffic
Street Furniture	Presence of various street furniture or public amenities, spacing of street lights
Trees and Shading	Number of trees, percent cover of walkway by tree canopies, awnings, etc.
Sidewalks	Presence, continuity, width, material, and state of repair
Private Development	Building setbacks and heights, land use, percentage of window frontage, building state of repair
Community Open Space	Type of open space adjacent to street, other pedestrian routes connected to the street,
Negatively Perceived Characteristics	Presence of graffiti, litter, posters/stickers, general maintenance and cleanliness

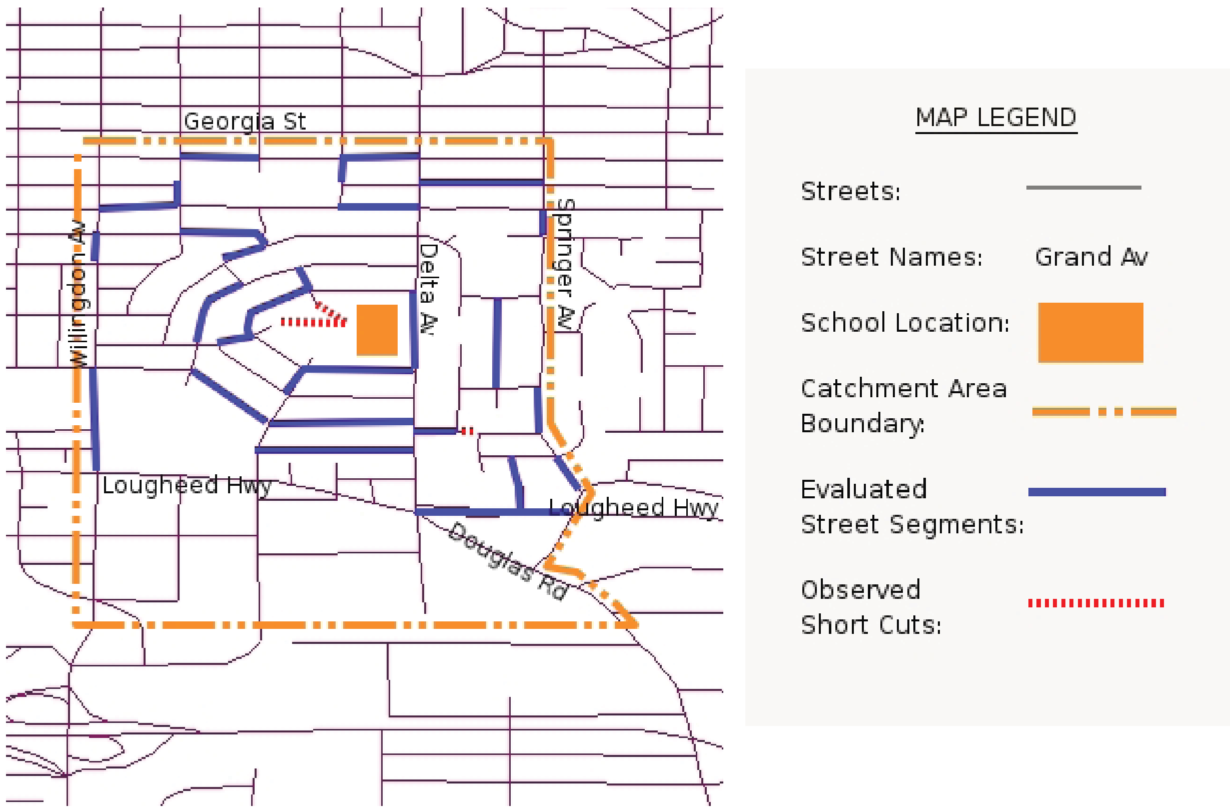
3.3.3 Defining the Study Area and Selecting Street Segments

The goal of the micro-scale data collection was to obtain sufficient information so that pedestrian conditions could be described for each child's route from home to school. To this end, the addresses of each child were used to pin-point their home location. These locations then informed selection of street segments for evaluation with the intent of maximizing the number of streets enumerated on each child's route. This approach is highly unique and maximizes the linkage between the pedestrian environment stimulus (the route to school) and the response (travel choice). It is furthermore highly consistent with theoretical models presented in Chapter 2.

Maps of the school catchment areas were obtained from the 4 relevant school districts. Most respondents live within the catchment area, however 30% were found to live between several blocks and several kilometres outside this boundary. Those external to the catchment were primarily from Marlborough and Mission Central Elementary Schools where French Immersion programs (which draw from a larger catchment) are offered. The catchment areas for each school are illustrated in Chapter 4.

It was decided to restrict street and intersection evaluations to the area inside each school's catchment boundary, which had several benefits. Since most students live inside the catchment this guaranteed only a small number would be excluded from the micro-scale analysis. It also ensured that for students within the catchment, real data would be available for a greater proportion of their route. Finally, the relatively compact nature of the catchment areas (average 2.36km^2) allowed evaluators to minimize the time they spent traveling between segments, thus enabling data collection on more street segments for the overall time spent. A sample of 25 to 30 street segments and their adjoining intersections were selected within each catchment area with a specific emphasis on including segments along which the children would be required to travel on their trips to school. Each street segment and adjoining intersection were assigned a unique identifier that attributed it to the specific school. (For example Hatzic Elementary is school #6; Hatzic street segments were coded 601 to 630.) Figure 3.2 provides an example of the Brentwood Park Elementary School catchment area and the distribution of street segments selected for evaluation.

Figure 3.2 Sample Catchment Area Map with Evaluated Street Segments Marked



3.3.4 Evaluator Training and Data Collection

Data collection was conducted as a SCARP class project in “Non-Motorized Transportation and Urban Design” (PLAN 581) taught at UBC by Dr. Frank. Eight student evaluators from PLAN 581 were trained by Dr. Kathleen Kern who had previously worked collecting data on the NQLS study in Seattle. Two three-hour training sessions were held as part of the class curriculum. The first reviewed the survey instrument and compared the possible answers for specific types of variables in a slide show (for example, the difference between a square and a rolled curb, how to define a buffer, etc.). The second training session was in the field, using the survey instrument as a group, and then practicing individually on both residential and commercial streets. The integration of this project within a class setting offered an opportunity for first year master’s student to gain direct exposure to real world factors influencing the pedestrian environment and to thesis research design and development while collecting the data used for this study.

Street and intersection evaluations were conducted over a 4 week period in February and March 2006. The trained evaluators were each assigned to a pair of schools, with one as the "primary" and one as the "secondary" evaluator for each neighbourhood; an "a" or "b" was added to segment codes to differentiate between evaluators at each school. The primary evaluator was responsible for completing the survey for each segment selected within the neighbourhood. The secondary evaluator completed half of the assigned segments, selected at random. This allowed for an evaluation of inter-rater reliability to estimate the level of precision in the data collection. The computerized survey system automatically transformed data into a comma delimited (.csv) database.

3.3.5 Data Compilation

Compilation of the micro-scale data collected revealed that data were not available for all street segments and intersections originally selected for evaluation. Despite pre-testing of the hand-held computers and training of evaluators there was a loss of data due to a probable combination of equipment malfunction and evaluator error/oversight. Unfortunately, time constraints prevented return site visits to replace the missing data. Nonetheless, a sufficient amount of data remained to undertake the desired analysis. Table 3.7 indicates the number of complete segment and intersection evaluations for which data are available.

Table 3.7. Number of Intersections and Street Segments Evaluated Per School

School	Number of Intersections	Number of Street Segments
Boundary Community	26	28
Brentwood Park	27	28
Brooksbank	31	30
Hatzic	23	23
Marlborough	29	27
Mission Central	28	30
Walter Moberly	23	29

The data set produced by the NQLS Micro-Scale Survey contained far too many variables to manage within the context of this analysis. Based on the literature available and this author's personal perception, a limited number of variables were selected that were suspected to have a particular influence on children's travel patterns. For example sidewalk quality, intersection controls, and road width were all given a high priority because of their relation to pedestrian safety from traffic. Land use types were excluded on the assumption that the travel choices of children in grades 4 and 5 are unlikely to be influenced by their ability to run errands on the way to/from school (although it is acknowledged that land use mix can contribute or detract from street safety/ambiance). Street lighting was thought not to be important for the exclusively day-time trips such as travel to school. Table 3.8 lists the specific variables selected.

Table 3.8. Variables selected from the NQLS Micro-Scale Survey

Street Segments	Intersections
Number of lanes	Intersection design (T-type or 4-way)
Extent of Sidewalks (left and right hand side)	Type of Traffic Control
Presence of Buffer (left and right hand side)	Crosswalk Marking
Steepness of Grade	Crosswalk Signage
Presence of Traffic Calming Measures	Pedestrian Button
Other Pedestrian Routes Connected to the Sidewalk (left and right hand side)	

Inter-Rater Reliability

The second step in compiling the micro-scale survey data set was to assess the reliability of the data for the variables selected using a Kappa test to measure inter-rater reliability (IRR). The Kappa score calculation is stronger than evaluating simple percent agreement because it accounts for the level of agreement that would occur simply by chance. Kappa scores can range between -1 and +1; a score of 1 indicates perfect agreement while a score of -1 indicates perfect disagreement; a zero score means there is no more agreement than what would be expected by chance.[14] Variables with few potential values are known to generate lower Kappa scores because there is a greater likelihood that agreement will occur by chance; this is an important observation because most of the data from the micro-scale survey are recorded as dichotomous values. Thus Kappa scores were generally expected to be low. Bakeman and Gottman[15] state that Kappa scores of 0.7

or greater are considered satisfactory. In this case, Kappa values larger than 0.7 would validate a decision to use the primary evaluator's data for each school.

IRR was tested by limiting the sample to only those segments and intersections scored by both evaluators at each school. The recorded values were then compared segment by segment and variable by variable using SPSS to determine the level of agreement between responses from the two evaluators at each school. Results of the Kappa test are reported here because validation of this data was essential prior to developing the pedestrian friendliness index (see section 3.4.3).

The IRR for the overall sample was extremely high. Seventy-nine percent of the measures were considered constants, indicating 100% agreement. This condition resulted when both evaluators indicated the same score *and* the variable has the same value for all segments at the school.[b] School-by-school IRR of 100% varied from 65% at Mission Central to 92.5% at Brentwood Elementary. An additional 10% of the IRR scores could not be calculated because the responses from one rater were a constant (i.e. one rater scored that variable consistently the same for the entire school while the other did not). In these cases a simple percent agreement was used, with 95% of the cases scoring between 70-95% and the remaining 5% scoring 60% simple percent agreement.

The second summary value of interest is the number of variables with a Kappa score below 70%. Only 7% of all the variables compared scored in this range. Complete results of the Kappa test are contained in Appendix E.

Street grade was one variable with consistently low Kappa scores (ranging between schools from a low of 0.364 to a high of 0.772). However, it is known that this variable is one of the most subjective in the data set. Closer examination of the data reveals most of the non-agreements are a difference between "steep" and "moderate" or "moderate" and "slight" slopes, rather than more worrisome differences such as between "flat" and "steep"

b Unfortunately this is also an indication of low variation among some variables such as number of lanes which may be contributing to inconclusive results in the inferential analysis.

slopes. It was decided to accept this data despite the low Kappa scores.

The variable of “other pedestrian routes” was initially selected for the analysis phase of this research. However, the Kappa scores for pathways showed the least amount of agreement of all the variables across all pairs of evaluators with an average of only 0.6 and scores ranging from -0.22 to 0.886. As a result adjacent pathway data were excluded from further analysis. This is not considered detrimental to the study as the presence of pathways or significant short-cuts were accounted for when determining routes to school (see section 3.4.2).

Considering the outcomes of the Kappa scores, it was decided to accept data collected by the primary evaluator for each school for all the variables listed in Table 3.8, except for the “other pedestrian routes” which was excluded entirely from the analysis.

Imputing Micro-Scale Data

Due to the data collection methods there were no missing values in any of the street segments or intersections. However every catchment area contained numerous street segments that were not evaluated. In order to reasonably estimate pedestrian conditions for each child’s entire route to school it was necessary to impute values for the unevaluated street segments. This was undertaken by drawing from known street segments and intersections within the same catchment area. Street segments and intersections were compared only on the basis of the variables selected for the detailed analysis (see Table 3.8 above), excluding “other pathways” which were eliminated due to poor Kappa scores.

The single most important tool used to determine similarity of streets was direct on-site observation and the expert opinion of this author. This method allowed direct measurement through a single trained observer, increasing the degree of standarization. This was particularly important for the two schools in Mission where the presence of sidewalks and buffers was extremely inconsistent. Rules were established to standardize decision making. Known segments directly adjacent on the same street were considered first, followed by a different segment on the same street. If neither of these were available or suitable, a segment on a parallel street of similar nature would be used. Intersections were required to be of the same type (t or 4-way) and between streets of a similar nature to the intersection missing data. Imputing intersections was simplified by the fact that the original survey collects a low level of detail on intersection traffic controls. For example, it does not distinguish between 2-way and 4-way stops. This made it easier to impute values that would score the same survey values despite some differences in actual conditions. (This is discussed further in Chapter 6.)

For future reference, a record was maintained of which street segments and intersections (as defined by street names) were equivalent to which evaluated street segments (as defined by an evaluation code). It should be noted that the limited number of variables analyzed in this study greatly facilitated the imputation process. The greater the number of variables being analyzed, the more difficult it will be to find street segments that approximate one another.

3.4 Determining a Unique Pedestrian Environment Score for Each Child

3.4.1 Students in the Catchment Area

In order to analyze the influence of micro-scale environment on travel choice it was essential to asign a unique score to each child's route to school that might help explain variation in travel choice between children living in the same neighbourhood. As indicated in Section 3.3.3, 30% of students were found to live outside the catchment area; these students were excluded from further analysis because pedestrian environment data were only available within the catchment boundaries. A small number of children living on streets outside but directly adjacent to the catchment were retained when it was felt sufficient data existed to accurately asign a unique score.

Table 3.9 indicates the number of students from each school found to live inside the catchment area. The impact of this exclusion was most profound at Marlborough and Mission Central Elementary Schools, both of which offer French Immersion programs that draw students from a very broad geographic area. However, the remaining sample of 239 is still large enough for a rigorous statistical analysis.

Table 3.9. Impact of Catchment Area Exclusion on Total Sample Size

School	Complete Survey Pairs Returned	# Responding Students Inside Catchment Area
Boundary	42	34
Brentwood Park	45	33
Brooksbank	39	35
Hatzic	27	20
Marlborough	101	46
Mission Central	38	20
Walter Moberly	52	51
TOTAL	344	239

-

3.4.2 Estimating Routes

It is generally accepted that pedestrians choose the shortest route possible when walking for utilitarian trips.[16] With this in mind, site visits to each school identified the location of important short-cuts between homes and schools. For example, Boundary Community and Mission Central Elementary schools each have public staircases providing short-cuts between streets (particularly those separated by steep hills). One street near Brentwood Park has bollards blocking cars mid-way, but provides a continuous pedestrian route that dramatically shortens the walking distance for several students in the study. Walter Moberly is surrounded by public playing fields that provide an easy shortcut to avoid streets and access the school from the rear. The location of these shortcuts was taken into consideration in determining each child's route to school. It was also assumed that smaller (narrower) streets are preferable due to safety (lower volumes, slower traffic) and are more pleasant (less noise and pollution) than their larger counterparts. Photos 3.1a and 3.1b illustrate some of the short cuts.

Photo 3.1a Short cut at Mission Central connecting the school yard to 2nd at Welton.

Photo 3.1b Short cut at Boundary connecting Tempe Cres. to Tempe Knoll

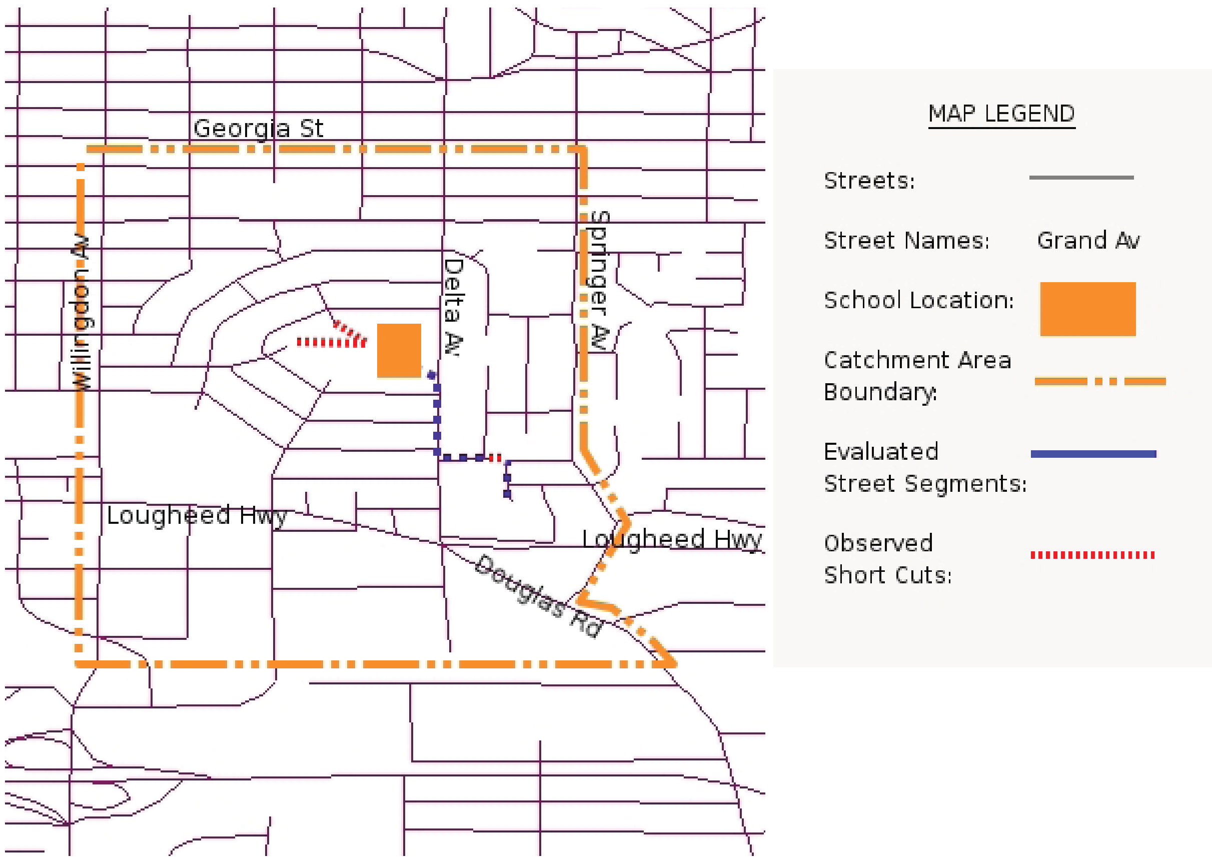
After identifying the home location, each child's walking route to school was estimated based on the assumptions that the preferred route would:

1) Be the shortest and most direct possible route between home and school;
2) Include all identified shortcuts between home and school that serve to shorten the route, and
3) Favour a minor/residential street over a larger street if that choice did not lengthen the overall trip.

Figure 3.3 illustrates the route to school selected for one participant at Brentwood Park Elementary School. Using this method, two unique "route equations" were created for each child consisting of the segment numbers along which they would have to travel to reach the school; one for street segments and one for intersections. For children living on the same block as the school, the closest intersection was used to create a complete data set, even though these children may not have to cross the street.

Obviously this method has limitations because route choice can be affected by many factors. A child may detour to walk with a friend, choose a different route because there are multiple options that are all the same distance, or may begin/end their trip at the location of a babysitter or daycare rather than their home address. Under the circumstances obtaining this level of detail from each parent would have required equipping each student with a GPS device during the survey resulting in a smaller sample size and a different study design. The method used resulted in increased power in sample size and generalizability and is based on reasonable shortest path assumptions of travel route choice.

Figure 3.3 Sample Map of Route to School (Brentwood Catchment)



3.4.3 Creating an Index of Pedestrian Friendliness

As described in Chapter 2, features of the built environment tend to co-vary in space, meaning that certain amenities are frequently found together. Buffers do not exist without a sidewalk (although sidewalks exist without buffers); light-controlled intersections tend to come with pedestrian crossing signals. This means it is often difficult to isolate the influence of one variable from another. Similarly, the influence of certain features may vary depending on what complimentary features are available. A pedestrian network with sidewalks and signalized crossings is likely to be more effective than a network with only one or the other. To help compensate for this it is common to create an index – one number that represents a combined score of all pedestrian environment measures.[17] Four basic methods were tested in an effort to create a “pedestrian friendliness” index appropriate for this case study: the z-score index, the equal weighting index, and two “lowest score” indices based on values from both the z-score and equal weighting indices.

Index Method 1: Z-Score Index

The first index tested used a z-score (the number of standard deviations from the mean) to standardize values for each of the variables considered. This method followed that applied to macro-scale variables in the NQLS study.[18] To create z-scores, categorical variables were first converted into a form that could be manipulated numerically as described in Table 3.10. For example, crosswalk markings and signage were recorded on a yes/no basis for each leg of an intersection; these values were converted into a proportion of intersection legs that exhibited that feature.

Table 3.10. Converting Categorical Data into Calculable Scores

Variable	Original Measure	Transformed Measure
Street Segments		
Number of Lanes	Number of travel lanes on left and right side of segment.	Total number of lanes
Extent of Sidewalks (left and right hand side)	Ordinal score for proportion of sidewalk on left and right side of segment.	Ordinal score for amount of sidewalk on the street side with the longest continuous sidewalk.
Presence of Buffer (left and right hand side)	Presence/absence of buffer on left and right side of segment.	Ordinal score for total amount of buffer (none, 1 side, or both sides)
Steepness of Grade	Ordinal score for steepness of grade (higher score is more steep).	No transformation required.
Presence of Traffic Calming Measures	Presence/absence of each of 7 different traffic calming elements.	Total number of traffic calming elements present on the street segment.
Intersections		
Intersection design (T-type or 4-way)	Nominal selection of which intersection type.	No transformation possible; variable was initially removed from the analysis.
Type of Traffic Control	Nominal selection of which traffic control type for the intersection.	Created ordinal score with none=0, yield or traffic circle=1, stop sign=2, traffic lights=3
Crosswalk Marking	Presence/absence of crosswalk marking for each leg of the intersection.	Proportion of intersection legs with a crosswalk marking.
Crosswalk Signage	Presence/absence of crosswalk signage for each leg of the intersection.	Proportion of intersection legs with a crosswalk signage.
Pedestrian Button	Presence/absence of pedestrian button.	Ordinal ranking (none = 0, present=1)

The z-scores for the number of lanes and steepness of grade were multiplied by -1 to reverse the direction of influence because steeper slopes and more lanes were thought to decrease the attractiveness of walking.

A set of unique scores for each child was created by averaging the z-scores of each variable from each of the segments or intersections in that child's route equation. This process is illustrated below; recall that the same segment/intersection identifier may appear multiple times due to the imputation process.

School: #1 Walter Moberly
Participant Code: 1037

Street Segment Identifiers: 22 + 31 + 31 + 1
Street Segment Score for Sidewalks

= average of sidewalk z-scores for each segment
= (0.69056 + -1.51477 + -1.51477 + 0.69056)/4
= -0.41211

Intersection Identifiers: 22 + 22 + 2 + 1
Intersection Score for Crosswalk Signage

= average of crosswalk signage z-scores for each segment
= (-0.37 + -0.37 + 2.44 + -0.37)/4
= 0.33352

Three simple indices were created by summing the following scores for each child:

1) Street Segment Index (sum of street segment variable scores)
2) Intersection Index (sum of intersection variable scores)
3) Pedestrian Friendliness Index (sum of Street Segment and Intersection Indices)

Finally each of the indices was quartiled to accentuate the differences between groups.

Analysis of these index scores revealed that the z-score based standardization caused significant problems because the variable scores were not normally distributed. This meant that relatively rare street characteristics received disproportionately high or low z-scores simply because they were rare. For example, the minimum z-score for the type of traffic control was -2.99 because most streets had stop signs but only a few had no controls. In contrast the minimum possible score for traffic calming was only -0.52. When these were combined into the pedestrian friendliness score, streets that scored poorly on traffic controls fared much worse than those scoring poorly on traffic calming. There is no evidence from this study or in the literature to suggest that the disproportionate scores actually reflect the relative influence of these street characteristics on probability of walking. In fact exploring that relative influence is an objective of this study. This observation highlighted the need to create an index where each variable would be weighted equally, which led to the Equal Weighting Index.

Index Method 2: Equal Weighting Index

The second approach to index development was to assign a value between 0 and 1 to each variable characteristic so that the maximum potential score would be the same for each variable. This was done using ordinal scoring as described in Table 3.11. Note that for this index, stop signs and traffic lights are assigned the same score. This was done because tests of the first index suggested that intersections with lights scored much higher than those without because they tend to also have crosswalk signage and pedestrian buttons. However, intersections with lights also tend to be the widest and have the most traffic – making it counterintuitive that they would score really high. For this reason, the variable of pedestrian buttons was also removed completely. Segment, intersection, and pedestrian friendliness index scores were created for each child using the same method described above, but substituting the equally weighted variable scores for the z-score based values.

Index Methods 3 and 4: Lowest Score Indices

An alternative hypothesis was that the safety or perceived safety of a child's trip to school could be strongly influenced by dangerous conditions along only one street segment or at one particular intersection along the route. To test this hypothesis each street segment and each intersection were given two indexed scores calculated by adding the scores for each variable on that segment. Each child was then assigned a "lowest segment" score and “lowest intersection” score based on the lowest scoring segment and intersection along their identified route to school. These two scores were then added for each child to determine the “lowest pedestrian friendliness” score.

Table 3.11. Ordinal Ranking of Variables for the Equal Weighting Index

Variable Name	Rank in Original Data	Standardized Score (0-1)
Number of Lanes	2 lanes 3 lanes 4 lanes 6 lanes	1 0.67 0.33 0
Street Grade	0 - flat 1 – slight slope 2 – moderate slope 3 – steep slope	1 0.67 0.33 0
Traffic Calming	0 elements 1 element 2 elements 3 elements	0 0.33 0.67 1
Buffer	None 1 side both sides	0 0.5 1
Sidewalk (amount on side with longest)	None 1-25% 25-50% 50-75% 75-99% 100%	0 0.2 0.4 0.6 0.8 1
Traffic Control	None Yeild Traffic circle Stop sign Traffic Light	0 0.5 0.5 1 1
Crosswalk Marking	None 1 of 4 legs 1 of 3 legs 2 of 4 legs 2 of 3 legs 3 of 4 legs All legs	0 0.25 0.33 0.5 0.67 0.75 1
Crosswalk Signage	None 1 of 4 legs 1 of 3 legs 2 of 4 legs 2 of 3 legs 3 of 4 legs All legs	0 0.25 0.33 0.5 0.67 0.75 1

The Lowest Score Indices were calculated and tested for their level of significance using both the Z-Score Index and the Equal Weighting Index. (It was calculation of the lowest score that revealed the problems of the z-score index discussed previously.)

3.5 Data Analysis

3.5.1 Descriptive Analysis

Travel survey and micro-scale survey data were described in terms of frequencies for each response on a school-by-school basis and for the combined sample population of 239 respondents. Measures of central tendency were calculated, alternatively using the mean and mode as appropriate. Results of this descriptive analysis are presented in Chapter 4.

2.2.2 Inferential Analysis

Methods of inferential analysis are described in Chapter 5 in tandem with presentation of results. Due to the issues identified with the Z-Score Index, only the Equal Weighting Index and it's variations (Lowest Score and Modified Equal Weighting) were used in the inferential analysis stage.

3.5.3 Qualitative Analysis

Qualitative objectives of the study were to assess the efficacy of the selected micro-scale survey tool within the context of the Greater Vancouver Area and the route-specific research methods. Analysis of this efficacy was based on on-going observations of the author and micro-scale evaluators made during both the data collection and analysis stages of the study. Results and recommendations arising from this qualitative evaluation are contained in Chapter 6.

3.6 Methodological Limitations

Some limitations in the methodology were identified at the point of study design while others only became apparent as the data were collected and analyzed. This was expected as evaluation of the methodology was a significant research question. Limitations initially identified are discussed here; some of these were referenced previously in this chapter.

Limitations arising during the research process are presented in Chapter 6 as results of the qualitative evaluation of the process.

Some of the limitations have implications for the quality of data collected and the subsequent analysis and results. Such implications are referenced here and discussed further with the presentation of results in Chapter 5.

School Selection and Variability of Neighbourhood Form

As discussed in section 3.3.1 (School Selection), the research priorities of the *Action Schools! BC* project placed significant restrictions on the types of neighbourhoods available for inclusion in the study. This means that inter-school variation among the 7 selected schools is not likely to represent the true extremes of possible variation in micro-scale attributes. On top of this, intra-school variation is limited due to the nature of the catchment areas selected. Most of the catchment boundaries in this study are defined by major roads, meaning that few (if any) students have to cross major roads on their trip to school. The compactness increases the chance that streets will have been developed at similar times and thus have similar characteristics. These factors in combination are likely to remove a substantial amount of variation when considering the micro-scale pedestrian environment on a route-specific basis.

Travel Survey Design and Administration

Time constraints prevented the survey from being pre-tested with a sub-sample population to identify potential misinterpretations of questions, add relevant questions that had not been asked, or to otherwise refine the survey. Analysis of the survey responses confirms some issues that may have been addressed through a pre-test. Although a pre-test could have improved the range of questions asked on the survey, it not believed that this omission substantially impacts the quality of data for the variables used in this analysis. Many of the questions used in the survey were drawn from other survey instruments which offered a de-facto pre-test for these questions.

An additional limitation was that the strike of the B.C. Teachers Federation moved distribution of the survey closer to Christmas holidays for most of the participating schools. This may have reduced the overall response rate.

Imputing Data

Missing data points in the travel survey were dealt with as systematically as possible. Household income was by far the most common missing value and is also the most difficult to impute accurately. The results of analysis on income may have been affected by this situation.

Data imputation is likewise a significant uncertainty in the micro-scale survey data and may have influenced the outcome of the pedestrian friendliness index. However it is suspected that greater uncertainty was introduced by the nature of the micro-scale survey itself – an issue discussed further in Chapter 6.

The Pedestrian Friendliness Index

Assuming the micro-scale data collected are an accurate representation of the pedestrian environment, the method of averaging street segment scores to create a unique route score decreased the precision of the tool. Not all street segments are the same length; a score more proportional to the actual street lengths could be calculated if this study were to be replicated using GIS technology but was not possible in this analysis.

In addition to this, several assumptions were made regarding the child's route to school (as discussed in Section 3.4.2). These assumptions may have produced an estimated route different from the child's normal route, for example if they take a slightly longer route in order to avoid busy intersections. In addition, there was no micro-scale evaluation conducted on the short cuts (except for one with bollards diving a street) because they were only pedestrian pathways. Several of the public staircases provided were extremely steep (at Mission Central in particular), and some could be perceived as too secluded for safety (too many surrounding trees, etc.). The conditions of these shortcuts may influence parental perceptions of safety but their attributes are not reflected in the micro-scale pedestrian environment data. Despite these limitations, it is believed that the methods of producing theses scores remain a reasonable basis on which to explore route-specific pedestrian environment conditions.

A larger problem lies with the accuracy with which the micro-scale survey reflects actual road conditions. This accuracy was unknown before data collection began; observations and recommendations for survey improvement are discussed in Chapter 6.

CHAPTER 4 - DESCRIPTIVE STATISTICS

This Chapter presents results of a descriptive analysis of the travel survey and micro-scale survey data. This is contrasted with data from the Canadian Census to provide a picture of the total study sample, the specific neighbourhoods involved, and the variation in demographics, travel behaviour, and urban form included in the study. Summary frequency tables of the data used in this descriptive analysis are contained in Appendix F.

Census data provided here were compiled from the combination of Census Dissemination Areas (CDAs) that most closely represent the catchment area of each school. CDAs are the smallest geographic area for which 2001 Census data are available through University of British Columbia agreements (i.e. without making a specific order to Statistics Canada).

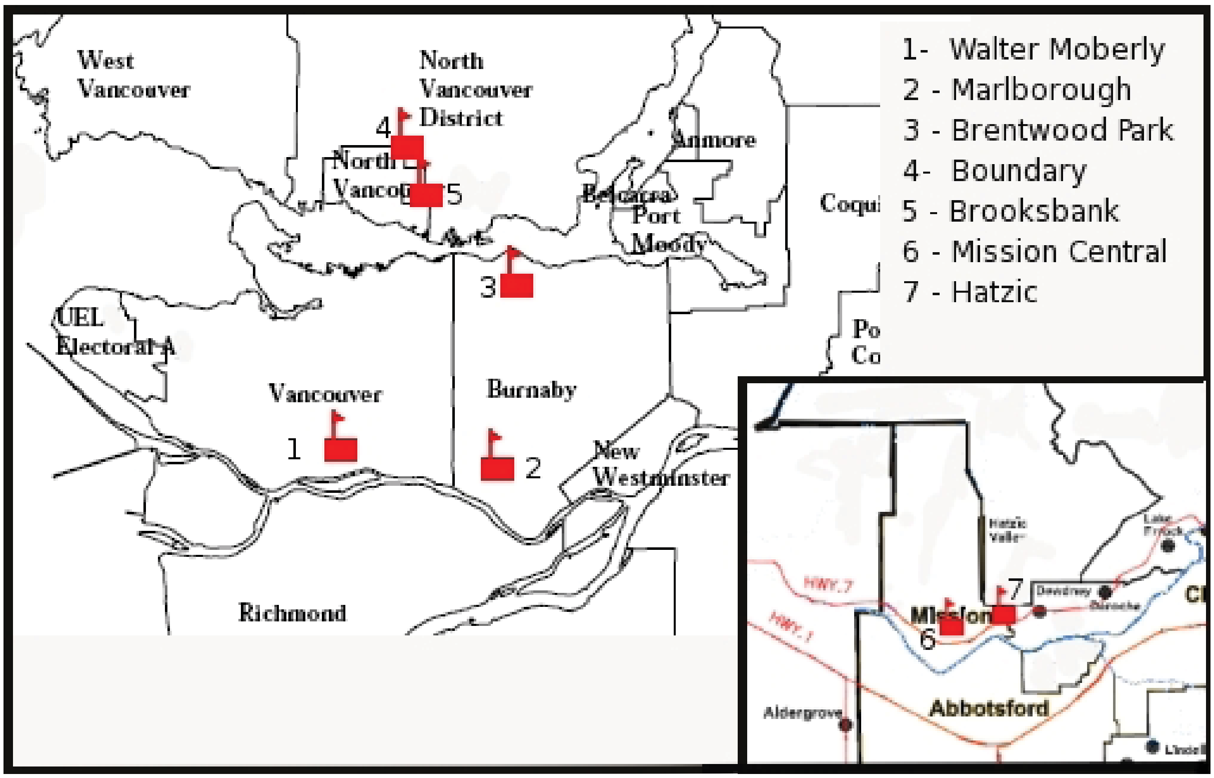
Out of the seven schools included in this analysis, 562 students agreed to participate in the survey by returning signed consent forms. Of these, 345 returned a complete pair of travel surveys, giving an overall response rate of almost 61%. However, 106 of these students lived outside their school's catchment boundary, leaving only 239 (42% of those who returned consent forms) for whom complete data – including the pedestrian environment measures - were available. The following descriptive results are drawn only from this sample of respondents living within the school catchment area.

Results are first presented for the entire sample, followed by descriptions on a school-by-school basis.

4.1 Overall Sample

The 7 schools included in this analysis represent a range of neighbourhoods across 4 different school districts in B.C.'s Lower Mainland. Two are located in each of the Burnaby, North Vancouver, and Mission School Districts; one school is located in the Vancouver School District. Figure 4.1 illustrates the approximate location of each school.

Figure 4.1. Locating Participating Schools in the Lower Mainland
Base maps courtesty of the Greater Vancouver and Fraser Valley Regional Districts respectively.
Not to Scale.

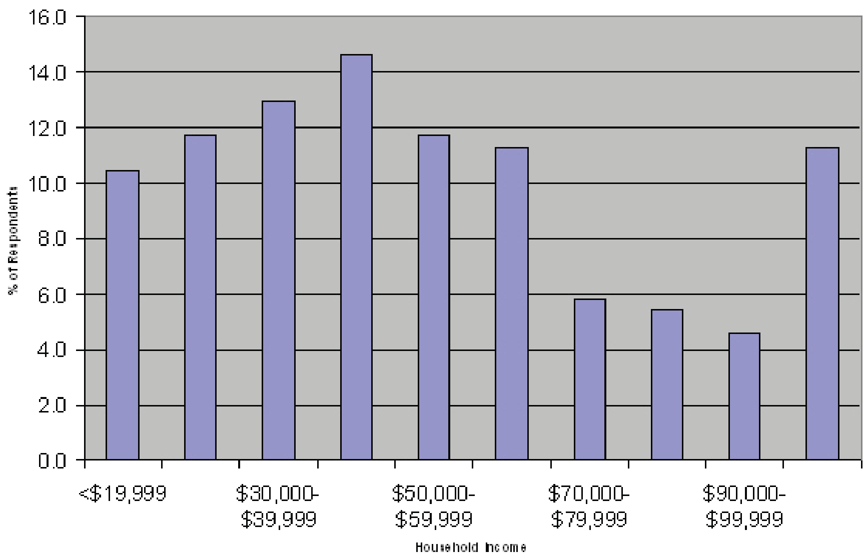


4.1.1 Demographics – Household Income and Vehicle Ownership

Slightly more girls (51%) responded to the survey than boys. Their ages range from 8 to 11, with the vast majority being 9 year olds (47%) and 10 year olds (48%). This means that the participants are all at comparable developmental stages with respect to their levels of independence and decision-making skills for walking alone.

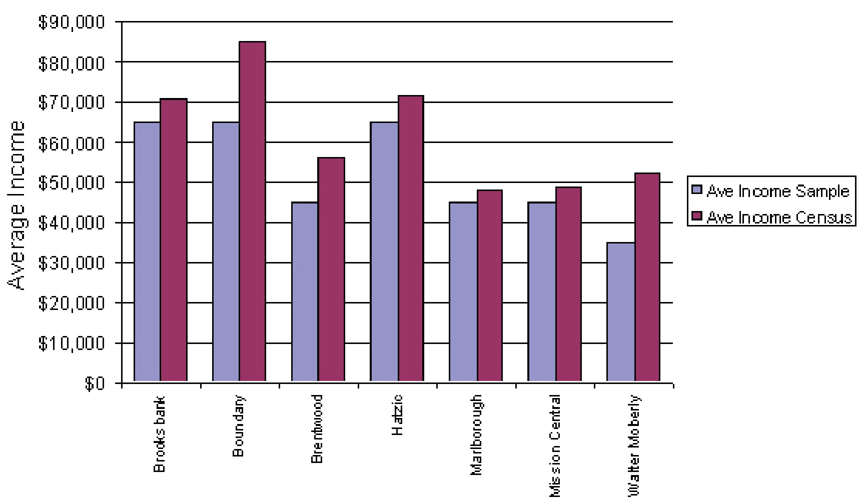
Household incomes, as illustrated in Figure 4.2 range from less than \$20,000 to over \$100,000, although there is significant uncertainty because17% of these were imputed from census data. The least frequently reported income brackets are between \$70,000 and $100,000 per year, totaling only 16% of the entire sample. This is substantially lower than the 22% earning between $0 and $30,000 even though the range of incomes is the same in those two groups. The approximate average income lies between $40,000 and $49,000.

Figure 4.2 Income Distribution of Total Sample



Household incomes are not evenly distributed between the 7 neighbourhoods – as illustrated in Figure 4.3. Three schools have approximate average incomes between $60,000 and$70,000; three are between $40,000 and $49,000, and one is between $30,000 and $39,000. Figure 4.3 illustrates that the average incomes at each school are consistently lower than the average Census-reported incomes for the area. This is likely due in part to way incomes are reported. Census data requests actual income, whereas the highest possible income bracket in the survey was $100,000 or greater. Incomes of $150,000 would increase the average census income but would have less influence on the sample data.

Figure 4.3 Reported and Census Average Incomes by School Neighbourhood



Vehicle ownership is correspondingly distributed with 7 households (3%) indicating no vehicles, 43% indicating one, 42% indicating two, and 12% indicating three or more vehicles. Figure 4.4 illustrates the relationship between household income and vehicle ownership, with higher-income households reporting on-average more vehicles than those with lower incomes.

Figure 4.4. Average Vehicle Ownership by Household Income

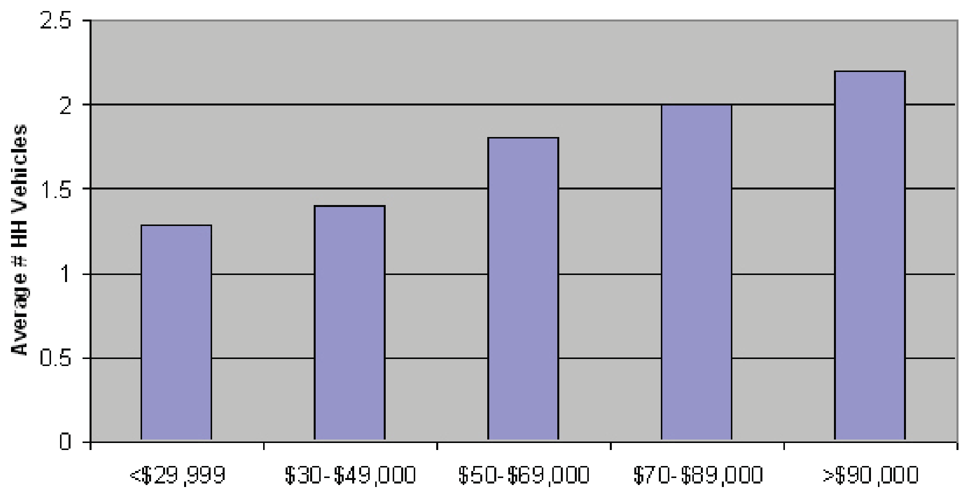


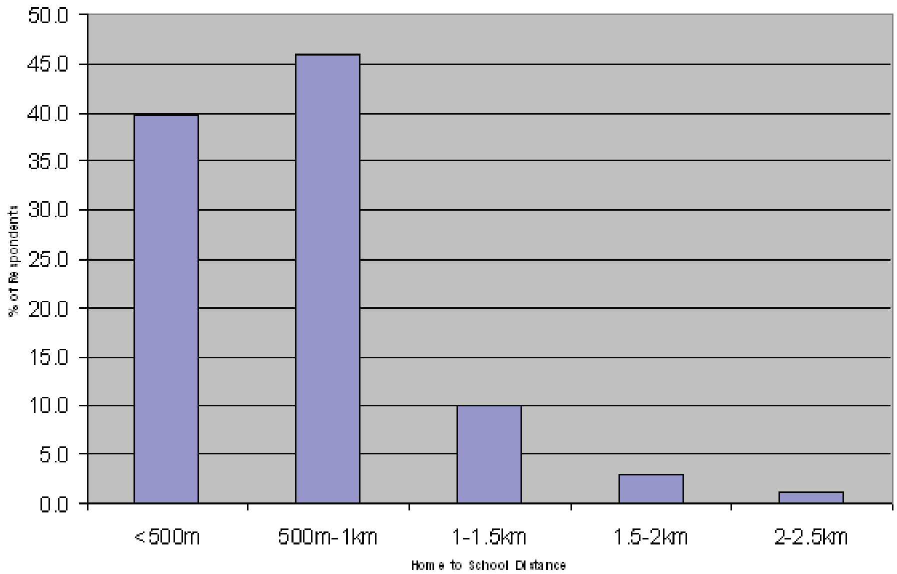
Table 4.1. Summary of Selected Demographic Variables.
(See complete details in Appendix F)

	Full Sample	B'bank	Boundary	B'wood	Hatzic	M'brough	Mission	Moberly
Sample Size	**239**	**33**	**34**	**33**	**20**	**47**	**20**	**52**
Demographics								
Ave HH Income	$40-$49,000	$60-$69,000	$60-$69,000	$40-$49,000	$60-$69,000	$40-$49,000	$40-$49,000	$30-$39,000
Ave HH Vehicles	1.49	1.94	2.09	1.52	2.3	1.26	1.4	1.5
Distance (Mode)	500m-1km	550m-1km	0-500m	500m-1km	0-500m	0-500m	500-1km	0-500m

4.1.2 Distance

Limiting the sample to children within the catchment boundary inherently reduces variability in the home to school distances. Figure 4.5 reflects this as 40% of all students report living less than half a kilometre away from their school. An additional 46% live between 500m to 1km away, and 13% live between 1-2 kilometres from school. As with the limited age range, the catchment areas concentrate the sample within a reasonable (less than half an hour) walking distance from school that allows the analysis focus more on micro-scale conditions as influences on travel choice.

Figure 4.5. Distribution of Home to School Distances



4.1.3 Travel Behaviour

Overall, 64% of children in the sample "usually" use an active mode of travel for at least one of their trips to/from school. Forty-nine percent walk in the morning and 56% walk home after school; 42% are driven in the morning but only 35% get a drive home in the afternoon. School buses are of little importance in the sample (less than 2%), while no students take public transit. This is not surprising given that the sample is limited to within the school catchment areas which are all fairly small in size. Somewhat more surprising is that active modes other than walking are also very rare. Less than 2% of respondents report using an active mode other than walking – although fully 15% indicate a preference for bicycling or using another active mode. Figures 4.6 and 4.7 illustrate these relationships.

Figure 4.6. Morning and Afternoon Travel Modes

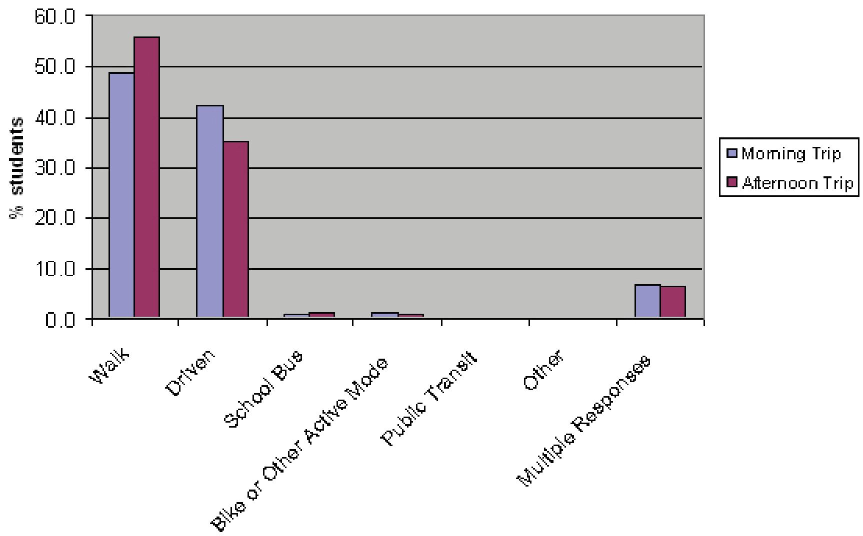
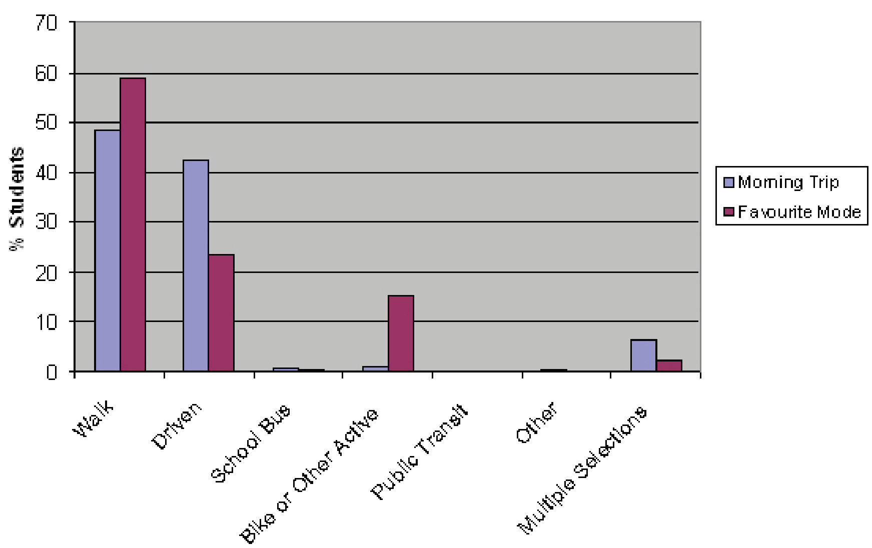


Figure 4.7 Morning Travel Mode Versus Favourite Travel Mode



Despite limiting the sample to children living within school catchment areas, Figure 4.8 illustrates that distance is still an important factor. This relationship is tested more rigorously through the inferential analysis in Chapter 5.

Fewer than half of respondents indicated their teachers had ever encouraged them to walk or bicycle to school; none of the schools are participating in a formal "safe routes to school" type program. Household travel choices among the entire

Figure 4.8. Proportion of Active Travel by Distance

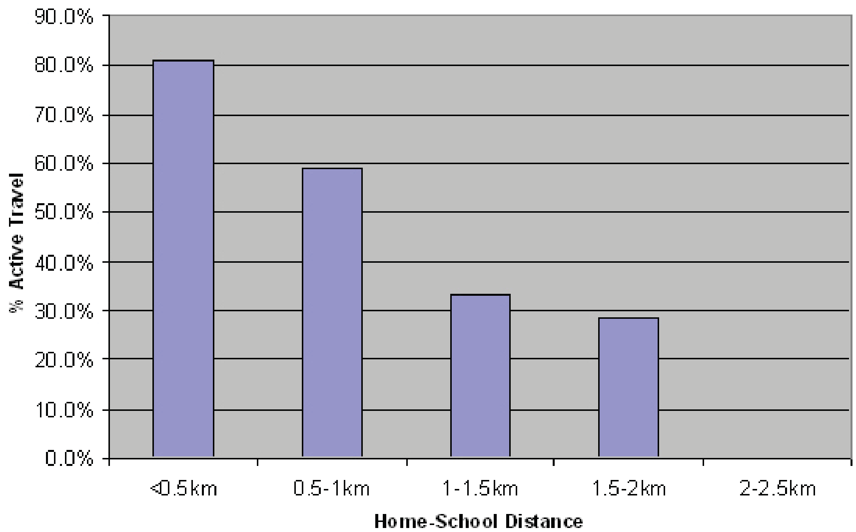
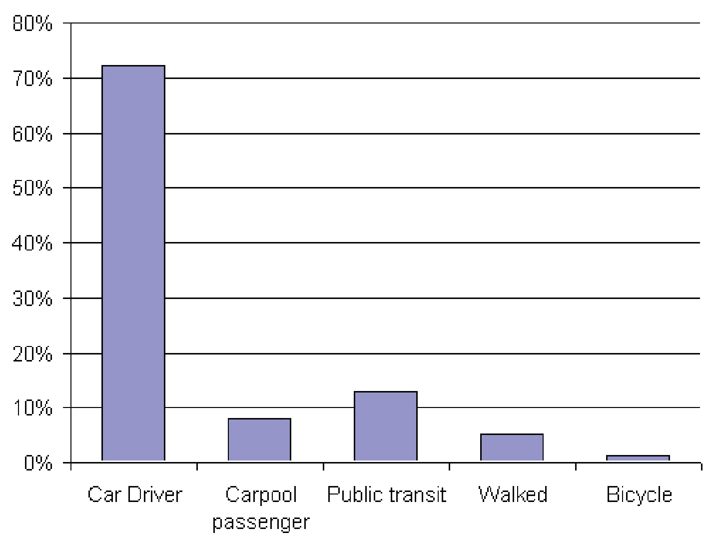


Figure 4.9 Census-Reported Mode of Travel to Work



sample reflect much lower rates of walking than the children's travel to school. Over 55% never or rarely (less than one time per week) use a non-motorized form of travel, and only 11% use active transport more than 4 times per week.

The only census data that reflect travel mode preferences are preferences for travel to work. The populations in the seven catchment areas for this study demonstrate a clear preference for driving with 72% reporting being the primary driver and 8% being carpool passengers for their trips to work.

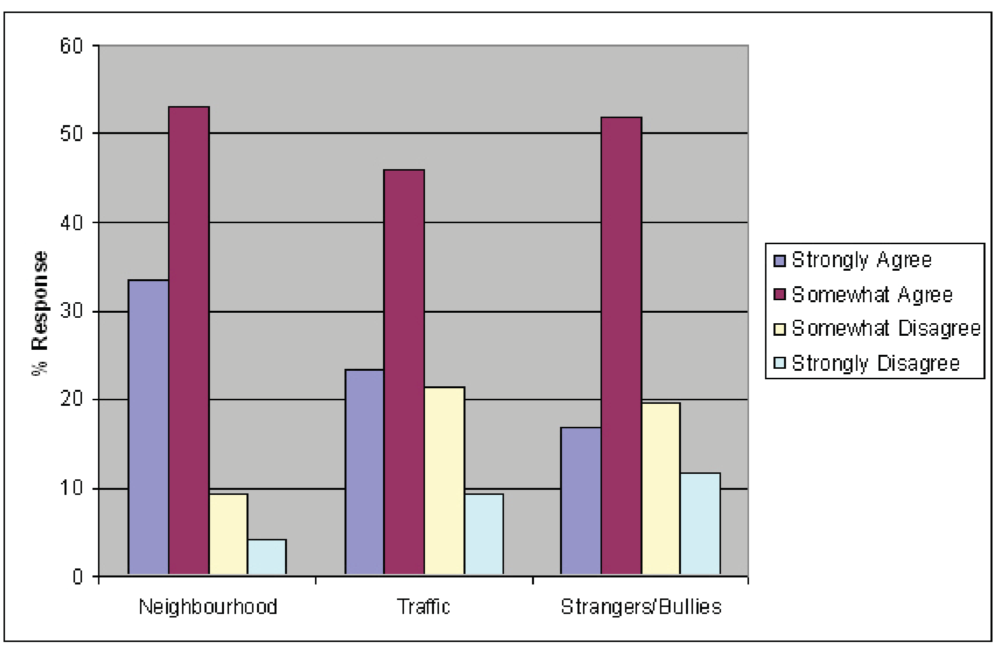
Table 4.2. Summary of Selected Travel Behaviour Variables.
(See complete details in Appendix F)

	Full Sample	B'bank	Boundary	B'wood	Hatzic	M'brough	Mission	Moberly
Sample Size	**239**	**33**	**34**	**33**	**20**	**47**	**20**	**52**
Travel Choice								
% walk to school	48.5	27.3	41.2	51.5	40	61.7	50	56
% driven to school	42.3	63.6	47.1	39.4	50	29.8	45	35
% active at least one way	63.6	54.5	55.9	63.6	60	70.2	50	75
favourite mode (mode)	walk	walk	walk	walk	walk	walk	driven	walk

4.1.4 Perceptions of Safety and Travel Preferences

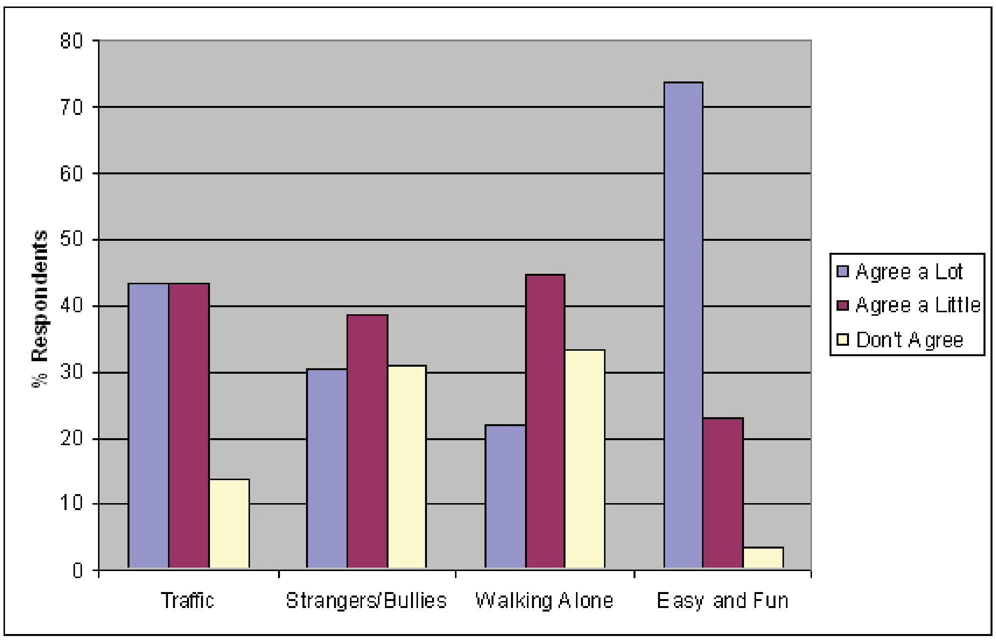
Only one third of parents strongly agree that their neighbourhood is a safe place for their child to walk, although over 55% somewhat agree with this statement (totaling over 86% with some level of agreement). Parents show greater concern when questioned about specific safety issues for their child walking to school. Sixty-nine percent strongly or somewhat agree that their child is safe from traffic. Nearly the same have some agreement about safety from strangers, although a greater amount only agree "somewhat". Figure 4.10 illustrates parental responses to each of the questions regarding perception of safety.

Figure 4.10 Parental Perceptions of Safety



Fewer than 15% of children are concerned about traffic in their neighbourhoods, with "agree a lot" and "agree a little" being equally split at 43%. Children are much more concerned about strangers and bullies with 30% indicating they did not agree, and only 31% indicating they "agree a lot". Even fewer children – only 22% - strongly agree that they feel safe walking alone in their neighbourhood, suggesting that many of the children walking to school walk with friends or an adult. Happily, these fears did not prevent nearly three quarters of children from agreeing that it is easy and fun to walk. Figure 4.11 illustrates the children's responses to perceptions of safety.

Figure 4.11 Children's Perceptions of Safety



There is disagreement among parents about their parental responsibility to drive their children to school. Thirty-three percent strongly agreed, 32% somewhat agreed, and only 13% strongly disagreed that driving their child to school is an important part of their parental responsibility. However, it is unclear if results of this question may be skewed by an interpretation that "making sure my child gets to school is an important" parental responsibility.

Table 4.3 Summary of Selected Perception of Safety Variables. See Appendix F for complete details.

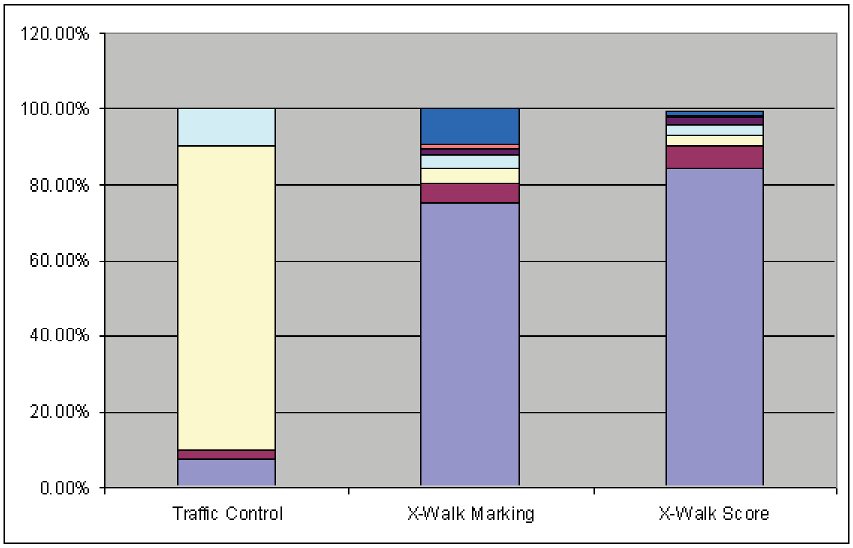
	Full Sample	B'bank	Boundary	B'wood	Hatzic	M'brough	Mission	Moberly
Sample Size	**239**	**33**	**34**	**33**	**20**	**47**	**20**	**52**
Parent Perceptions	**1=feel safe**	**4=don't feel safe**						
Traffic Safety (mean)	2.12	2.11	2.12	2.3	1.95	2.26	2.2	2.12
Stranger/Bullies (mean)	2.33	2.11	1.94	2.45	1.95	2.5	2.35	2.33
Reasons cited	convenience, distance	easiest daily schedule, convenience	convenience, distance	convenience, safety from strangers/bullies	convenience, distance	convenience, distance	convenience, only option	convenience, child's preference
Child Perceptions	**1=feel safe**	**3=don't feel safe**						
Traffic Safety (mean)	1.67	1.57	1.68	1.97	1.7	1.65	1.8	1.67
Stragner/Bullies (mean)	2	1.91	1.82	2.24	2.2	1.98	1.95	2

4.1.5 Micro-Scale Pedestrian Environment Evaluation

Intersections

Valid data were obtained for 192 intersections, exactly half of which are “t” intersections, and half are 4-way. Otherwise, the overall sample of intersections displays little variability among the micro-scale features used in this analysis. Eighty percent of intersections are controlled by at least one stop sign, 75% have no crosswalk markings, 85% have no crosswalk signage, and 90% have no pedestrian crossing button. This lack of variation is due to a combination of low variability in the measured characteristics as well as some weaknesses in the sensitivity of the measurement instrument (e.g. no distinction between 2 way and 4 way stops - discussed further in Chapter 6). Figure 4.12 compares the level of variation among each of the measured intersection elements by illustrating how each potential response is proportionally distributed in the total sample. The dominant response for traffic control is a stop sign; the dominant response for both crosswalk markings and crosswalk signage is “none”.

Figure 4.12. Proportional Distribution of Intersection Characteristics



The level of variation increases somewhat when comparing the different school neighbourhoods against each other. Figure 4.13a highlights that stop signs dominate the intersections in all the neighbourhoods, with Marlborough exhibiting the lowest proportion of 72%. Hatzic has the greatest proportion of intersections with no control at all (22%), and Marlborough has the highest proportion of intersections controlled by traffic lights. Figure 4.13b illustrates that the catchment areas of Mission Central and Walter Moberly Elementary Schools both have a high proportion of intersections with pedestrian crossing signs compared to the other schools.

Figure 4.13a Variation of Traffic Control Features by School

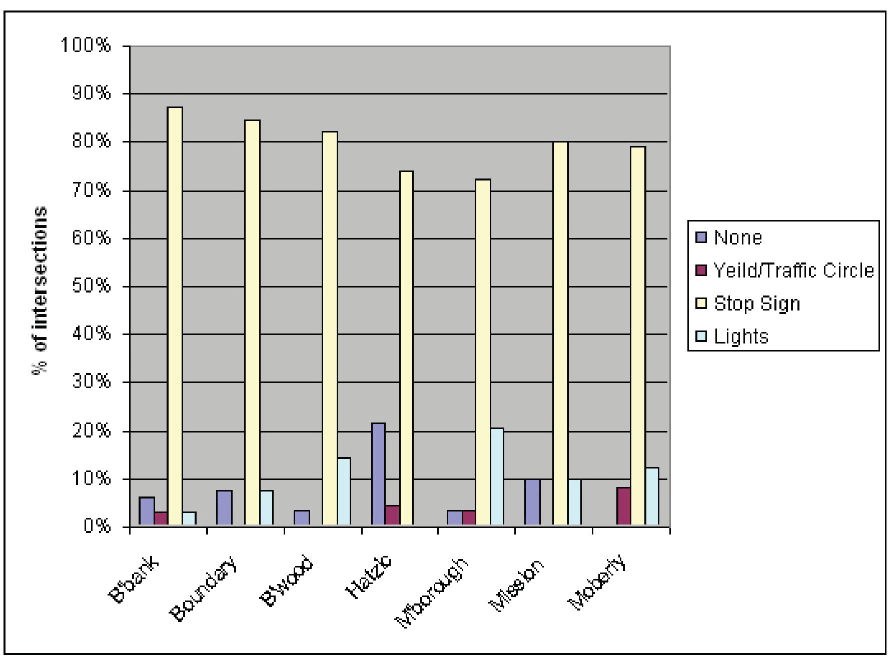
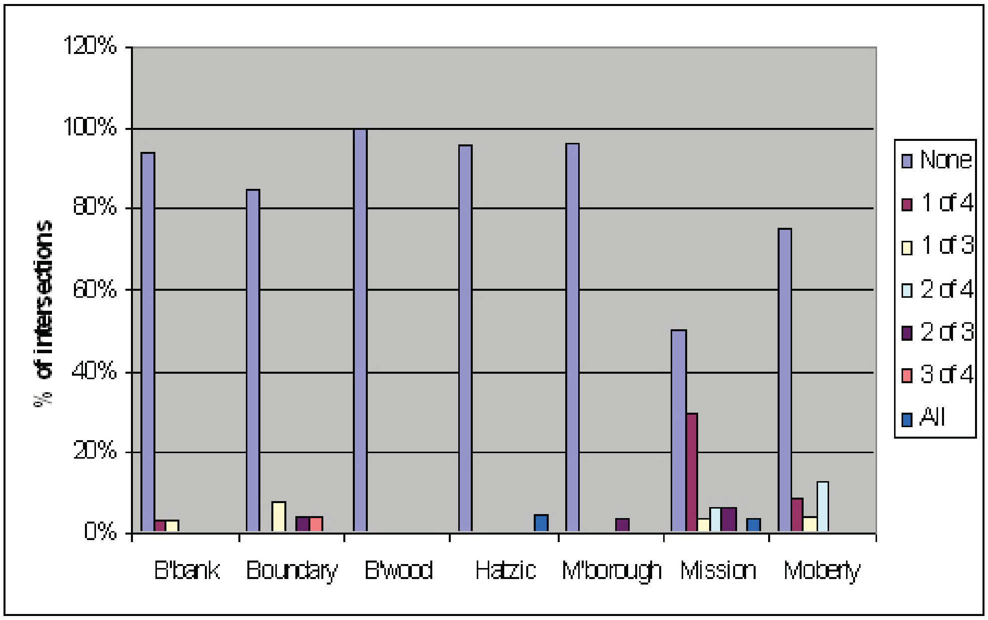


Figure 14.13b Variation of Crosswalk Signage by School



Street Segments

Valid data were obtained for a total of 198 discrete street segments. Among the measured elements included in this study, the greatest variation was found in the street grade, presence of sidewalks and existence of buffer between the sidewalk and road. The presence of traffic calming measures varies a little, with 75% of segments having no traffic calming and 20% having one traffic calming element. There was very little variation in the total number of lanes, with 86% having one lane in each direction.

Figure 4.14 Proportional Distribution of Street Segment Characteristics.

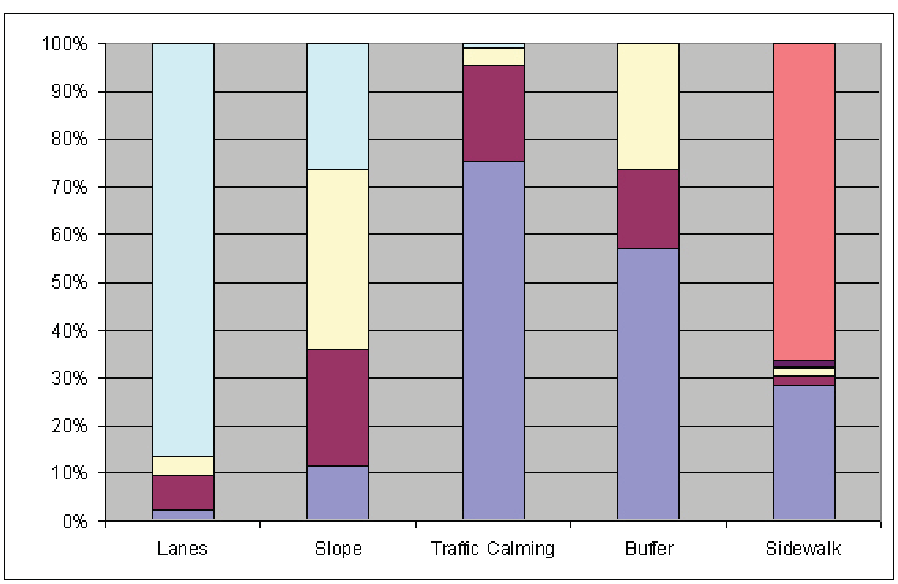


Figure 4.14 is comparable to Figure 4.12; it illustrates the proportional distribution of different characteristics for each street segment variable. The sample

was dominated by streets with 2 lanes and no traffic calming measures. Most streets have sidewalk on 100% of at least one side of the street, with the next biggest group being streets with none. Over half the streets measured had no buffer, but nearly 25% had a buffer on both sides of the street. This figure shows that the street grade or slope was the variable showing the most even distribution.

Figure 4.15a Variation of Sidewalk Coverage by School

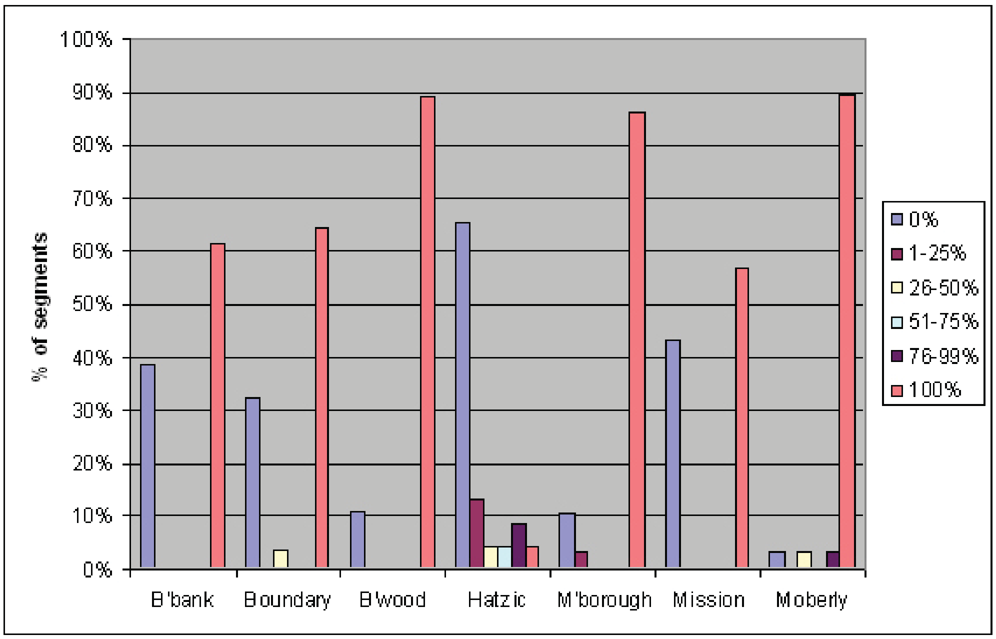
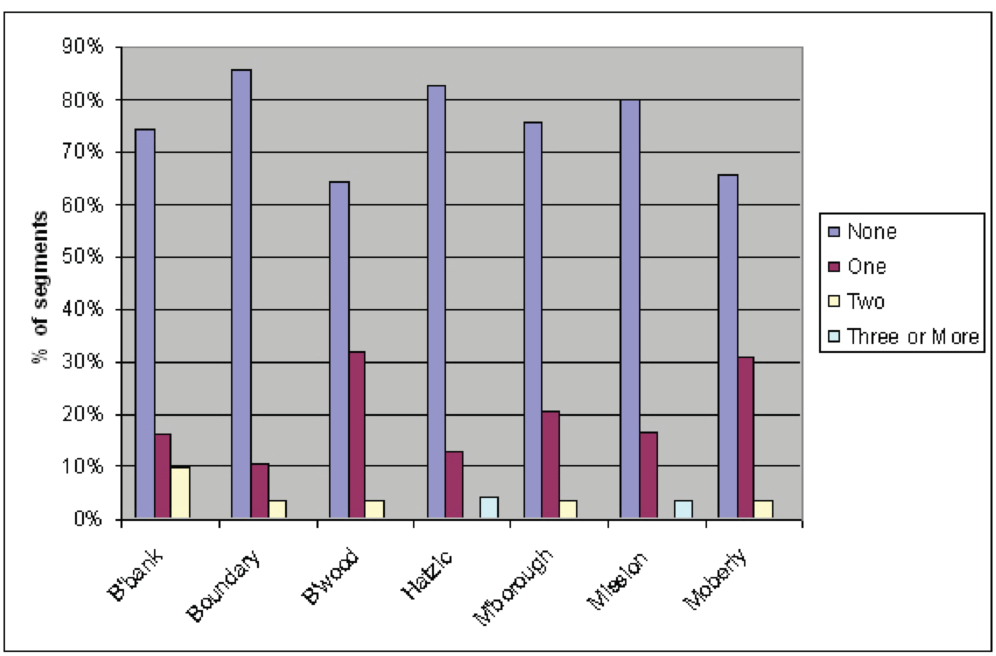


Figure 4.15b Variation in the Presence of Traffic Calming Elements



Figures 4.15a and 4.15b provide other evidence of the variation between schools. Three of the seven neighbourhoods are represented by only segments with no or complete sidewalk coverage while two others (Boundary and Marlborough) have only a small amount of streets that fall outside this category. While this isn't a huge diversity of sidewalk coverage, it does create two very distinct groups which will

contribute to additional variation in the calculation of unique pedestrian friendliness scores. Hatzic Elementary School exhibits the greatest difference from the other neighbourhoods with almost no street segments with complete sidewalk coverage, over 60% without any sidewalk, and 30% with partial coverage. All of the schools have some street segments with some traffic calming elements. Both Hatzic and Mission Elementary Schools have several segments with 3 or more traffic calming measures, although Brentwood and Walter Moberly have the highest proportion of segments with some kind of calming installed.

Figure 4.16a Distribution of Pedestrian Friendliness Scores

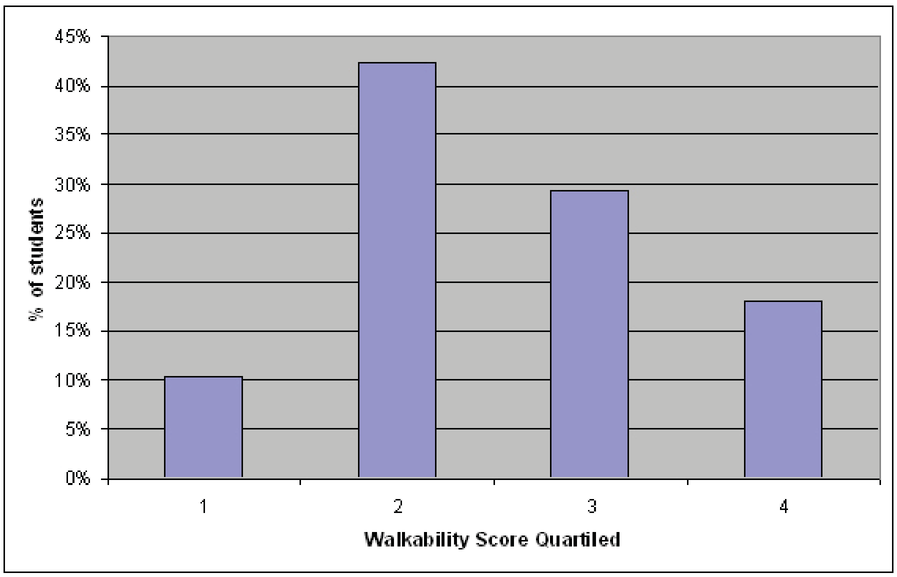
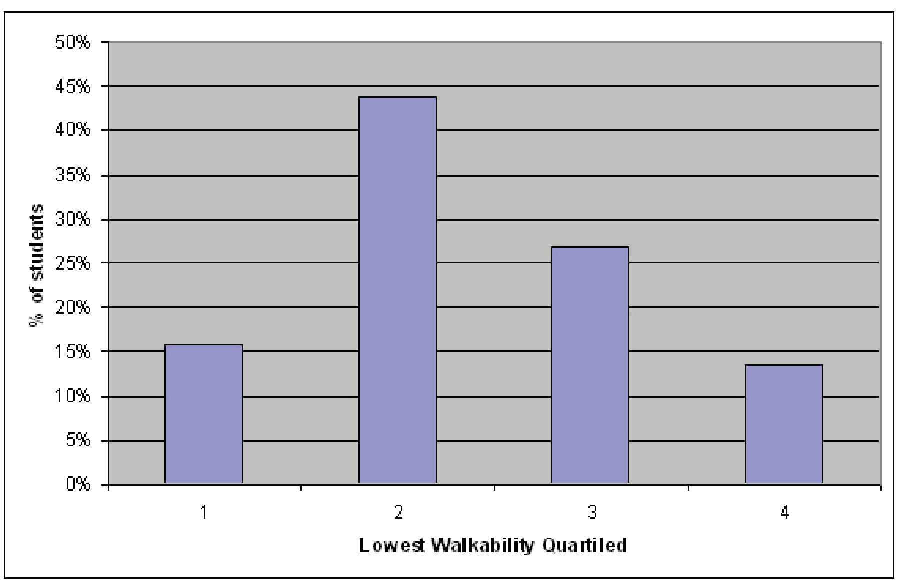


Figure 4.16b Distribution of Lowest Pedestrian FriendlinessScores



Variation in urban form was also more pronounced on a route by route basis. Scores based on the equal weighting method ranged from 1.55 to 6.42. Scores based on the equal weighting lowest score method ranged from 1 to 6. Figures 4.16a and 4.16b illustrate the distribution of pedestrian friendliness and lowest pedestrian friendliness scores after quartiling the scores. Although the proportions of students in each score category are similar, the pedestrian friendliness score is not a perfect predictor of the lowest pedestrian friendliness score.

Figure 4.17a Pedestrian Friendliness Score Quartiled by School

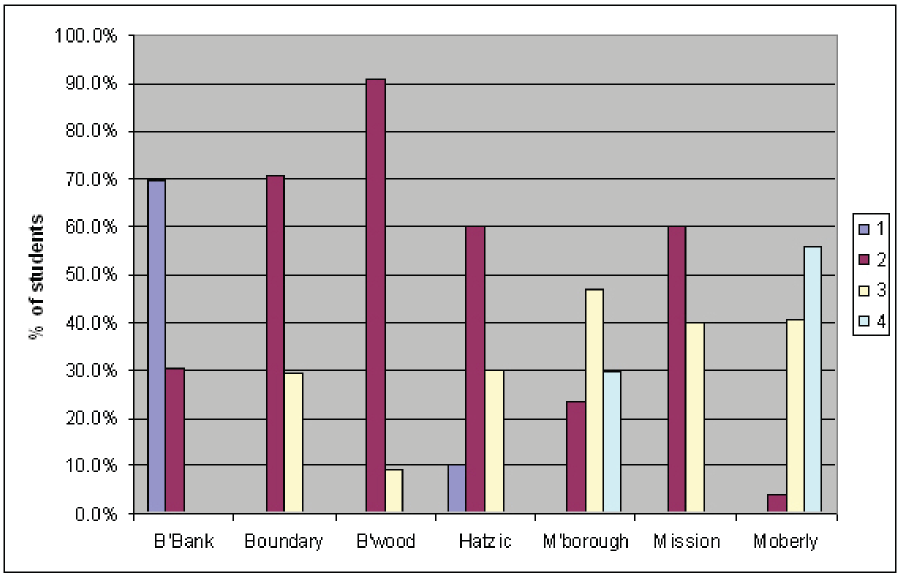
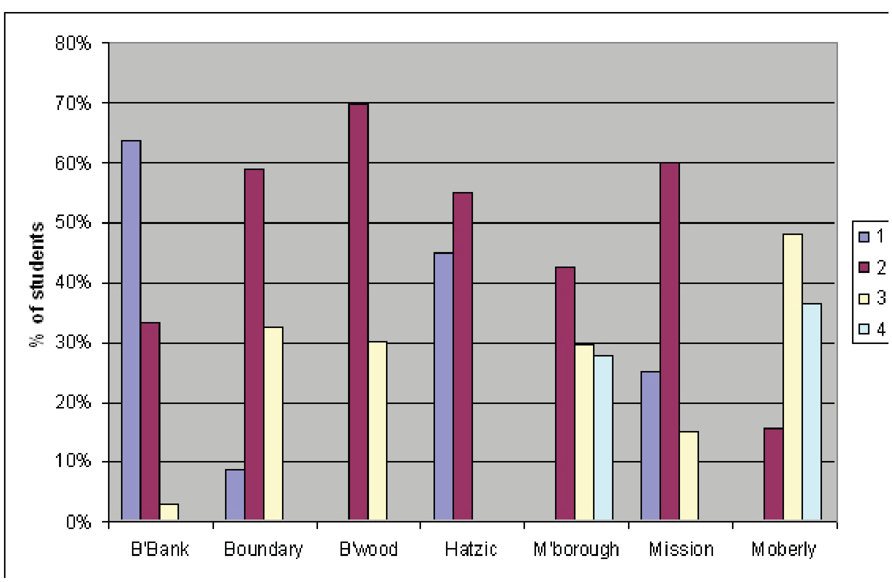


Figure 4.17b Lowest Pedestrian Friendliness Score Quartiled by School



Figures 4.17a and 4.17b illustrate how the pedestrian friendliness and lowest pedestrian friendliness indices vary by school. Brooksbank has the highest concentration of low scores for both the indices with Marlborough and Walter Moberly have the most scores in the upper ranges. A visual comparison between the school pedestrian friendliness indices and scores for the characteristics in Figures 4.13 and 4.15 reveals some links. For example, Walter Moberly and Marlborough have among the highest proportions of sidewalk coverage and lowest proportions of uncontrolled intersections. They are also the only two schools with

scores in the highest quartiles for pedestrian friendliness.

Table 4.4. Summary of Selected Pedestrian Environment Scores.
(For full details see Appendix F)

	Full Sample	B'bank	Boundary	B'wood	Hatzic	M'brough	Mission	Moberly
Sample Size	**239**	**33**	**34**	**33**	**20**	**47**	**20**	**52**
Pedestrian Environment Scores	**Low=poor pedestrian environment**	**High=good pedestrian environment**						
Lowest	2	2	3.15	3.26	2.66	3.5	3.61	3.89
Highest	6.23	4.04	4.7	4.67	4.34	5.83	4.63	6.22
Average Quartiled Score	2.55	1.3	2.29	2.09	2.2	3.06	2.4	3.5

However, the distribution of street segment scores in a catchment area is not necessarily reflective of the unique walkability scores. This is because students' homes are often clustered with some street segments appearing in numerous unique route equations and others (especially the major arterials on the catchment boundaries) appearing in only one or two.

4.2 Brooksbank Elementary School, North Vancouver

(See Appendix F for tables summarizing this data.)

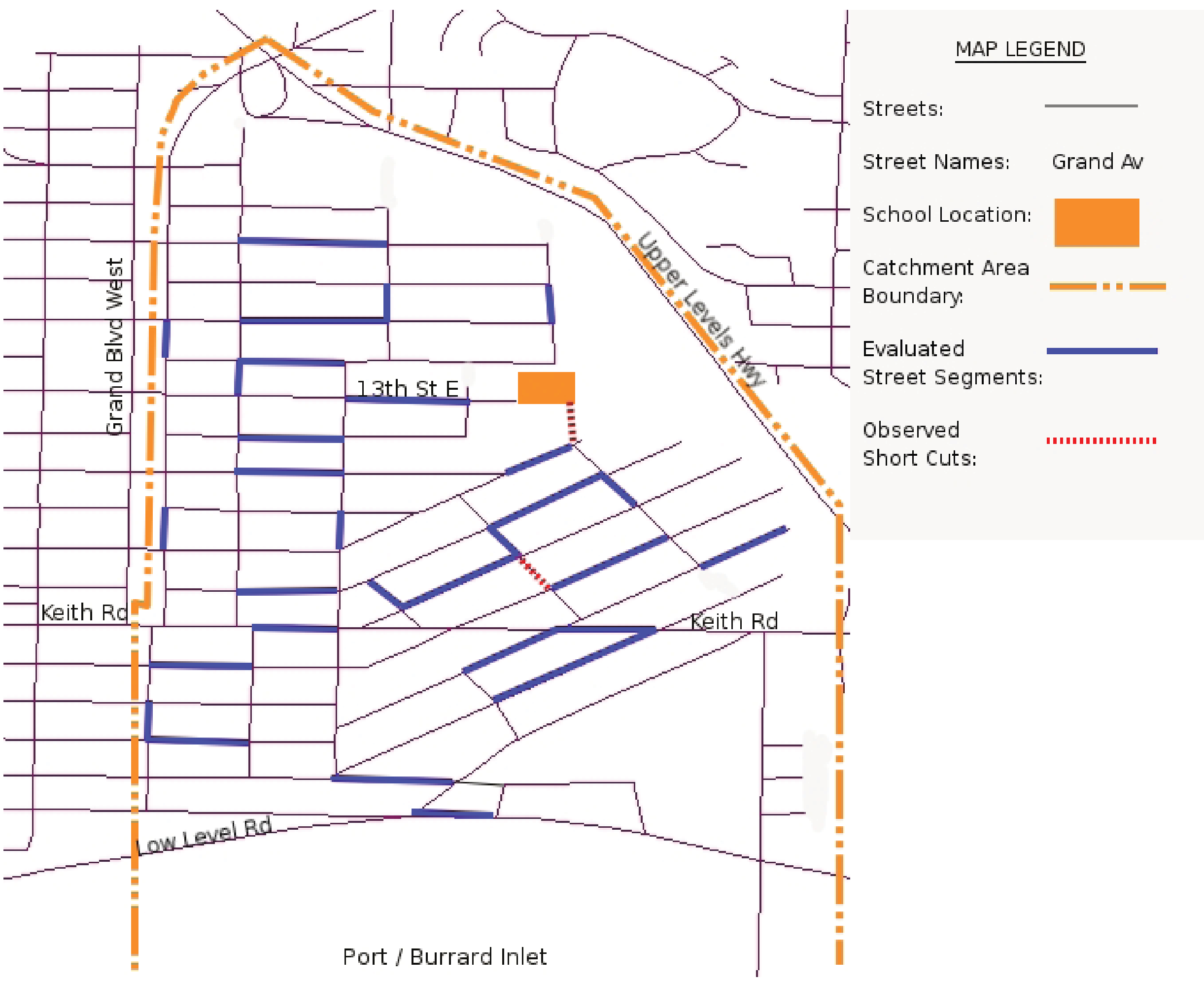
Brooksbank Elementary School in the North Vancouver School District has a current enrollment of 343 students from Kindergarten to grade 7. The catchment area is approximately 2.1km from north to south, and 1.5 km east to west at its widest point for an estimated 2.5 km^2; the school is located in the central-eastern portion of the catchment boundary. The Upper Levels Highway forms the eastern border of the catchment area. Grand Boulevard and Keith Road are the two largest streets that any child in this sample population would have to cross. Keith accommodates fast-moving traffic with two lanes in each direction; some intersections have traffic lights. Grand Blvd East has only one wide lane in each direction but traffic may be moving quickly going to or from highway access points and Lynn Valley Road. There is a linear public park to the west side that separates Grand Blvd East from Grand Blvd West; there are limited places for cars to cut through the park area which are controlled by 4-way stops.

Photo 4.1 Brooksbank Elementary School

The Brooksbank catchment area is dominated by single family homes, and is built on a modified grid pattern of streets with a number of cul-de-sacs backing on to the hydro corridor beside the highway to the east of the school. There is a small industrial and retail district in the south-east corner that does not intersect with the route to school of any children involved in this study.

Brooksbank sits at the terminus of a quiet residential street where the end of the road becomes the school's small parking lot. The school is set behind the parking area, with a large play structure and playing fields to the side. Several informal pathways connect adjacent houses to the playing fields, and a municipal trail runs for several kilometres through the corridor between the rear of the school and the Upper Levels Highway.

Figure 4.18 Brooksbank Elementary Catchment Area with Evaluated Segments Marked



4.2.1 Demographics and Distance

A total of 65 grade 4 and 5 students from Brooksbank submitted signed consent forms to participate in the Action Schools! BC research program (including the walkability survey). Thirty-five (53%) of these responded and live within the catchment boundary.

The Brooksbank sample has 20 boys and 15 girls. Two of these are 11 years old, with the rest almost evenly divided between 9 and 10 years. The respondents live in relatively high income households; fewer than 20% report earning under $50,000 per year and more than 30% earning over $80,000. The approximate average income falls just above $60,000, compared to approximately $71,000 reported in the 2001 census. There are no households earning less than $30,000. Likewise household vehicle ownership is high, with every household owning at least one car, 57% owning 2 cars and over 17% owning 3 or more cars. Over 90% of respondents live within 1.5 km of the school and 31% are within 500 metres.

4.2.2 Travel Behaviour

The vast majority (66%) of responding parents indicated their child is driven to school most of the time, with 26% walking to school. However, the split is reversed for the return from school trip when 51.4% of parents reported their child walks most of the time and only 43% are picked up by vehicle. No children ride a bicycle either to or from school. However, most Brooksbank students would prefer to be active, with 51% indicating walking as their favourite way to get to school and 9% indicating they prefer to bike. Sixty percent of children indicated they have been encouraged by teachers to use non-motorized travel for coming to school. Short distances between home and school appear to be factors in children walking as nearly 75% of parents either “somewhat” or “strongly” disagreed that the school is too far for their child to walk.

The top two reasons cited for using these travel modes were ease of scheduling (37%) and convenience (34%), followed by distance and safety from strangers and bullies (23% each). Personal preference of the child and opportunity for exercise both ranked high

(14% and 17% respectively) while safety from traffic was selected as an influencing factor by only 5.7% of responding parents.

Motorized travel is clearly the predominant choice for household trips with 66% indicating they choose non-motorized travel either never or less than one time per week; 30% use active travel 1-3 times per week.

4.2.3 Perceptions of Safety

Both parents and children at Brooksbank feel their neighbourhood is relatively safe. Only 1 (of 33) parents “somewhat disagreed”, and none “strongly disagreed” with the statement that their neighbourhood is a safe place for their child to walk. However, when asked specifically about their child walking *to school*, this number increased with 26% “somewhat disagreeing” or “strongly disagreeing” that their child is safe from traffic, and 20% either “somewhat” or “strongly” disagreeing that their child is safe from strangers or bullies. Almost half the children agreed “a lot” that they feel safe from cars, with less than 6% disagreeing; significantly fewer felt safe from strangers or bullies, with 20% not agreeing, and 51% agreeing only a little. Slightly more disagreed with feeling safe walking by themselves. Despite these apprehensions, two thirds of the children agreed “a lot” and none disagreed that walking is easy and fun.

Parents were divided regarding driving and their responsibility as a parent; over 60% selected “strongly” or “somewhat” agree; 29% “somewhat disagree”; less than 9% “strongly” disagreed that driving is an important parental responsibility.

4.2.4 Micro-Scale Pedestrian Environment Evaluation

Valid data was collected for 31 discrete street segments, as indicated in Figure 4.18. Most (94%) of the streets were 2 lanes wide – one lane in each direction - with the remaining 2 street segments having 3 lanes. The area is quite hilly, and 84% of all segments had at least some slope; 29% had a moderate grade steep and 20% were very steep. Deliberate measures to calm traffic were found on one quarter of the street segments, with 10%

having more than one calming element. Sixty-one percent of streets had sidewalk along the entire length of at least one side, but only 21% of these (13% of total street segments) have a buffer between the sidewalk and the street.

In the Brooksbank catchment 32 intersections were evaluated. Almost two-thirds of the intersections were 4-way, with the rest being 3-way or “T” intersections. Ninety-one percent have either a stop sign or stop lights, but less than 10% have any kind of crosswalk marking either on the roadway or with signage.

4.3 Boundary Community Elementary School, North Vancouver

(See Appendix F for tables summarizing this data.)

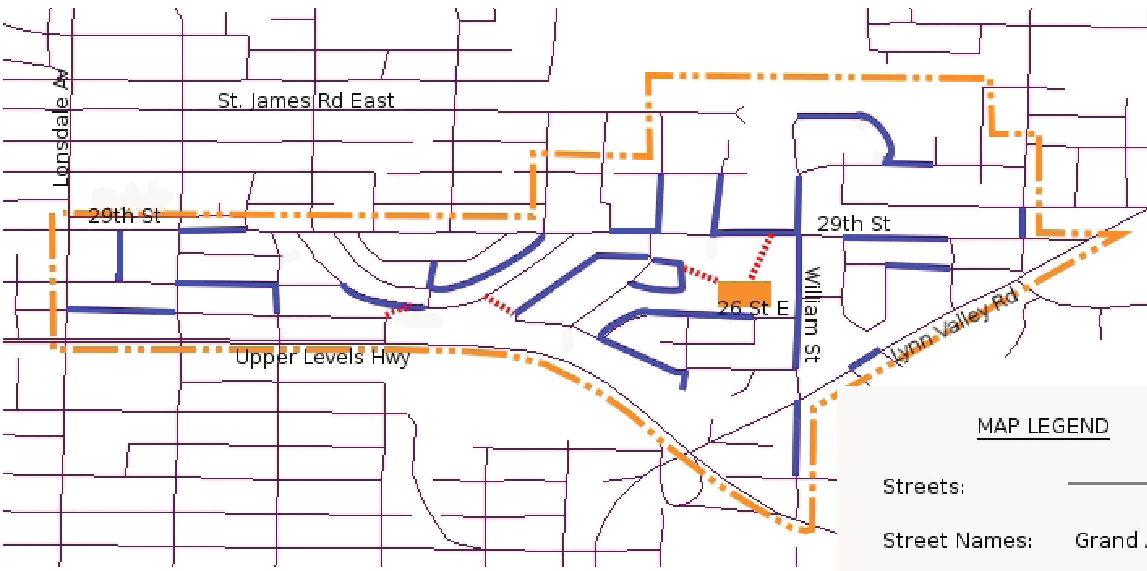
Boundary Community Elementary School in the North Vancouver School District has a current enrollment of 292 students from Kindergarten to grade 7. The oddly shaped catchment area is 2.2km at its longest width and 1.5km at its tallest point or approximately 2.3 km^2; the school is located almost in the centre of the catchment. Lynn Valley Road is a major through-fare with traffic entering and coming from the Upper Levels Highway. A few students in the sample population have to cross this road; traffic lights are located at William St. and Lynn Valley. 29th Avenue is also a significant street in that the lanes are wide and traffic moves fairly quickly. There are limited places to cross with the 4-way stop at William and 29th being the most controlled.

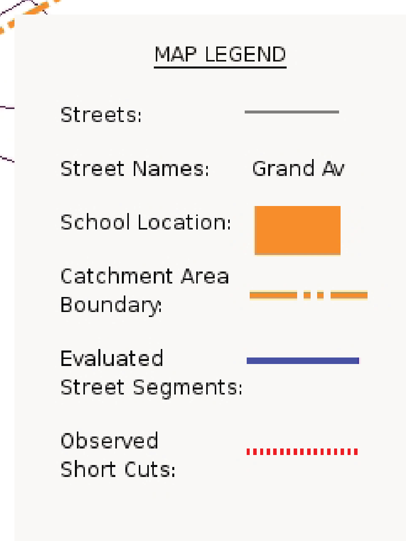
Photo 4.2 Boundary Community Elementary

The school building is situated close to the sidewalk on a quiet residential street, with two small parking lots at the front and side. There is a large play area behind the school, including a baseball diamond (with no outfield) and a climbing aparatus. Three informal pathways connect from the rear of the play area to adjacent streets, providing short cuts to adjacent streets and homes.

The Boundary catchment area is an exclusively residential area of single family homes with a rough grid pattern interrupted by crescent streets. A series of formal and informal pathway short-cuts connect the crescent streets reasonably well to the adjacent grid; examples include short cuts between 26th Street and Tempe Crescent, and between Tempe Crescent and Tempe Knoll.

Figure 4.19 Boundary Community Catchment Area





4.3.1 Demographics and Distance

A total of 57 grade 4 and 5 students from Boundary submitted signed consent forms to participate in the Action Schools! BC research program (including the walkability survey). Thirty-four complete survey pairs were returned from students living within the catchment area.

The gender of respondents was split almost 60:40 in favour of girls. Over half the children were 10 years old at the time of the survey with 44% being 9 years old, and only 1 being 8 (likely a child with a birthday late in the year.) The majority of students report living quite close to the school; 44% are less than half a kilometer away, 94% less than a kilometer, and 100% less than 1.5 kilometres.

Income distribution varies dramatically among respondents, with the most frequent response (32%) being $100,000 or greater, but a nearly equal amount reporting household income below $50,000. The approximate average income falls just above $60,000, compared to $85,000 in the census. Nearly 20% of households earn less than $30,000, contrasting with Brooksbank where no families were in the bottom two categories. Household vehicle ownership closely follows income; 30% own only one vehicle, 41% have two vehicles, and nearly 30% of households own 3 or more vehicles. There are no households reporting 0 vehicles.

4.3.2 Travel Behaviour

Forty-seven percent of the children are driven to school, and only 41% driven home. Active modes of transport (including walking) are the second favourite option at 44%, rising slightly to 50% for the journey home. As with Brooksbank, many children who are currently driven would prefer to use an active mode of transport; less than 9% indicated that being driven is their favourite way to get to school with the remainder preferring to walk or use another non-motorized mode of travel. More than three quarters of respondents indicated that their teacher encouraged them to use non-motorized travel for coming to school, which may be an influencing factor. Eighty percent of parents strongly disagreed that their child's school is too far away to walk or bike, suggesting (not surprisingly) that distance is not the only consideration in travel mode choice. Just under half (46%) of participating families reported using some non-motorized mode of travel for non-school trips one or more times per week.

Parents at Boundary Community cited convenience (38%) and distance (26%) as the top reasons for their travel mode choice, followed by easiest daily schedule (24%). Eighteen percent of parents felt that traffic safety was a significant influence while only 12% felt that strangers and bullies were a primary influence. More parents selected opportunity for exercise and child's preference than safety from strangers and bullies.

4.3.3 Perceptions of Safety and Travel Preferences

Most (88%) parents felt their neighbourhood is safe for their child to walk, although traffic was somewhat of a concern to parents, and children were particularly uneasy about strangers and bullies. Less than 6% of children said they "don't agree" to feeling safe from cars, while 24% "don't agree" to feeling safe from strangers and bullies. Sixty-eight percent of parents either somewhat or strongly agreed that their child is safe from traffic while walking to school, while over 85% felt the same about safety from strangers or bullies. Despite this concern for their safety, 85% of children agreed "a lot" that it is easy and fun to walk, supporting their stated preferences for walking or cycling to school rather than being driven. There was no agreement in parental opinion regarding their responsibility for driving their children to school.

4.3.4 Micro-Scale Pedestrian Environment Evaluation

Valid data were collected from 28 discrete street segments as marked in Figure 4.19. Only three (89%) of the street segments measured had more than 2 lanes, each of which had two lanes in each direction. Street grade varied from flat to steep, but with most segments having only a slight (61%) or moderate (21%) grade. Traffic calming measures were installed on 4 (14%) of the segments, with one segment having two calming elements. Sixty-four percent of the segments had sidewalks along 100% of at least one side, while 32% had no sidewalk at all. A buffer was recorded on only one of the segments with sidewalk.

Valid data were collected from 26 intersections. Three-way T-type intersections dominate the area, comprising over 65% of all intersections surveyed. Over 90% of intersections have some kind of traffic control, but three quarters have no kind of on-road crosswalk marking and only 15% have any lights or signage to designate them as cross-walks. Only two of the intersections surveyed had any kind of button-controlled pedestrian crossing indicator.

4.4 Brentwood Park Elementary School, Burnaby

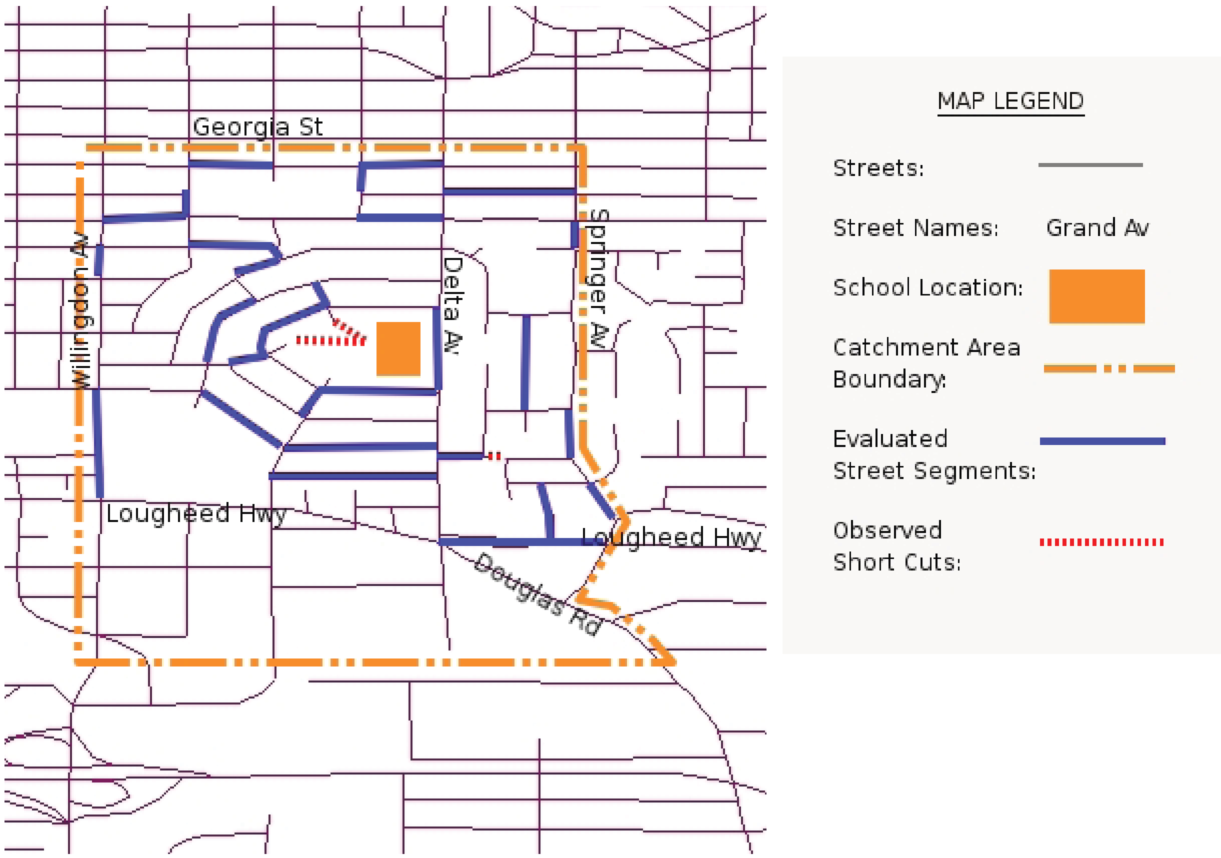
(See Appendix F for tables summarizing this data.)

Brentwood Park Elementary School, located in the City of Burnaby has a current enrollment of approximately 400 students from Kindergarten to grade 7. The catchment area is relatively small, extending 1-5km north-south and 1.2km east-west with an area of 1.9 km^2. Brentwood Elementary is in the centre of the catchment, situated on a minor through-street. The school backs onto a community park and is surrounded by the back laneway for the residential crescent immediately adjacent. The school's website reports a culturally and socio-economically diverse population with 15% of all students receiving English as a Second Language (ESL) instruction.[1]

Photo 4.3 Brentwood Park Elementary School

The Brentwood catchment area contains a combination of single family and multi-family residences. The Brentwood Mall is located at the corner of the catchment area with some high-density residential adjoining it. The major streets are in a rough grid pattern, but an area of concentric crescent streets dominates the area to the west of the school. The southern part of the Brentwood catchment is industrial (close to the railroad tracks), but no students from the sample live in that area. The Lougheed Highway cuts through the catchment area, but development to the south of this is primarily commercial/industrial; there are no students in the sample that have to cross the highway. Willingdon Avenue and Springer Avenue South are both substantial through streets but they form the boundaries of the catchment and no children cross these either. Parker St. to the north is the next largest and some children are required to cross it; it is residential with a high school and one wide lane of traffic in either direction. Intersections are controlled by stop signs, except for traffic lights at Springer and Willingdon.

Figure 4.20 Brentwood Park Elementary Catchment Area



4.4.1 Demographics and Distance

A total of 53 grade 4 and 5 students from Brentwood Park submitted signed consent forms to participate in the Action Schools! BC research program. Thirty-three complete survey pairs were returned from students living within the catchment area.

The gender distribution is almost equally split with only one more boy than girl among respondents. Over 90% of the children are 9 or 10 years old; two (6%) are 11 years old. No children live greater than 1.5km away from school; 15% are less than 500 metres away and 85% are under 1km. Income distribution is skewed towards the lower end of the scale with nearly 50% of households earning less than $40,000; a mid-size cluster of households reported income between $50-$69,000 (24%) and 6% reported over $100,000. The approximate average for the group is between $45-$50,000, compared to $56,000 reported in the census.

Vehicle ownership is moderate, with 60% of households reporting only one vehicle. Nonetheless, nearly 9% of the households reported 3 or more vehicles.

4.4.2 Travel Behaviour

Half of the Brentwood students reported walking to school in the morning, a figure that rises to 58% for the journey home. Forty percent are driven to school, but only 30% picked up by car. The remainder selected multiple responses. Brentwood students also express a preference for active modes of travel, with 83% reporting walking, bicycling, or another active mode as their favourite way to get to school, and only 12% preferring to be driven. Less than half half indicated their teachers encouraged them to use non-motorized travel to come to school.

Travel choice for non-school trips is almost evenly split between never or rarely (<1 time per week), and 3 or more times per week.

4.4.3 Perceptions of Safety and Travel Preferences

A strong majority (85%) of parents either strongly or somewhat agreed that their neighbourhood is a safe place for their child to walk, but this changed dramatically when they were questioned about specific dangers for their child walking to school. Only 9% strongly agreed and 55% somewhat agreed that their child is safe from traffic; 12% strongly and 47% somewhat agreed their child is safe from strangers and bullies. Childrens' perceptions of safety were mixed, with feelings of safety from cars almost evenly divided between agreeing a lot, agreeing a little, and not agreeing. Children were more apprehensive about strangers and bullies with 39% disagreeing that they feel safe, and only 15% agreeing a lot. Once again, the children's preferred modes of travel did not reflect any safety concerns, with 67% agreeing "a lot" and 27% "agreeing a little" that it is easy and fun to walk.

There was no agreement in parental opinion regarding their responsibility for driving their children to school. Sixty-four percent strongly disagreed that the school was too far away for their child to walk, while only 3% strongly agree with that statement.

4.4.4 Micro-Scale Pedestrian Environment Evaluation

Valid data were obtained for 28 discrete street segments in the Brentwood catchment as marked in Figure 4.20. Eighty-nine percent have one lane in each direction; two streets have 4 lanes, and one segment (Willingdon at Brentlawn) has 6 lanes (3 in each direction). The area is relatively flat, with 65% of the segments being flat or having only a slight grade; only 2 segments (7%) were considered steep. More than one third of street segments have at least one traffic calming element. Sidewalk coverage is good with 89% of segments having sidewalk on 100% of at least one side; however only 18% of the segments have any kind of buffer.

Valid data were obtained for 28 intersections in the Brentwood catchment area. Forty-three percent of the intersections were 3-way and 57% are 4-way, and over 96% of them have either a stop sign or traffic lights. Only 18% of intersections have any crosswalk marking, half of which (3 intersections) are marked on all legs; there are no pedestrian crossing signs, but 4 intersections do have have a pedestrian crossing button.

4.5 Hatzic Elementary School, Mission

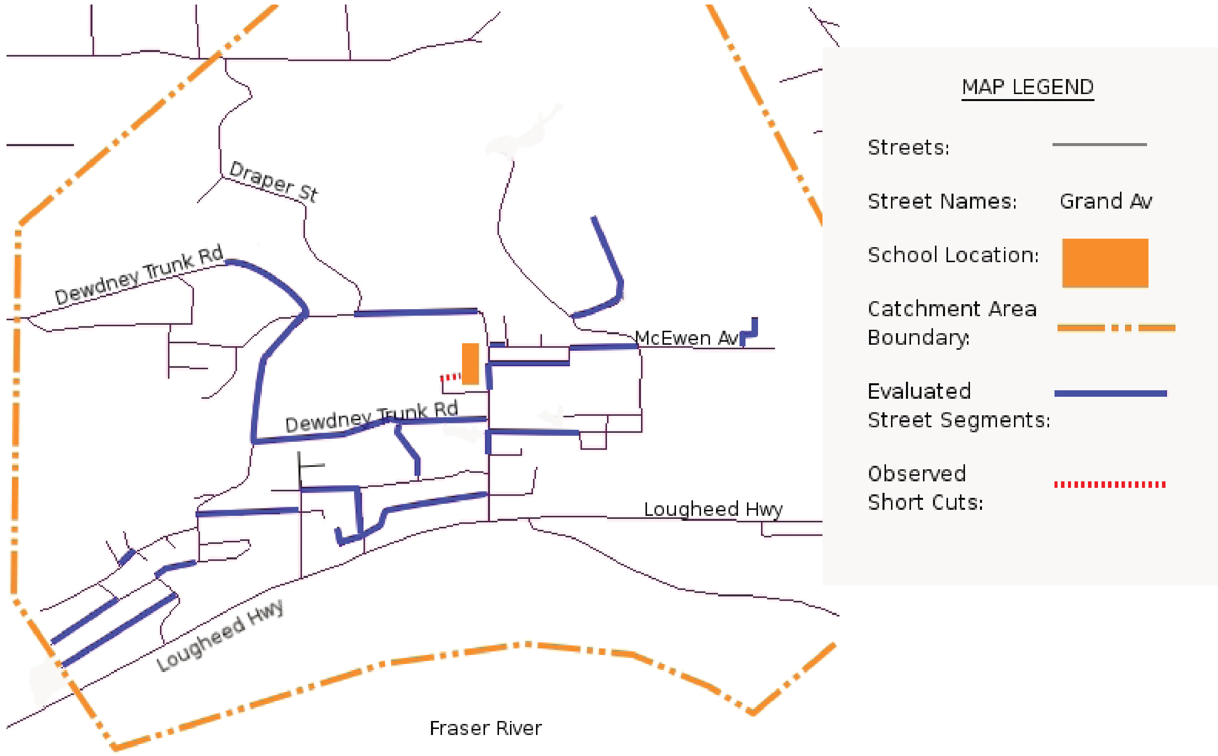
(See Appendix F for tables summarizing this data.)

Hatzic Elementary School in Mission has a current enrollment of approximately 250 students from Kindergarten to grade 7. The catchment area is over 4km long and 2.2km wide; the total area is over 4.5km^2, making it the largest catchment area of any school included in this study. The school is located in the south-central portion of the total catchment, but is toward the northern portion of the main Hatzic settlement. The school building is located close to the street on a main through-road with large play areas behind and beside and a limited amount of parking in front of the school. The road has a gravel shoulder but no sidewalk. Dewdney Trunk Road is the largest street that cuts through the catchment area, with one wide lane of traffic in each direction.

Photo 4.4 Hatzic Elementary School

The Hatzic community is somewhat isolated from the main town of Mission and is exclusively residential except for a monastery and one small convenience store. Development is a mix of semi-rural (multi-acre lots with agricultural land or wooded areas) and single-family dwellings at suburban densities. There are longer blocks and larger residential lots than the other schools in the study, and a pattern of more curvilinear and dead-end streets.

Figure 4.21 Hatzic Elementary Catchment Area



4.5.1 Demographics and Distance

A total of 47 grade 4 and 5 students from Hatzic Elementary submitted signed consent forms to participate in the Action Schools! BC research program (including the walkability survey). Twenty complete survey pairs were returned from children living within the catchment area. A specialized arts program at the school likely draws students from outside the catchment, but only children within the catchment were included in the study.

Respondents include 9 boys and 11 girls. The population is slightly younger than at the previous schools with 65% being only 9 years old at the time of the survey; 30% were 10 years old, and 5% (one student) were 11. Despite the large catchment area, 30% of live less than 500 metres from school, and an additional 25% under 1km. Three students (15%) live between 2 and 2.5km.

The Hatzic population has households reporting in almost every income bracket, but only 3 (15%) reported earning less than $50,000; 30% fall between $60-$69,000; 20% earn greater than $100,000 per year. The approximate average falls between $60-$70,000, compared to $71,500 in the census. Every family has at least one vehicle, with 55% having 2, and 30% having 3 or more vehicles.

4.5.2 Travel Behaviour

Travel to school is evenly divided between being driven and active modes. One child (5%) switches from driving to walking for the afternoon journey. Seventy percent of the children like to be active on the way to school, with only 30% preferring to be driven. Just over half indicated their teacher had encouraged them to walk or bicycle to school.

Over half (55%) of participating families reported using some non-motorized mode of travel for non-school trips one or more times per week.

4.5.3 Perceptions of Safety and Travel Preferences

Ninety-five percent of parents either strongly (50%) or somewhat (45%) agreed that the Hatzic neighbourhood is a safe place for their child to walk. Although expressions of concern increased slightly when questioned specifically about traffic and strangers/bullies, there remained a strong overall trend of parents feeling their neighbourhood is safe for children to walk; only 10% strongly disagreed that their child is safe from traffic while none strongly disagreed about their child's safety from strangers or bullies. Children showed similarly low levels of concern about traffic, with only 10% *not* agreeing they feel safe from cars; a higher proportion (35%) are concerned about strangers or bullies. As before, a very high proportion of children agree it is easy and fun to walk (80% agree a lot; 10% agree a little).

A strong majority of parents either somewhat (45%) or strongly (15%) agree that driving their child to school is an important part of their parental responsibility. Only 25% somewhat or strongly agree that the school is too far for their child to walk or cycle.

4.5.4 Micro-Scale Pedestrian Environment Evaluation

In the Hatzic catchment, valid data were obtained for 23 discrete street segments, as marked in Figure 4.21. All the streets have only one travel lane in each direction. The area is generally flat (48% of segments), but with some moderate (22%) and steep (17%) hills. Seventeen percent of the segments have some traffic calming element, with two segments (including Draper in front of the school having three. However, sidewalk coverage is very poor with 65% of streets having no sidewalk, and an additional 13% having no more than 25% sidewalk on either side. Less than 5% of street segments have sidewalk on 100% of at least one side. Data indicate more segments have buffers than have sidewalks (a situation that is by definition impossible); unfortunately it was not possible to return and double check these scores.

Valid data were collected from 23 intersections. Less than 20% of the surveyed intersections are 4-way. Stop signs or stop lights are present at 74% of the intersections, although fewer than 10% have any kind of crosswalk marking and only 1 has a pedestrian crosswalk sign. None of the intersections have a pedestrian crossing button.

4.6 Marlborough Elementary School, Burnaby

(See Appendix F for tables summarizing this data.)

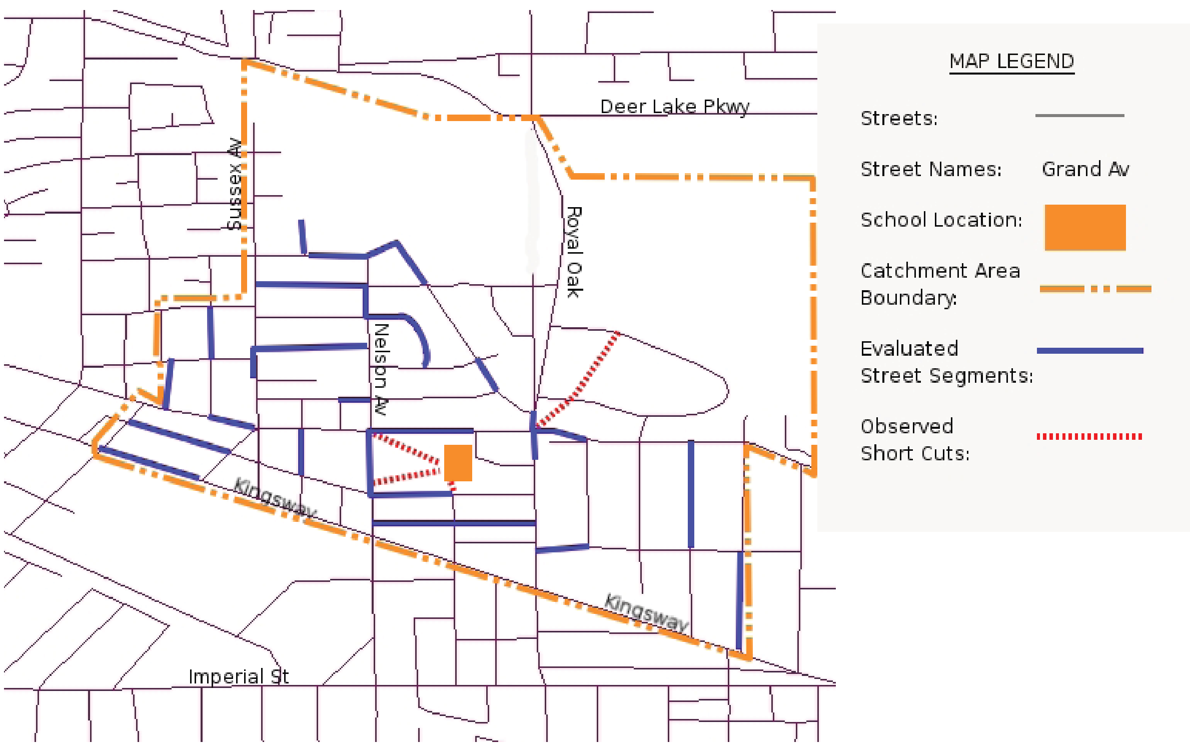
Marlborough Elementary School is the largest school in this study with 1050 students ranging from Kindergarten to grade 7. The relatively small catchment area (for the population) is 2.1km long by 1.5km wide and a total area of 1.9 km^2. This reflects the high-density residential towers near the Kingsway Road and adjacent Metrotown Mall, as well as an influx of students from outside the catchment for the French immersion program. The school property occupies almost the entire block surrounded by Royal Oak, Dover, Nelson, and Sanders. Sanders is the only of the four border streets that is not a significant through-fare; the others may present a barrier to children walking, although there are traffic lights at all four corners. Kingsway forms the catchment border to the south and has 2 to 3 lanes in either direction; it carries high volumes of fast moving traffic but no children in the sample are required to cross this street. The school buildings are surrounded by playing fields and some parking areas (off of Nelson). A one-way street cuts into the property between Royal Oak and Dover and acts as a driveway for a drop-off/pick-up facility. Although largely surrounded by a chain-link fence, there are pedestrian access points to the school yard from all sides of the block.

Photo 4.5 Marlborough Elementary School

The Marlborough catchment area has a mix of single family and high density residential dwellings, and is bordered by the Kingsway Road with some street-oriented retail on the north side, and the large Metrotown shopping mall/office/Skytrain complex on the south side. The northern catchment boundary cuts through Deer Lake Park. The street network is a modified grid with reasonably connected roads, but many three-way intersections.

The horse-shoe shaped Oakmount Crescent (east of Royal Oak) is bisected north to south by a linear park that connects the two halves of the crescent with a public staircase leading to the intersection of Oakland/Dover and Royal Oak. Pathways from adjacent multi-family developments intersect the park, making it a well-traveled area and a pleasant off-road short cut leading almost directly to the school.

Figure 4.22 Marlborough Elementary Catchment Area



4.6.1 Demographics and Distance

A total of 158 grade 4 and 5 students from Marlborough submitted signed consent forms to participate in the Action Schools! BC research program (including the walkability survey). Only 47 complete pairs were returned from students living within the catchment area, reflecting the school's French Immersion program.

The Marlborough gender balance is split almost 60:40 in favour of boys. Just over half were 10 years old, 44% were 9 years old, and 4% (2 children) were 8 years old at the time of the survey. All of the students in the sample live less than 1km from school, with 70% being less than 500 metres away. Nearly all income brackets are represented, however over 45% earn less than $40,000 while 67% earn less than $50,000. The approximate average income is between $40-$49,000 per year, compared to $48,000 reported in the census. No families report more than 2 vehicles, while nine percent of (4 families) have none, and 57% have only one vehicle.

4.6.2 Travel Behaviour

Marlborough has the highest number of students walking to school; 63% walk and only 28% are driven; the number of walkers rises to 70% for the return trip. There is a high latent demand for cycling to school with 13% selecting this as their favourite mode, and only 11% of students preferring to be driven. Only 26% indicated their teachers had ever encouraged them to walk or use some other active mode of travel to get to school, but this may reflect the high number of students already walking within the sample – or the difficulty in discouraging driving to school with a high proportion of the total student population living far outside the catchment.

4.6.3 Perceptions of Safety and Travel Preferences

Overall, nearly 85% of responding Marlborough parents somewhat or strongly agreed that their neighbourhood is a safe place for their child to walk. This perception dropped to only 66% when questioning safety from traffic on the way to school, and only 55% for safety from strangers. Many children also reported feeling safe from traffic with 44% agreeing a lot, and 48% agreeing a little. Like their parents, children showed more concern about safety from strangers or bullies; 26% indicated they did not agree with this statement and only 28% agreed a lot. The Marlborough students' interest in walking reflects their reported favourite modes of travel to school; only 1 student (2.2%) did not agree that it is easy and fun to walk, and 72% agreed a lot.

Despite the high number of children who walk, most parents strongly (33%) or somewhat (37%) agreed that driving their child to school is an important parental responsibility. This raises the question of how this statement was interpreted by some parents; it could have been interpreted as “making sure my child gets to school is an important responsibility as a parent.” Over three quarters of parents “strongly disagreed” that it is too far for their child to walk to school, while none “strongly agreed” and less than 7% somewhat agreed.

4.6.4 Micro-Scale Pedestrian Environment Data

Valid data were collected from 29 discrete street segments as marked in Figure 4.22. The number of lanes demonstrates the diversity of road types within the Marlborough catchment, and thus the various traffic conditions that children must encounter en route to school. Two-thirds (19) of the street segments have only 2 lanes, but 21% (6) have 4 (2 in each direction), 2 segments have 3 lanes, one has 5 and one (on Kingsway) has 6 lanes. The topography is generally flat with 65% of segments being flat or a slight grade, 31% moderately steep, and only 1 segment considered very steep. Traffic calming is present on almost one quarter of the segments and sidewalk coverage is very good. Eighty-six percent of street segments have sidewalk on 100% of at least one side; 10% have no sidewalk at all. Buffers are not as prevalent, with 45% of the streets having no buffer, and 14% having a buffer on only one side.

Valid data were collected from 29 intersections in the Marlborough catchment area. Fifty-nine percent of the intersections are 3-way intersections and the remaining 41% are 4-way. Ninety-three percent have either a stop sign or stop light, but only 31% have any kind of crosswalk marking. Only one intersection has any crosswalk signage, but 28% have one or more pedestrian crossing buttons.

4.7 Mission Central Elementary School, Mission

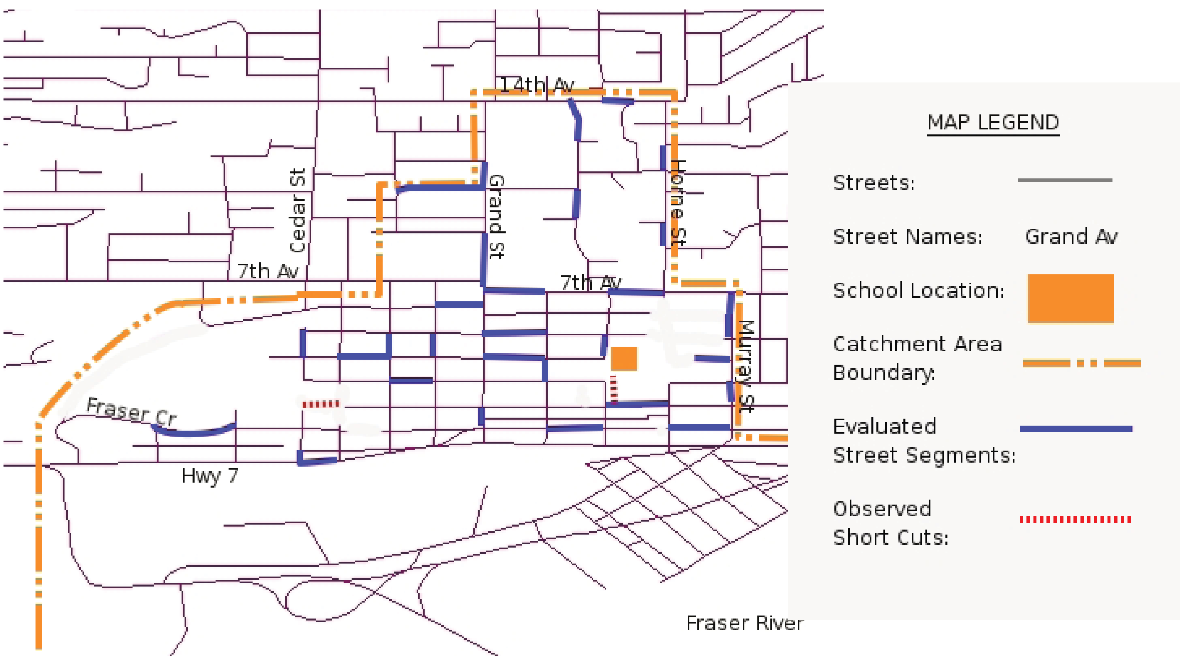
(See Appendix F for tables summarizing this data.)

Mission Central Elementary School has a current enrollment of 306 students from Kindergarten to grade 7. The catchment area is approximately 1.5km long by 2km wide with an area approximately 202 km^{2}. The school is the school located toward the south-east portion of the catchment on a quiet residential street with a steep ravine and a creek separating it from homes behind it (on and around Murray Street). There is a small parking area in front of the school, and a large playing field immediately to the south. A steep set of public stairs creates a connection up the hill from 2nd Avenue at Welton, directly to the school yard. A second (much smaller) set of stairs connects the school yard to homes on 5th Avenue (East of Welton). 7th Avenue and Grand Street are the two roads that may present barriers to some children walking to school. 7th Ave has a combination of residential and commercial uses with one to two lanes in each direction (depending on the street segment). Grand Street is of similar size with several outdoor public playing fields north of 7th Ave and residential to the south. Traffic lights are in place only at 1st Avenue and 7th Avenue, but there are several zebra-striped pedestrian crossings in between.

Photo 4.6 Mission Central Elementary School

The Mission Central catchment area has a tight grid pattern of streets with predominantly short blocks. The area includes street-oriented retail and mixed-use development, as well as single and multi-family residences. It is bordered to the south by the Lougheed Highway and the town's industrial port district. The terrain includes numerous steep hills (mostly rising from south to north). Two sets of public stairs are particularly important for the students in this sample to access the school; one (described above) from 2nd Ave to the school yard, the other connecting the west and east portions of 1st Ave (near Maple).

Figure 4.23 Mission Central Elementary Catchment Area



4.7.1 Demographics and Distance

A total of 63 grade 4 and 5 students from Mission Central submitted signed consent forms to participate in the Action Schools! BC research program. Only twenty complete pairs were returned from students living within the catchment area, reflecting the French Immersion program that draws students from far outside the catchment.

The sample includes nearly twice as many girls as boys. Half the children were 10 years old at the time of the survey and another 45% were 9 years old; only 1 was 8. All respondents live less than 2km from school, with 20% being less than 500m, and an additional 50% being less than 1km. Reported household incomes are clustered in high and low income brackets; 55% earn less than $50,000 per year while 25% earn more than $80,000. The approximate average income is $40-$49,000, compared to $49,000 reported in the census. Household vehicle ownership reflects this with 2 households (10%) reporting no vehicle and 45% having only one; 5% of households report three vehicles but none have more than 3.

4.7.2 Travel Behaviour

Fifty percent of respondents walk to school, with 45% driving by car and one student (5%) taking a school bus. In contrast to the other 6 schools in the study, the number of children using motorized modes of travel increases for the journey home. Only 30% of respondents walk home, while half are driven and 3 (15%) take a school bus. None reported bicycling or using another active mode of transport for the trip to or from school. However, half of all children use an active mode for at least one of their trips to or from school. This is also the only school sample with a latent demand for being driven to school; 55% of Mission Central children prefer to be driven while only 30% prefer to walk and 15% would like to bicycle or use another active mode. Seventy-five percent of students indicated their teachers had never encouraged them to use an active mode of travel to get to school – a factor again (like Marlborough) potentially influenced by the large proportion of the school population that travels long distances to attend the French Immersion program.

Somewhat reflecting travel mode to school, 50% of parents indicated they never or rarely (<1 time per week) use a non-motorized mode for non-school trips. Thirty-five percent use an active mode 1-3 times per week, and 3 families (15%) indicate using an active mode 4 or more times per week (reflecting the 2 families who do not own any vehicles).

4.7.3 Perceptions of Safety and Travel Preferences

Seventy-five percent of parents somewhat or strongly agree that their neighbourhood is a safe place for their child to walk, and nearly as many (70%) believe their child is safe from traffic. The strong and somewhat agreement of safety drops to only 60% when considering strangers and bullies. The children's perceptions of safety reflect their parent's views with only 25% disagreeing that they feel safe from traffic, and 35% disagreeing about safety from strangers or bullies. Despite the stated preference for being driven to school, only one student disagreed that it is easy and fun to walk; 70% strongly agreed.

Parents opinions were completely divided on whether driving their child to school is an important responsibility, with strong opinions each garnering a 20% response, and the "somewhat" opinions each 30%. However, most parents (80%) either somewhat or strongly disagreed that they live too far from school for their child to walk.

4.7.4 Micro-Scale Pedestrian Environment Data

Valid data were obtained from 30 street segments as marked in Figure 4.23. Small-volume streets with only 2 lanes represent 25 (83%) of the segments measured; 4 segments have 3 lanes and 1 segment (on Grand Street) has 4 lanes. The topography is mostly flat and slight grade (67%), but with several moderate (17%) and steep (17%) hills. Twenty percent of segments have at least one traffic calming measure. Just over half the segments have 100% sidewalk on at least one side, but the rest have none at all; buffers are present on all but one segment with sidewalks. Sidewalks are inconsistent, being present on one block and missing on the next block of the same street.

Valid data were collected from 30 intersections in the Mission Central catchment. Two-thirds of the intersections are 4-way, and one-third are 3-way; 80% of the intersections are controlled a stop sign. Marking of crosswalks is inconsistent among the sampled intersections; 43% have no markings, 13% have markings on all legs. Crosswalk signage is similarly varied, although half of the intersections have crosswalk signage on at least one leg. Pedestrian buttons are installed at only 2 of the intersections – both along Grand Street.

4.8 Walter Moberly Elementary School, Vancouver

(See Appendix F for tables summarizing this data.)

Walter Moberly Elementary School in the City of Vancouver has a current enrollment of over 770 students from Kindergarten to grade 7. The school is very culturally diverse, with 69% of students enrolled in English as a Second Language (ESL) programs and 93% living in households where English is not spoken at home. There is a small asphalt play area at the front, with parking at the side. The remainder of the block between Ross and Prince Albert is a municipal park with several playing fields and a baseball diamond. The catchment area is the smallest in the study group, measuring approximately 1.2km from north to south (discounting the industrial and river area to the south) and only 1km east to west for a total of 1.1 km^2. The school is roughly in the centre of the catchment at the intersection of two residential streets.

Photo 4.7 Walter Moberly Elementary School

The Walter Moberly catchment area is largely comprised of single family homes, with small commercial/industrial clusters along Knight Street and South East Marine Drive. Knight Street connects to a bridge crossing the Fraser River and is an important trucking route with high volumes of high speed traffic. Fraser Street and South East Marine are likewise busy, but with fewer large trucks and better buffers. Fortunately, few students in the sample are required to travel along or cross any of these three roads.

Figure 4.24 Walter Moberly Elementary Catchment Area

4.8.1 Demographics and Distance

A total of 119 grade 4 and 5 students from Walter Moberly submitted signed consent forms to participate in the Action Schools! BC research program (including the walkability survey). Fifty-two complete survey pairs were returned from students living within the catchment area. The high ESL population at the school may have affected this response rate with parents unable to complete the survey.

The sample includes slightly more girls (55%) than boys. Their ages range from 9 to 11 with 9 year olds representing 45% and 10 year olds 49%. All students live very close to the school with 58% being under 500m, 42% between 500m and 1km, and none living greater than 1km from school. The approximate average income of respondents is between $30 and $40,000 per year, significantly lower than the census estimate of $52,500. Seventy-three percent of households earn less than $50,000 per year, and 27% earn less than $20,000. Three of the responding households (6%) earn more than $80,000 per year. Vehicle ownership is higher than might be expected given the income distribution. Only 1 household has no vehicle, 53% have 1, and 41% have two vehicles; two families report three or more vehicles.

4.8.2 Travel Behaviour

Walter Moberly has the second highest proportion of students walking with 57% walking to school and 65% walking home. Thirty-three percent of students are driven to school, and one takes a school bus; this drops to 28% and zero respectively for the afternoon trip. Three quarters of students use an active mode for at least one of the journeys to/from school. The children's favourite ways to get to school reflect their actual travel modes with 63% preferring to walk and 29% preferring to be driven; 3 children would prefer to ride their bike or use another active mode to get to school. Half indicated that their teachers had ever encouraged them to use a non-motorized way to get to school.

Household travel habits do not reflect the mode of travel to school with less than one third of respondents indicating their family uses an active mode for a non-school trip at least once per week. The lack of amenities such as a grocery store within the catchment area may explain this discrepancy.

4.8.3 Perceptions of Safety and Travel Preferences

Over 80% of parents feel their neighbourhood is a safe place for their child to walk. Although specific concern for traffic on the way to school is somewhat higher, 70% of parents still somewhat or strongly agreed that their child was safe, and only 9% strongly disagreed. Half of the children agreed a lot that they are safe from cars, with 35% agreeing a little. Concern about strangers and bullies was more divided among parents, with 65% somewhat or strongly agreeing their child is safe, but 22% strongly disagreeing. Children were divided about feeling safe from strangers and bullies with 39% agreeing a lot but the same number not agreeing. Only 16% of children agreed a lot that they feel safe walking by themselves, while 45% did not agree with this statement. Nonetheless, 75% of children still agreed a lot that it is easy and fun to walk, while only 1 did not agree.

Despite the high number of children walking to school at Walter Moberly, 57% strongly agreed and 26% somewhat agreed that driving their child to school is an important parental responsibility. As discussed for Mission Central, this may reflect a misinterpretation of the statement where parents feel that making sure their child gets to school is important (independent of travel mode). This interpretation may have been particularly prevalent here with Walter Moberly's high ESL population. Alternatively, these parents may strongly feel they should drive their child to school but they are limited in choice due to vehicle ownership. Only 12% of parents felt they live too far away for their child to walk, with 88% somewhat or strongly disagreeing that their house is too far away.

4.8.4 Micro-Scale Pedestrian Environment Evaluation

Valid data were collected from 29 discrete street segments as marked in Figure 4.24. Most (86%) street segments were only two lanes, but the larger streets had 4 (2 segments) and 6 (2 segments) lanes. The land slopes from north to south toward the river, with east-west streets being reasonably flat. This produced a diverse topographic measure with 66% recorded as flat or slight grade, 24% moderate and 10% recorded as steep. Traffic calming was prevalent with measures on over one third of the streets, including mostly signage and traffic circles. Inverness Street is a north-south bike route for this part of the city, although there is no designated bike lane. Sidewalk coverage is excellent with 90% of sampled street segments having 100% sidewalk on at least one side, and only 3.4% having no sidewalk at all. The sidewalk network is supported by buffers on both sides of 79% of the street segments, and on one side for 14% of the segments.

Valid data were collected from 24 intersections in the Walter Moberly catchment area. Sixty-two percent of these are 4-way intersections and 38% are 3-way. Stop signs or traffic lights are present at 92% of the intersections, but only 20% have any kind of crosswalk marking. Twenty-five percent of the intersections have crosswalk signage in at least one direction, but only 3 (12.5%) of them have a pedestrian crossing button (those located on Fraser, Knight, and SE Marine).

CHAPTER 5 - ANALYTICAL STATISTICS

Chapter 4 illustrated the range and diversity of responses within the study population. This chapter follows with an inferential analysis to determine if and where statistically significant relationships exist between travel behaviour, perceptions of safety, and the micro-scale pedestrian environment while controlling for the demographic variables of gender, age, household income and household vehicle ownership.

Dichotomous Travel Mode Variable

For the inferential analysis, travel modes from the travel survey were condensed to create a dichotomous variable. A child was considered “active” if their parent reported that they usually walked, bicycled, or used another form of non-motorized transportation on their trip to school, their trip home from school, or both. (This dichotomous variable is reported in Chapter 4 and Appendix F under the heading “Active Travel”.) This strategy served an important purpose of highlighting which children were achieving desired behavioural outcomes of daily physical activity and helping to reduce vehicular traffic in the vicinity of schools.

For the reader’s reference, Tables 5.1a and 5.1b on the following page provide a glossary of all the variables used in this inferential analysis. Recall that scores used for discrete micro-scale variables in the chi square test represent the average of scores from the segments and intersections along each child’s walk to school. The pedestrian friendliness and lowest pedestrian friendliness scores for each child represent the sum of the averages for each variable as measured along their route.

Table 5.1a Glossary of Variables (Travel Survey)

VARIABLE NAME	TYPE AND DESCRIPTION	POSSIBLE VALUES
Gender	Dichotomous	Male / Female
Age	Continuous	All between 8 to 11 years old
Distance	Ordinal; distance from home to school based on empirical measure of shortest possible route	1=0 - 500m 2=500m-1km 3= 1 – 1.5km 4= 1.5-2km 5= 2-2.5km
Household (HH) Income	Ordinal; reported by parents in increments of $10,000	1= <$20,000 2=$20-$30,000 … 9=$90-$100,000 10=>$100,000
Neighbourhood Income	Ordinal; represents Census Canada average income for the catchment areas of each school	Income range assigned same categories as Household Income; same value assigned to all students at the same school
Number of Household (HH)Vehicles	Ordinal; reported by parents.	0= no cars 1=1 car 2=2 cars 3= 3 cars 4= 4 or more cars
Travel Mode	Dichotomous	1 = active mode at least 1 way 0 = no active mode

Table 5.1a Glossary of Variables (Travel Survey) continued...

Parental Perceptions of Safety		
Neighbourhood is a safe place for child to walk	Ordinal; reported by parents on 4-point Likert Scale	1 = strongly agree child is safe 4 = strongly disagree child is safe
Child is safe from traffic while walking to school	Ordinal; reported by parents on 4-point Likert Scale	1 = strongly agree child is safe 4 = strongly disagree child is safe
Child is safe from strangers/bullies while walking to school	Ordinal; reported by parents on 4-point Likert Scale	1 = strongly agree child is safe 4 = strongly disagree child is safe
Children's Perceptions of Safety while walking or biking in their neighbourhood		
Feel safe from cars	Ordinal; reported by children on 3-point Likert Scale	1=agree alot they feel safe 3=don't agree they feel safe
Feel safe from strangers/bullies	Ordinal; reported by children on 3-point Likert Scale	1=agree alot they feel safe 3=don't agree they feel safe
Feel safe walking alone	Ordinal; reported by children on 3-point Likert Scale	1= agree alot they feel safe 3=don't agree they feel safe

Table 5.1b Variable Glossary (Micro-Scale Survey)

Variable Name	Rank in Original Data	Standardized Score (Equal Weighting Method)
Number of Lanes	2 lanes 3 lanes 4 lanes 6 lanes	1 0.67 0.33 0
Street Grade	0 - flat 1 – slight slope 2 – moderate slope 3 – steep slope	1 0.67 0.33 0
Traffic Calming	0 elements 1 element 2 elements 3 elements	0 0.33 0.67 1
Buffer	None 1 side both sides	0 0.5 1
Sidewalk (amount on side with longest)	None 1-25% 25-50% 50-75% 75-99% 100%	0 0.2 0.4 0.6 0.8 1
Traffic Control	None Yeild Traffic circle Stop sign Traffic Light	0 0.5 0.5 1 1
Crosswalk Marking	None 1 of 4 legs 1 of 3 legs 2 of 4 legs 2 of 3 legs 3 of 4 legs All legs	0 0.25 0.33 0.5 0.67 0.75 1
Crosswalk Signage	None 1 of 4 legs 1 of 3 legs 2 of 4 legs 2 of 3 legs 3 of 4 legs All legs	0 0.25 0.33 0.5 0.67 0.75 1

Indexed Scores	How Calculated	Range of Scores
Unique micro-scale variable scores (for each child)	Average of the scores for that variable from all the segments/intersections along that child's route to school.	Ranges from 0 to 1 for each variable.
Pedestrian Friendliness Score (Quartiled)	The sum of the unique averaged micro-scale variable scores for the child's route to school.	Ordinal; Ranges from 1 (poor score) to 4 (excellent score) because of quartiling.
Lowest Pedestrian Friendliness	The sum of the values for the lowest scoring segment and lowest scoring intersection along the child's route to school.	Continuous; Ranges from 1 (worst score) to 6 (least poor score)

5.1 Factors Influencing Travel Mode

5.1.1 Determining Relationships Among Independent Variables

The first step in the inferential analysis was to understand how groups of variables are interrelated. Demographic data were collected in the parent's travel surveys. Strong correlations between demographic variables may influence the selection of control variables in later regression analysis. Table 5.2 shows the results of a Spearman's Rank Correlation showing the strength and direction of relationship between demographic variables. (Spearman's Rank treats the data as ordinals rather than continuous values which best describes the variables in question.) Not surprisingly there is a strong relationship between household income and vehicle ownership, as well as median neighbourhood income (as reported by the Census) and vehicle ownership. The positive correlation between distance from school and neighbourhood income is merely coincidental since all respondents from the same school were assigned the same neighbourhood income value.

Table 5.2 Correlation of Demographic Variables

	Gender	Age	Distance (100m)	HH Income	Nbhd Income	HH Vehicles
Gender Spearman's Correlation		.041	.047	.012	.032	.035
Sig. (2-tailed)		.525	.465	.856	.626	.590
Age Spearman's Correlation	.041		-.036	-.079	.003	-.049
Sig. (2-tailed)	.525		.579	.222	.967	.455
Distance (100m) Spearman's Correlation	.047	-.036		.119	.188(**)	.173(**)
Sig. (2-tailed)	.465	.579		.066	.004	.007
HH Income Spearman's Correlation	.012	-.079	.119		.374(**)	.426(**)
Sig. (2-tailed)	.856	.222	.066		.000	.000
Nbhd Income Spearman's Correlation	.032	.003	.188(**)	.374(**)		.365(**)
Sig. (2-tailed)	.626	.967	.004	.000		.000
HH Vehicles Spearman's Correlation	.035	-.049	.173(**)	.426(**)	.365(**)	
Sig. (2-tailed)	.590	.455	.007	.000	.000	

** Correlation is significant at the 0.01 level (2-tailed).

Table 5.3 describes the results of a Spearman's Correlation between respondents' perceptions of safety. It illustrates significant correlations between all the perceptions of safety variables. It is not surprising that parents who are concerned about traffic safety are frequently also concerns about other sources of risk; neither is it surprising that the perceptions of elementary school children are similar to those of their parents.

Finally, demographic and perception of safety variables were correlated. The results in Table 5.4 demonstrate that parental concerns over traffic safety for their child walking to school increase significantly with the travel distance. They also show that as household income increases, parental perceptions of overall safety and safety from strangers/bullies while walking to school improves. Income is not associated with perception of safety from traffic. Parents in households with more vehicles are less concerned about their child's safety from strangers/bullies while walking to school; however this relationship is confounded by the strong correlation between income and vehicle ownership.

Table 5.3. Correlations between perceptions of safety variables.

	Parents Perceptions			Children's Perceptions		
Parent's Perceptions	**Nbhd Safe to Walk**	**Safe from Traffic**	**Safe from Strangers/ Bullies**	**Safe from Cars**	**Safe from Strangers/ Bullies**	**Safe Walking Alone**
Nbhd Safe to Walk Spearman's Correlation		.553(**)	.579(**)	.278(**)	.204(**)	.112
Sig. (2-tailed)		.000	.000	.000	.002	.085
Safe from Traffic Spearman's Correlation	.553(**)		.525(**)	.239(**)	.173(**)	.115
Sig. (2-tailed)	.000		.000	.000	.007	.077
Safe from Strangers/ Bullies Spearman's Correlation	.579(**)	.525(**)		.238(**)	.300(**)	.151(*)
Sig. (2-tailed)	.000	.000		.000	.000	.020
Children's Perceptions						
Safe from Cars Spearman's Correlation	.278(**)	.239(**)	.238(**)		.541(**)	.274(**)
Sig. (2-tailed)	.000	.000	.000		.000	.000
Safe from Strangers/ Bullies Spearman's Correlation	.204(**)	.173(**)	.300(**)	.541(**)		.183(**)
Sig. (2-tailed)	.002	.007	.000	.000		.004
Safe Walking Alone Spearman's Correlation	.112	.115	.151(*)	.274(**)	.183(**)	
Sig. (2-tailed)	.085	.077	.020	.000	.004	

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 5.4. Correlations Between Demographics and Perceptions of Safety

	Nbhd Safety	Traffic Safety	Safety from Strangers/ Bullies
Distance (100m) Spearman's Correlation	.156(*)	.269(**)	.039
Sig. (2-tailed)	.016	.000	.551
HH Income Spearman's Correlation	-.163(*)	-.033	-.154(*)
Sig. (2-tailed)	.011	.612	.017
Nbhd Income Spearman's Correlation	-.164(*)	-.065	-.205(**)
Sig. (2-tailed)	.011	.319	.001
HH Vehicles Spearman's Correlation	-.047	.089	-.174(**)
Sig. (2-tailed)	.473	.169	.007

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Measuring the correlations between the micro-scale measures of the pedestrian environment is an important way to illustrate that certain characteristics co-vary in space. Table 5.5 describes the results of a Pearson's Correlation between the pedestrian environment scores (using the equal weighting method) for the evaluated street segments and their associated intersections. The Pearson's Correlation was selected in this case because the pedestrian environment scores are continuous rather than ordinal. (Note: This sample is limited to only 181 segments and intersections because missing data prevented some segments and intersections from being paired.) Highlighted values indicate significance of 0.05 or better.

Table 5.5: Correlation Between Micro-Scale Variables

	Number of Lanes	Slope	Traffic Calming	Buffer	Sidewalk	Traffic Control	Crosswalk Marking	Crosswalk Signage
Number of Lanes								
Pearson R		.007	.076	-.095	-.224	-.077	-.364	-.006
Sig. (p)		.928	.307	.202	.002	.301	.000	.936
Slope								
Pearson R	.007		.120	.092	.132	.098	.181	.149
Sig. (p)	.928		.109	.217	.077	.191	.015	.046
Traffic Calming								
Pearson R	.076	.120		.023	.093	.042	.167	.176
Sig. (p)	.307	.109		.756	.215	.571	.025	.017
Buffer								
Pearson R	-.095	.092	.023		.093	-.058	.126	.143
Sig. (p)	.202	.217	.756		.211	.435	.092	.055
Sidewalk								
Pearson R	-.224	.132	.093	.093		.162	.238	.109
Sig. (p)	.002	.077	.215	.211		.029	.001	.143
Traffic Control								
Pearson R	-.077	.098	.042	-.058	.162		-.001	-.015
Sig. (p)	.301	.191	.571	.435	.029		.993	.844
Crosswalk Marking								
Pearson R	-.364	.181	.167	.126	.238	-.001		.555
Sig. (p)	.000	.015	.025	.092	.001	.993		.000
Crosswalk Signage								
Pearson R	-.006	.149	.176	.143	.109	-.015	.555	
Sig. (p)	.936	.046	.017	.055	.143	.844	.000	

This table shows a strong inverse relationship between the lane score and the presence of crosswalk markings (larger streets are more likely to have crosswalk markings). It indicates that more continuous sidewalks, more distinct traffic control measures, and the presence of crosswalk markings tend to be found together. An association between traffic control measures and crosswalk markings may have been obscured by assigning the same score to traffic lights and stop signs.

5.1.2 Pairwise Relationships With Travel Mode

A Chi Square test was used as a preliminary test of relationships between the dependent and independent variables because it is more appropriate than the correlation for use with a dichotomous variable. Chi Square indicates whether the relationship between variables is significantly non-random, but does not suggest the direction or magnitude of the relationship. Table 5.6 lists the variables analyzed against travel mode with the Chi Square test.

These Chi Square results give a good indication of which variables might be influential in the next stage of analysis – the binary regression. For example, distance and number of household vehicles will be important control variables, but household income will not. The insignificant relationship with age is due to the small age range of the study population; a study comparing children from a greater diversity of ages may have different results.

Table 5.6 Chi Square relationships with Active / Not Active Travel Mode

Independent Variable	Chi Square Value	Chi Square Significance (p)
Demographics		
Distance (100m)	54.743	.000
Distance (500m)	33.221	.000
# HH Vehicles	18.749	.001
HH Income	6.692	.669
Gender	1.13	.288
Age	2.777	.427
Parent Perceptions of Safety		
Neighbourhood Safety	17.856	.000
From Traffic	35.055	.000
From Strangers/Bullies	17.741	.000

Table 5.6 Chi Square relationships with Active / Not Active Travel Mode (continued)

Children's Perceptions of Safety		
From Cars	11.065	.004
From Strangers/Bullies	1.978	.372
Walking Alone	9.643	.008
Micro-Scale Variables		
Lane Score	32.884	.025
Traffic Calming Score	64.036	.009
Sidewalk Score	67.143	.000
Crosswalk Marking Score	65.560	.057
Crosswalk Signage Score	55.319	.009
Slope Score	79.603	.121
Buffer Score	32.842	.167
Traffic Control Score	23.935	.121
Segment Index Quartiled	7.189	.066
Intersection Index Quartiled	14.795	.002
Pedestrian Friendliness Index Quartiled	12.008	.007
Lowest Segment Quartiled	14.519	.002
Lowest Intersection Quartiled	12.863	.005
Lowest Pedestrian Friendliness Quartiled	17.109	.001

The pedestrian friendliness index was recalculated to remove variables not significant in the Chi square, but this actually decreased the significance of the chi square for pedestrian friendliness so the original quartiled scores were retained as above. A likely explanation for this is that each variable by itself is not highly influential, but when several low-scoring variables appear in one child's score their cumulative impact is enough to make the overall index significant. For example, a poor buffer score by itself is not enough to be significant, but when it is accompanied by low scores for cross-walk markings and traffic controls the overall effect becomes significant. This explanation follows the correlations in Table 5.5; it also follows the literature which suggests that pedestrian environment characteristics co-vary in space and that they have synergistic effects on the safety and enjoyment of walking. Other modified indices were also tried to increase the weighting of certain variables but none were as significant as those above.

The insignificant Chi Square result with respect to household income is contrary to travel choice research among adults. Potential explanations for this are discussed in Chapter 6.

5.1.3 Creating a Statistical Model – Binary Regression Analysis

The Chi Square test indicated whether or not relationships between two variables are random or not, but only when the variables are considered independently of one another. In order to calculate the degree to which independent variables explain whether children walk or not, and how these variables interact with each other, it is necessary to conduct a regression analysis. Logistic regression was selected because of its ability to deal with non-linear relationships among variables that do not fit along a normal curve[1] (both of which are the case with this dataset). A *binary* logistic regression (where the dependent variable has only two possible values – active or not) was used because it will compare the relative influence of each explanatory variable on the probability of a “successful” outcome[2] – in this case the outcome that a child is active on their way to or from school.

Binary logistic regression models were run in SPSS using different combinations of variables, in particular testing the influence of the various pedestrian environment indices in combination with all the demographic and perceptual variables. Table 5.7 presents the result of tests using the pedestrian friendliness index (quartiled) and the lowest pedestrian friendliness index (which was more significant than in its quartiled form). A few definitions are appropriate here to help explain the tests results.

- The **B** is the regression coefficient.
- The **odds ratio (OR)** is the exponentiation of B. In this case the OR is used to predict the how much the odds of a child walking will change for a one unit change in that variable.
- The **95% Confidence Intervals (CI)** for the odds ratio indicate the range within OR could fall for the true population mean. A CI that crosses 1 (i.e. the lower estimate is <1 and the upper estimate is >1) indicates that the variable is not a good predictor for whether or not a child will walk to school.[3]
- The **Hosmer and Lemeshow Test** is a measure of “goodness of fit” of each model.

A good model is indicated by a high significance (p) value; if the p-value is less than 0.05 then the model does not adequately fit the data.[4]

- The **Model Summary Statistics** provide similar information to the R^2 value in multiple linear regression.[5] The Cox & Snell R Square and Nagelkerke R Square present (respectively) upper and lower estimates of how much variance the model can account for.[6] Model #2 has a Hosmer and Lemmeshow significance score of 0.899, indicating the model is a good fit for the data. The R square measures suggest this model can account for between 28% and 38% of the variation in active versus non-active travel.

- **Classification tables** compare the observed values to those that would be expected if the model was a perfect predictor. They indicate the proportion of cases for which the model makes an accurate prediction. In comparison, a no-model estimate is based on which outcome (walk or not) is the most prevalent in the sample. In this case, in the absence of knowledge of other predictors, predictions that a child will walk are expected to be accurate 63% of the time because 63% of the children in the study sample are active. Results of the classification tables are listed as "Model accurately predicts outcome XX% of the time".

Table 5.7 Results of Binary Logistic Regression Models

Model #1 (Distance-100m and Demographics)

				95% C.I. for OR	
	B	Sig.	OR	Lower	Upper
Gender	-.147	.623	.863	.480	1.552
Age	-.197	.436	.821	.500	1.348
Distance (100m)	-.241	.000	.786	.716	.863
HH Income	.042	.511	1.043	.921	1.181
Nbhd Income	.034	.781	1.034	.815	1.312
HH Vehicles	-.471	.024	.624	.414	.941
Constant	4.784	.057	119.636		

Hosmer and Lemeshow Goodness of Fit Test

Chi-square	df	Sig.
13.956	8	.083

Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
267.547(a)	.175	.239

a Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Model accurately predicts the outcome 69% of the time.

Model #2 (Distance-100m, Demographics, Perceived Safety)

				95% C.I. for OR	
	B	Sig.	OR	Lower	Upper
Gender	-.106	.750	.899	.467	1.730
Age	-.409	.150	.665	.381	1.160
Distance (100m)	-.220	.000	.802	.725	.888
HH Income	.052	.453	1.053	.919	1.207
Nbhd Income	-.089	.503	.915	.705	1.187
HH Vehicles	-.609	.011	.544	.339	.872
Parent – Nbhd safety	.010	.973	1.010	.572	1.782
Parent – Traffic Safety	-.587	.014	.556	.348	.887
Parent – Safety from Strangers/ Bullies	-.533	.038	.587	.355	.970
Child – Safety from Cars	-.407	.174	.666	.371	1.197
Child – Safety from Strangers/ Bullies	.257	.325	1.293	.775	2.157
Child – Safe Walking Alone	-.143	.555	.867	.539	1.393
Constant	10.408	.001	33130.216		

Hosmer and Lemeshow Test

Chi-square	df	Sig.
3.500	8	.899

Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
235.100(a)	.279	.382

a Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Model accurately predicts the outcome 76% of the time.

Model #3a (Distance-100m, Demographics, Perceived Safety, Pedestrian Friendliness Quartiled)

				95% C.I. for OR	
	B	Sig.	OR	Lower	Upper
Gender	-.107	.748	.898	.466	1.730
Age	-.409	.150	.665	.381	1.160
Distance (100m)	-.221	.000	.801	.719	.893
HH Income	.052	.462	1.053	.918	1.208
Nbhd Income	-.091	.517	.913	.692	1.203
HH Vehicles	-.607	.013	.545	.338	.879
Parent – Nbhd safety	.012	.968	1.012	.571	1.791
Parent – Traffic Safety	-.587	.014	.556	.348	.887
Parent – Safety from Strangers/ Bullies	-.534	.037	.586	.355	.970
Child – Safety from Cars	-.408	.174	.665	.369	1.198
Child – Safety from Strangers/ Bullies	.257	.325	1.294	.775	2.159
Child – Safe Walking Alone	-.141	.564	.868	.538	1.402
Pedestrian Friendliness (Quartiled)	-.012	.957	.988	.635	1.537
Constant	10.454	.001	34687.506		

Hosmer and Lemeshow Test

Chi-square	df	Sig.
3.951	8	.862

Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
235.097(a)	.279	.382

a Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Model accurately predicts outcome 76% of the time.

Model #3b (Distance-100m, Demographics, Perceived Safety, Lowest Pedestrian Friendliness)

	B	Sig.	OR	95% C.I. for OR Lower	Upper
Gender	-.088	.793	.916	.474	1.770
Age	-.402	.158	.669	.383	1.169
Distance (100m)	-.207	.001	.813	.722	.916
HH Income	.056	.425	1.057	.922	1.213
Nbhd Income	-.072	.599	.930	.710	1.218
HH Vehicles	-.614	.011	.541	.337	.869
Parent – Nbhd safety	-.013	.964	.987	.553	1.761
Parent – Traffic Safety	-.571	.018	.565	.352	.907
Parent – Safety from Strangers/ Bullies	-.535	.037	.586	.354	.969
Child – Safety from Cars	-.393	.191	.675	.375	1.217
Child – Safety from Strangers/ Bullies	.247	.345	1.280	.766	2.140
Child – Safe Walking Alone	-.153	.530	.858	.532	1.384
Lowest Pedestrian Friendliness	.092	.673	1.096	.715	1.681
Constant	9.858	.003	19105.488		

Hosmer and Lemeshow Test

Chi-square	df	Sig.
4.193	8	.839

Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
234.921(a)	.280	.383

a Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Model accurately predicts outcome 76% of the time.

Model #4 (Distance-500m, Demographics, Perceived Safety)

				95% C.I. for OR	
	B	Sig.	OR	Lower	Upper
Gender	-.151	.648	.860	.449	1.645
Age	-.418	.137	.659	.380	1.143
Distance (500m)	-.946	.000	.388	.249	.606
HH Income	.027	.692	1.027	.899	1.175
Nbhd Income	-.056	.672	.946	.730	1.225
HH Vehicles	-.661	.006	.516	.321	.829
Parent – Nbhd safety	.030	.918	1.030	.586	1.812
Parent – Traffic Safety	-.593	.013	.553	.346	.882
Parent – Safety from Strangers/ Bullies	-.529	.039	.589	.357	.973
Child – Safety from Cars	-.445	.131	.641	.359	1.142
Child – Safety from Strangers/Bullies	.288	.264	1.333	.805	2.207
Child – Safe Walking Alone	-.137	.568	.872	.545	1.395
Constant	10.777	.001	47912.715		

Hosmer and Lemeshow Test

Chi-square	df	Sig.
2.872	8	.942

Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
238.172(a)	.270	.370

a Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Model accurately predicts outcome 76.6% of the time.

Model #5 (Only variables significant in previous models; Distance-100m)

				95% C.I. for OR	
	B	Sig.	OR	Lower	Upper
Distance (100m)	-.223	.000	.800	.724	.884
HH Vehicles	-.582	.006	.559	.368	.848
Parent – Traffic Safety	-.599	.006	.549	.357	.844
Parent – Safety from Strangers/ Bullies	-.500	.025	.607	.391	.940
Constant	5.630	.000	278.570		

Hosmer and Lemeshow Test

Chi-square	df	Sig.
2.803	8	.946

Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
241.009(a)	.261	.358

a Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Model accurately predicts outcome 74.5% of the time.

Model #6 (Only variables significant in previous models; Distance-500m)

				95% C.I. for OR	
	B	Sig.	OR	Lower	Upper
Distance (500m)	-.961	.000	.383	.247	.592
HH Vehicles	-.652	.002	.521	.343	.793
Parent – Traffic Safety	-.612	.005	.542	.353	.834
Parent – Safety from Strangers/ Bullies	-.485	.030	.616	.397	.954
Constant	5.949	.000	383.454		

Hosmer and Lemeshow Test

Chi-square	df	Sig.
3.094	8	.928

Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
244.164(a)	.252	.344

a Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Model accurately predicts outcome 76.2% of the time.

These results show that all the models except for #1(including only distance and demographic data) have a good fit with the data (Hosmer-Lemeshow Test significance of over p=0.8), but that only distance, vehicle ownership, and parental perception of safety variables provide significant predictive power after controlling for other variables. Neither of the pedestrian environment indices was significant when distance from school was included in the equation.

Distance (measured in 100m increments) was consistently the most influential variable in all the tests with increased distance resulting in decreased probability of walking. Not surprisingly, distance measured at 500m increments (Model #4) was more significant and has a lower odds ratio (producing a larger change in the odds of walking), but does not significantly change the odds ratios for parental perceptions of safety from traffic or strangers and bullies; it also does not alter the estimated accuracy of predictions.

Although neither the pedestrian friendliness nor the lowest pedestrian friendliness measures were significant after considering distance and household vehicles, lowest pedestrian friendliness had a much lower significance score than pedestrian friendliness. This suggests that a short distance or one intersection of poor walking conditions can influence an overall travel decision (although not significantly after considering other factors).

Another model was applied (not shown in the tables) that tested the effects of including only the extreme values of the sidewalk score. Cases in the middle ranges were excluded from the analysis so that n=191. The significance of the sidewalk score was p=0.172; a great improvement over the pedestrian environment scores in Models #3a and #3b but still not significant enough to retain in the model. This result is likely affected by the lack of variation in sidewalk scores since the quartiling technique excluded only 48 cases from the sample and 82% of the remaining cases fell in the highest quartile.

Making Predictions Using Odds Ratios

The odds ratios from this binary regression can be used to estimate the degree to which each significant variable influences travel mode choice. For this purpose, the results from Model #5 were used because this model produced the highest score for the goodness of fit test (p=0.946). From the odds ratios, it can be deduced that a 100m increase in the distance between home and school will have an effect of 0.8 on the chance of a child walking to school. In other words, all other things being equal, the odds of walking to or from school for a child living 600m away from school is lower by a factor of 0.8 compared to a child living only 500m from school. Interpreting the odds ratios for all variables in the model, it can be stated that assuming all other variables remain constant, the odds that a child will be active on the way to or from school will <u>decrease</u> by a factor of:

- 0.8 for every additional 100 metres the child lives away from school;
- 0.56 for each additional vehicle in the child's household;
- 0.55 for every unit increase in their parent's concern over safety from traffic; and
- 0.61 for every unit increase in their parent's concern over safety from strangers and bullies.

These statements are made assuming the incremental difference is the same for each additional unit of measurement, which is unlikely to be the case. For example, the change in the likelihood of walking will be different as a household decreases from 2 cars to 1 car compared to the change decreasing from 1 to 0 cars. The incremental change in probability over varying distances may be relatively equal for a limited distance but will drop dramatically after crossing a threshold of (perhaps) a half-hour walking distance (a theory supported by the literature). Unfortunately this analysis is unable to provide estimates at that level of detail.

Due to the significant influence of distance in the equation, the sample was divided by this variable for further analysis. Sufficient data were available to conduct a binary regression analysis for three distance categories divided by 500 metre increments from 0 to 1.5 kilometres from school. Results of this test are described in Table 5.8. Under these circumstances, the lowest pedestrian friendliness score was significant (p=.028) for children in the group living closest to school. Keeping other variables constant, for every one unit increase in the lowest pedestrian friendliness score, a child's odds of walking more than doubled (OR = 2.031). For this group, perceived safety from traffic was not influential, but perception of safety from strangers was quite important (OR = 0.419), p=0.031). However, pedestrian environment variables were not significant for any other distance group. It is also important to note that after controlling for perceptions of safety and the pedestrian environment, the number of household vehicles remained significant only for children living within 500 metres of school.

Table 5.8 Binary Regression By Distance

Distance Controlled Model #1 (Vehicles)

						95.0% C.I.for OR	
Distance		**B**	**df**	**Sig.**	**OR**	**Lower**	**Upper**
<500m (n=95)	HH Vehicles	-.585	1	.051	.557	.310	1.002
	Constant	2.452	1	.000	11.615		
500m-1km (n=110)	HH Vehicles	-.422	1	.094	.656	.400	1.075
	Constant	1.070	1	.022	2.917		
1-1.5km (n=24)	HH Vehicles	-.420	1	.469	.657	.211	2.048
	Constant	.145	1	.905	1.156		
1.5-2km (n=7)	HH Vehicles	1.386	1	.442	4.000	.117	136.957
	Constant	-2.773	1	.295	.063		

Hosmer and Lemeshow Test

Distance	Chi-square	df	Sig.
<500m (n=95)	1.708	1	.191
500m-1km (n=110)	2.669	1	.102
1-1.5km (n=24)	7.540	2	.023
1.5-2km (n=7)	.000	0	.

Model Summary

Distance	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
<500m	88.432(a)	.039	.063
500m-1km	145.931(b)	.026	.035
1-1.5km	30.004(c)	.023	.031
1.5-2km	7.777(d)	.082	.118

Distance Controlled Mode #2 (Vehicles, Perceived Safety)

Distance		B	df	Sig	OR	95.0% C.I. for OR Lower	Upper
<500m n=95	HH Vehicles	-0.894	1	.019	.409	.194	.862
	Parent-Nbhd Safety	-.027	1	.958	.973	.351	2.698
	Parent-Traffic Safety	-.055	1	.894	.947	.422	2.121
	Parent-Safety Strangers/ Bullies	-.892	1	.056	.410	.164	1.024
	Child-Traffic Safety	.558	1	.365	1.746	.523	5.836
	Child-Safety Strangers/ Bullies	-.238	1	.631	.788	.299	2.080
	Child-Safe Walking Alone	-.518	1	.239	.595	.251	1.412
	Constant	5.956	1	.000	386.190		
500m-1 km n=110	HH Vehicles	-.506	1	.099	.603	.331	1.099
	Parent-Nbhd Safety	.150	1	.688	1.161	.560	2.410
	Parent-Traffic Safety	-.897	1	.009	.408	.207	.802
	Parent-Safety Strangers/ Bullies	-.217	1	.517	.805	.417	1.552
	Child-Traffic Safety	-.677	1	.067	.508	.246	1.047
	Child-Safety Strangers/ Bullies	.044	1	.894	1.045	.545	2.003
	Child-Safe Walking Alone	.160	1	.606	1.173	.639	2.154
	Constant	4.276	1	.001	71.934		
1-1.5km n=24	HH Vehicles	-.996	1	.310	.369	.054	2.523
	Parent-Nbhd Safety	-.634	1	.677	.530	.027	10.454
	Parent-Traffic Safety	-2.395	1	.100	.091	.005	1.577
	Parent-Safety Strangers/ Bullies	-.455	1	.686	.635	.070	5.753
	Child-Traffic Safety	-1.266	1	.273	.282	.029	2.709
	Child-Safety Strangers/ Bullies	2.339	1	.078	10.369	.772	139.308
	Child-Safe Walking Alone	-.300	1	.778	.741	.092	5.969
	Constant	7.428	1	.164	1681.828		

Hosmer and Lemeshow Test

Distance	Step	Chi-square	df	Sig.
<500m	1	11.093	8	.196
500m-1km	1	7.635	8	.470
1-1.5km	1	5.081	8	.749

Model Summary

Distance	Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
<500m	1	77.604(a)	.143	.230
500m-1km	1	123.958(b)	.202	.273
1-1.5km	1	19.980(c)	.356	.495

Distance = 0-500m: Model accurately predicts the outcome 81% of the time.
Distance = 500m-1km: Model accurately predicts the outcome 73.6% of the time.
Distance = 1km-1.5km: Model accurately predicts the outcome 75% of the time.

Distance Controlled Model #3a (Vehicles, Perceived Safety, Pedestrian Friendliness Quartiled)

						95.0% C.I.for OR	
Distance		**B**	**Df**	**Sig.**	**OR**	**Lower**	**Upper**
<500m	HH Vehicles	-.866	1	.025	.421	.198	.895
n=95	Parent-Nbhd Safety	-.176	1	.751	.838	.282	2.493
	Parent-Traffic Safety	-.032	1	.940	.969	.424	2.213
	Parent-Safety Strangers/ Bullies	-.869	1	.067	.419	.166	1.062
	Child-Traffic Safety	.597	1	.346	1.816	.525	6.288
	Child-Safety Strangers/ Bullies	-.281	1	.576	.755	.282	2.023
	Child-Safe Walking Alone	-.567	1	.208	.567	.235	1.371
	Pedestrian Friendliness Quartiled	.449	1	.187	1.567	.804	3.053
	Constant	4.933	1	.003	138.834		
500m-1 km	HH Vehicles	-.525	1	.089	.592	.323	1.084
n=110	Parent-Nbhd Safety	.204	1	.588	1.227	.585	2.573
	Parent-Traffic Safety	-.879	1	.011	.415	.211	.819
	Parent-Safety Strangers/ Bullies	-.221	1	.510	.801	.415	1.549
	Child-Traffic Safety	-.713	1	.055	.490	.236	1.016
	Child-Safety Strangers/ Bullies	.041	1	.902	1.042	.543	1.997

	Child-Safe Walking Alone	.205	1	.515	1.228	.662	2.277
	Pedestrian Friendliness Quartiled	-.249	1	.397	.779	.438	1.388
	Constant	4.742	1	.001	114.705		
1-1.5km n=24	HH Vehicles	-1.042	1	.338	.353	.042	2.977
	Parent-Nbhd Safety	.083	1	.962	1.086	.036	32.647
	Parent-Traffic Safety	-3.461	1	.103	.031	.000	2.023
	Parent-Safety Strangers/ Bullies	-1.224	1	.436	.294	.014	6.389
	Child-Traffic Safety	-1.914	1	.170	.148	.010	2.271
	Child-Safety Strangers/ Bullies	3.178	1	.083	24.004	.661	872.122
	Child-Safe Walking Alone	.516	1	.709	1.676	.111	25.237
	Pedestrian Friendliness Quartiled	-1.443	1	.324	.236	.013	4.169
	Constant	10.815	1	.136	49782.618		

Hosmer and Lemeshow Test

Dist_actual_grps	Chi-square	df	Sig.
<500m	8.888	8	.352
500m-1km	13.458	8	.097
1-1.5km	2.166	8	.976

Model Summary

Dist_actual_grps	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
<500m	75.818(a)	.159	.255
500m-1km	123.235(b)	.208	.280
1-1.5km	18.866(c)	.385	.535

Distance = 0-500m: Model accurately predicts the outcome 79% of the time.
Distance = 500m-1km: Model accurately predicts the outcome 73.6% of the time.
Distance = 1km-1.5km: Model accurately predicts the outcome 83.3% of the time.

Distance Controlled Model #3b (Vehicles, Perceived Safety, Lowest Pedestrian Friendliness Quartiled)

Distance		B	df	Sig.	OR	95.0% C.I. for OR Lower	Upper
<500m	HH Vehicles	-.799	1	.045	.450	.206	.983
n=95	Parent-Nbhd Safety	-.325	1	.577	.723	.230	2.265
	Parent-Traffic Safety	.197	1	.659	1.218	.507	2.925
	Parent-Safety Strangers/ Bullies	-1.098	1	.031	.334	.123	.906
	Child-Traffic Safety	.638	1	.333	1.893	.520	6.896
	Child-Safety Strangers/ Bullies	-.259	1	.616	.772	.281	2.120
	Child-Safe Walking Alone	-.563	1	.230	.570	.227	1.428
	LowestPedestrian Friendliness	.709	1	.028	2.031	1.080	3.819
	Constant	3.631	1	.037	37.749		
500m-1 km	HH Vehicles	-.552	1	.078	.576	.311	1.064
n=110	Parent-Nbhd Safety	.215	1	.570	1.240	.590	2.610
	Parent-Traffic Safety	-.920	1	.008	.398	.202	.785
	Parent-Safety Strangers/ Bullies	-.225	1	.503	.799	.413	1.542
	Child-Traffic Safety	-.735	1	.051	.479	.229	1.005
	Child-Safety Strangers/ Bullies	.086	1	.798	1.090	.563	2.111
	Child-Safe Walking Alone	.208	1	.513	1.231	.661	2.293
	LowestPedestrian Friendliness	-.268	1	.384	.765	.418	1.399
	Constant	5.071	1	.002	159.389		
1-1.5km	HH Vehicles	-1.005	1	.307	.366	.053	2.523
n=24	Parent-Nbhd Safety	-.474	1	.785	.622	.021	18.860
	Parent-Traffic Safety	-2.510	1	.116	.081	.004	1.852
	Parent-Safety Strangers/ Bullies	-.573	1	.659	.564	.044	7.204
	Child-Traffic Safety	-1.370	1	.291	.254	.020	3.231
	Child-Safety Strangers/ Bullies	2.452	1	.099	11.617	.632	213.571
	Child-Safe Walking Alone	-.209	1	.857	.812	.084	7.859
	LowestPedestrian Friendliness	-.257	1	.851	.774	.053	11.293
	Constant	8.070	1	.209	3197.485		

Hosmer and Lemeshow Test

Dist_actual_grps	Step	Chi-square	df	Sig.
1.00	1	6.423	8	.600
2.00	1	22.628	8	.004
3.00	1	4.914	8	.767

Model Summary

Dist_actual_grps	Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1.00	1	72.138(a)	.191	.307
2.00	1	123.199(b)	.208	.280
3.00	1	19.945(c)	.357	.496

Distance = 0-500m: Model accurately predicts the outcome 83.2% of the time.
Distance = 500m-1km: Model accurately predicts the outcome 71.8% of the time.
Distance = 1km-1.5km: Model accurately predicts the outcome 79.2% of the time.

A final test was conducted to explore the relationship between distance and pedestrian friendliness scores. It was hypothesized that children living closer to school would inherently have higher pedestrian friendliness scores for several reasons. First, school zones are given special treatment with regard to posted speed limits and may also have more pedestrian amenities (particularly sidewalks, traffic calming, and pedestrian crossings) than other areas. The routes of children living close to or within these zones could have a higher ratio of pedestrian amenities along their route than those living farther away. In addition, the majority of schools in the sample are located on quiet residential streets (Marlborough being a key exception). Secondly, larger more traveled roads must exist somewhere and the farther away a child lives from school, the greater the chance they will encounter one or more of them in their journey to school.

In order to test this hypothesis, a linear correlation was conducted comparing distance (measured in 100m and 500m increments) and both the equal weight and lowest pedestrian friendliness scores. Table 5.9 indicates the results of these tests. Significant negative correlations (p=.000) were found between both measures of pedestrian friendliness and both increments of distance, indicating that as distance increases, the level of pedestrian friendliness decreases. The strongest correlation (R=-585) was between the lowest pedestrian friendliness score and distances measured in 100m increments.

Table 5.9 Distance Correlations with Pedestrian Friendliness Scores

500m Distance and PF Score Quartiled

		Distance (500m)	Pedestrian Friendliness Quartiled
Distance (500m increments)	Pearson Correlation	1	-.383(**)
	Sig. (2-tailed)		.000
Pedestrian Friendliness Quartiled	Pearson Correlation	-.383(**)	1
	Sig. (2-tailed)	.000	

100m Distance and PF Score Quartiled

		Distance (100m)	Pedestrian Friendliness Quartiled
Distance (100m increments)	Pearson Correlation	1	-.366(**)
	Sig. (2-tailed)		.000
Pedestrian Friendliness Quartiled	Pearson Correlation	-.366(**)	1
	Sig. (2-tailed)	.000	

500m Distance and Lowest PF Score Quartiled

		Distance (500m)	Lowest Pedestrian Friendliness
Distance (500m increments)	Pearson Correlation	1	-.543(**)
	Sig. (2-tailed)		.000
Lowest Pedestrian Friendliness	Pearson Correlation	-.543(**)	1
	Sig. (2-tailed)	.000	

100m Distance and Lowest PF Score Quartiled

		Distance (100m)	Lowest Pedestrian Friendliness
Distance (100m increments)	Pearson Correlation	1	-.585(**)
	Sig. (2-tailed)		.000
Lowest Pedestrian Friendliness	Pearson Correlation	-.585(**)	1
	Sig. (2-tailed)	.000	

5.2 Factors Influencing Parental Perceptions of Safety

It is hypothesized that elements of the pedestrian environment may have an influence on how parents perceive the safety of their neighbourhood, which in turn influences their willingness to allow their children to walk to school. The first step in testing this hypothesis was to conduct a Chi Square comparing the pedestrian environment indices against the three measures of parental perception of safety (overall neighbourhood safety, safety from traffic while walking to school, safety from strangers while walking to school). The only paired comparison for which the Chi Square was significant was the lowest pedestrian friendliness score and parental perception of safety from traffic (p=0.025).

Table 5.10: Chi Square Comparing Perceived Safety to Pedestrian Environment Measures

	Safe Neighbourhood	**Safe from Traffic**	**Safe From Strgrs/ Bullies**
Pedestrian Friendliness **Chi Square Value** **Sig (p)**	 8.815 .455	 6.941 .643	 10.787 .291
Lowest Pedestrian Friendliness **Chi Square Value** **Sig (p)**	 118.312 .177	 135.201 .025	 112.640 .288

The relationship between perception of safety from traffic and the lowest pedestrian friendliness score was explored further using a bivariate correlation. The resulting correlation coefficient was R = -0.170 (p=0.009). This indicates that as the "lowest" overall pedestrian friendliness score increases, parents are more likely to perceive their child to be safe from traffic while walking to school, although the relationship is not very strong.

Finally, cases in the mid-range of responses ("somewhat agree" and "somewhat disagree") to the three parental perceptions of safety were excluded, leaving samples of n=90, n=78, and n=68 respectively. Successive binary regression analyses were run using the perceptions of safety as the dependent variables and the two indices of the pedestrian environment as the explanatory variables. Once again, the only significant relationship was found between the lowest pedestrian friendliness score and parental perception of safety from traffic. The results of this regression are shown in Table 5.11. Although the pedestrian environment score was found to be significant at the 0.05 level, the model's classification tables predicts that accuracy will be lower (70.5%) than without the use of the model (71.8%) and only accounts for between 8 and 12% of the variation in the data.

Table 5.11 Binary Regression Measuring the Effect of the Lowest Pedestrian Environment Score on the High and Low Perceptions of Safety from Traffic.

					95.0% C.I.for OR	
	B	df	Sig.	OR	Lower	Upper
Lowest Pedestrian Friendliness	-.590	1	.017	.555	.342	.899
Constant	1.048	1	.207	2.853		

Hosmer and Lemeshow Test

Chi-square	df	Sig.
5.930	6	.431

Model Summary

-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
86.200(a)	.081	.117

5.3 Conclusions Drawn from Statistical Analysis

Chapters 4 and 5 have described the sample population and the pedestrian environments through which they travel to school. It is known that over 63% of study participants are regularly active for at least one direction of their home to school journey. All of the students live within 2.5 kilometers of school but distance is nonetheless a very important influencing factor on whether they are active or not in their travel to/from school. These findings are consistent with parental opinion; 28% of parents indicated distance was a primary decision making factor in the mode of travel to school for their child. Regression analysis indicates the number of household vehicles and parental perceptions of safety are also significant factors, but household income is not. "Convenience" and "easiest daily schedule" were selected as primary reasons for travel mode by 38% and 16% of parents respectively. However data on the influence of convenience were not collected in a way conducive to inclusion in the regression analysis. It was encouraging to find a latent demand for non-motorized travel and bicycling in particular; less than 2% of respondents reported bicycling to school but 15% indicated this is their preferred mode of travel. Pedestrian friendliness index of the micro-scale pedestrian environment is not a significant influencing factor, but the "lowest pedestrian friendliness" index is highly significant for children living within a 500m network radius of their school. For these children, a 1 unit increase in the lowest pedestrian friendliness score will more than double their odds of walking to or from school.

Household vehicle ownership remains significant after controlling for distance, as does parental perception of safety from traffic. Holding all other factors constant, the odds of a child walking to school decrease by a factor of:

- 0.8 for each additional 100 metres between their home and school,
- 0.56 for each additional vehicle in their household,
- 0.55 for each unit of increase in their parent's concern over safety from traffic,
- 0.61 for each unit of increase in their parent's concern over safety from strangers and bullies.

However, the influence of distance is confounded by the close relationship between distance and parental perception of safety, and distance and pedestrian friendliness scores. This demonstrates that distance is more complicated than a simple limitation on a child's physical ability to walk, or even the travel time required to do so.

Finally, the micro-scale characteristics measured in this study do influence parental perceptions of their child's safety from traffic while walking to school – specifically the "lowest pedestrian friendliness" street segments and intersections along the route. These measures do not influence parental perceptions of safety from strangers and bullies, nor do they affect perceptions of overall neighbourhood safety.

The initial hypothesis of this study was that micro-scale pedestrian environment variables would influence the use of non-motorized transportation for travel to/from school after controlling for income and vehicle ownership. It was thought that this influence would be heavily modified by distance, perceptions of safety, and convenience. Results indicate that the pedestrian environment is significant for children living within a 500m radius of school, but that the influence of distance masks this factor for children living farther away. Vehicle ownership and parental perceptions of safety from traffic and strangers and bullies remain significant across the entire sample. Measures of convenience were not included in the regression analysis, although numerous parents indicated it was a primary decision factor.

The next chapter will discuss these findings in the context of the existing travel to school literature. It will consider why the original hypothesis was not found to be true after controlling for distance, and will make recommendations for further research to improve understanding of factors influencing travel to school and improve the research methodology.

CHAPTER 6 - DISCUSSION AND CONCLUSION

"These two variables [of income and vehicle ownership] individually and together may have a strong enough influence on mode choice to overwhelm other factors favouring walk trips,
such as short distance to and from school."

Ewing et al., 2004

6.1 Overall Trends

As described in Chapter 4, nearly 50% of children in this study used an active mode of transport en route to school and 56% on the way home for a total of 63.6% who are active on a regular basis as part of their journey to or from school. Seventy percent of students living less than a kilometre from school are active, but only 30% who live between 1 and 2.5 kilometres engage in active commuting to school. These results are slightly lower than the national Go for Green study which reported walking among 86% of children living within 1 kilometre and among 50% of those living within 1 to 3 kilometres.[1] However, results from the current study are much higher than in the United States where only 30% of students living within one mile (1.6 km) report walking[2], and in the Gainsville study where fewer than 8% (all distances) were active.[3] There could be many reasons for these differences. Some of the additional walking in the Go for Green study is likely due to that study's inclusion of children of all ages; older children may be considered more able to walk by themselves, but the (lower) U.S. rates also include all ages so the age range can not explain all the differences. Region-specific variation in climate, average vehicle ownership and personal preferences for walking may play a role. It is also likely that the average pedestrian conditions across the United States are less conducive to walking than the limited variation in the pedestrian environment found within this study's sample, and that different school districts have lower distance thresholds for providing school bus service.

Twenty percent of the sample population - or nearly one-third of students who use an active mode - is active for only one half of their trip; two-thirds of these are active only on the way home, and one-third only on the way to school. This suggests that for these children distance, pedestrian environment, and safety of the route are not barriers to walking to school but that other factors prevent them from being active for both halves of the round-trip. Convenience is one possible factor and was mentioned by 38% of parents as one of the two most important influences on their child's travel mode to school. A further 16% cited the related factor of "easiest daily schedule", although respondents were asked to choose two factors so there is some overlap between the two responses. Two studies in the U.K. report that car journeys to school are frequently combined with other trips such as driving to work or dropping off children at multiple locations[4], which also supports the idea that convenience is a strong influencing factor.

The issue of convenience is complex and was not explored in detail in this study. The perceived convenience of different travel modes will vary depending on the type of trip and the individual; exploring how different parents define convenience is an important topic for further research. How many parents consider walking convenient? What about parents who drive their children? Is driving considered more convenient compared to the child walking by themselves, or compared to walking with the child (in which case safety might actually be the real issue). How do demographics influence the perception of convenience? What about parking conditions at the school?

6.2 Distance

Distance between home and school was by far the most significant factor influencing travel mode choice across the entire study sample - a result that supports the extensive literature linking distance to non-motorized transportation choice.[5] Predictions were made from the odds ratios that suggest for every 100 metre increase in distance between home and school, the odds of that child walking to or from school decrease by a factor of 0.8. However this outcome should be interpreted with caution. Although the logistic regression model was selected for its ability to address non-linear relationships, the results are presented as linear (i.e. having an equal increment of influence between each unit of the measured variable). It is more likely in the study sample that each 100 metre increase in distance has a relatively small impact on the odds of walking for children in relatively close proximity to school, but that the odds of walking change dramatically after certain threshold levels. Other research on children's travel to school suggests that such a threshold distance is around 1km.[6] Results from the current study support this; 69% of students living within a kilometre of their school were considered "active" compared to only 29% of those living more than a kilometre away. However, this study suggests that 500 is also an important threshold; over 80% of children living less than half a kilometre from school walked to school while less than 60% living between 500m and 1km reported being active. The 500 metre threshold is further supported by the distance controlled regression analysis which demonstrated that the pedestrian environment has a significant influence on walking to school for children living within 500 metres of school, but that it is not influential for those living farther away.

The effect of distance is more complicated than simple physical ability to walk since less than 15% of parents indicated that their child's school was too far from home for them to walk or bike. The influence of distance is confounded by strong correlations with both measures of pedestrian friendliness and parental perceptions of safety. Longer distances are associated with lower pedestrian friendliness scores and higher parental perception of risk from traffic; higher perceptions of risk from traffic are also associated with lower pedestrian friendliness scores. These relationships are understandable; as distance increases so does the child's level of exposure, or probability of encountering dangerous traffic conditions (e.g. larger streets) along the way. They suggest that the micro-scale pedestrian environment has a higher influence on the use of active travel modes than what the binary regression indicates, but that the synergistic relationships between the variables results in distance masking the strength of the influence of the pedestrian environment. The influence of distance may also be associated with convenience since greater distances mean longer walking times - a concept that could be explored in further research as discussed above.

6.3 Household Income and Vehicle Ownership

Contrary to research on adult travel patterns, household income was not found to be significant in this study – in fact it was not significant in the Chi Square test for non-randomness or in regression models where income was the only explanatory variable. One explanation for this is the uncertainty introduced with the high imputation rate for household income. However, this theory was rejected when after repeating the Chi Square excluding the imputed cases (n=199) with similarly insignificant results (p=.802). An alternative explanation could be a prevalence of non-working adults (e.g. a parent or grandparent) living in moderate to high income households who are available to accompany children walking to school. It could also be that the short home to school distances in this sample (compared to potential trip lengths to other destinations) have increased the incidence of walking among children from higher income households.

The accepted explanation for the relationship between income and travel choice is access to vehicles. In this study sample, household vehicle ownership was closely correlated with household income (R= .454, p=.000), and vehicle ownership is significantly associated with non-motorized travel to school. In this respect, a relationship with household income is retained. Vehicle ownership was found to be significant to travel choice regardless of distance with every additional vehicle decreasing the odds of walking by a factor of 0.56. This finding supports Ewing et al. who concluded that vehicle ownership (along with income) can be enough to overwhelm even the influence of short distances.[7] Similar to distance, it is unlikely that every additional vehicle in the household will have the same incremental influence on the odds of walking to school. Increasing the number of household vehicles from none to one will have a much stronger influence on that household's travel patterns than increasing the number of vehicles from 2 to 3 (particularly if the number of licenced drivers remains constant). Consequently the odds ratios from this model should be interpreted with caution.

6.4 The Influence of the Pedestrian Environment

The existing literature on children walking to school is inconclusive with respect to the influence of macro-scale variables such as population density, intersection density, and mix of land use[8]; some studies have found some of these to be significant,[9] but others concluded that income, distance, and vehicle ownership are overwhelmingly influential.[10] The current study hoped to determine whether a stronger relationship existed between children's mode of travel to school and micro-scale elements of the pedestrian environment. Results revealed that the micro-scale characteristics selected for analysis were significant when considering the lowest pedestrian score for children living within half a kilometre of school. Neither index of pedestrian friendliness was significant for other distance groups or in models of the entire sample controlling for distance at 100m or 500m increments.

There are several potential explanations for this. First it appears that 500m is an important threshold distance for walking to school among the children in this sample (as discussed in section 6.2). The cause of this threshold is most likely a combination of walking ability, travel time, and parental perception of safety (from traffic and from strangers and bullies). It is likely that after half a kilometre, the influence of these factors combine to overwhelm even a relatively attractive pedestrian environment in the decision to walk to school. Second, both the pedestrian friendliness scores were significantly negatively correlated with distance between home and school, indicating that higher scores tend to be clustered closer to the schools. It may be that the threshold level at which the lowest-pedestrian friendliness score becomes significant lies among the highest scores of the index and that within this sample, this threshold was only crossed within the 500m radius around the school.

Finally the lack of significance of either of the pedestrian friendliness scores in the regression of the entire sample is likely influenced by the variation in the overall sample of the pedestrian environment. The school catchment areas in this study are quite small, predominantly residential, and most major roads are located along the boundaries of the catchments. This is a wise decision by the school boards involved as it minimizes the number of students who must negotiate major roads on their way to school. The consequence for research is that this also minimizes the variation of pedestrian conditions within a catchment area. Significant similarities also existed between the catchments selected related to the predominance of residential uses. Eighty-six percent of the streets had only 2 lanes; 75% had no traffic calming; 80% of all intersections were controlled by stop signs; 75% had no crosswalk markings. There are clearly certain thresholds beyond which the pedestrian environment would be significant deterrents to children walking. This fact is demonstrated by the existence of “hazard bussing” policies where children live close to school but physical dangers stimulate the school board to pay for their transportation.[11] Multiple thresholds may exist (similar to the 500m and 1km thresholds identified for distance). Although there may be a threshold passed among the higher pedestrian friendliness scores found within 500m of the schools, it is likely that a broader diversity of pedestrian environment characteristics would reveal further threshold levels regardless of distance. Increasing the level of variation in the pedestrian environment is an important objective for future research.

Section 5.2.1 highlighted the finding that although some variables were not significant in chi square tests, they made an important contribution to the significance of the overall pedestrian friendliness indices. It was postulated that this was due to the cumulative effects of micro-scale variables in creating a pedestrian friendly street-scape and that the tendency for micro-scale environment features to co-vary in space means that single street segments will often exhibit a similar range of scores (high, medium, low) across all variables. This suggests that as the number of micro-scale features in one index increases, so should the gap between high and low scores, thereby increasing the significance. It would be valuable to test this hypothesis through further analysis of the existing dataset by incorporating a broader range of variables into the pedestrian friendliness indices. In particular, variables thought to influence safety from strangers and/or crime would be of interest to compliment the current study.

6.5 Perceptions of Safety

Five of the six questions on perceptions of safety from children and parents were significant in pair-wise chi square tests (children’s perception of strangers and bullies was not), but only two (parental perception of safety from traffic and safety from strangers and bullies) were significant in the regression analysis. Consistent with the literature,[12] parents on average expressed more concern about strangers and bullies on the way to school than they did about traffic, but in this study concern over traffic and strangers/bullies each have about the same level of influence in the regression. The data on perception are worth exploring further; for example this study has not analyzed the children who do use active transportation to determine which of these is accompanied by an adult or sibling which would mitigate safety concerns.

The only significant relationship between perception of safety and the micro-scale environment was between safety from traffic and the “lowest pedestrian friendliness” score. This makes sense because the pedestrian environment features selected for analysis in this study are more intuitively related to safety from traffic. Safety from strangers and bullies was not significant, but that is intuitively more associated with variables such as “eyes on the street” and visible building interiors, presence of graffiti, and building setbacks which were not included in the pedestrian friendliness index. The volume of other pedestrians on the street could also influence perception of safety from strangers and bullies, but this was not measured in the micro-scale survey.

The lack of significance with the perceptions of overall neighbourhood safety is interesting to note for the design of future surveys. It may be that parents differentiate between safety in their neighbourhood (which might include their street and those immediately adjoining it) and safety along the entire route between their home and the child’s school (which could be substantially farther). Also, perceptions of neighbourhood safety (as phrased in the parental survey) likely include a combination of issues related to traffic and strangers or bullies which would obscure a relationship between perceived neighbourhood safety and admittedly traffic-centric pedestrian environment variables. This differentiation between the neighbourhood and the route to school may also account for the finding that children’s perceptions of safety are not significant in the regression analysis. Alternatively, it could simply be that parental opinions consistently overwhelm those of children in travel mode choice decisions.

6.6 Observations on Methods

Chapter 3 described the NQLS micro-scale survey for inventorying features of the pedestrian environment. When this tool was selected it was known that data obtained through its use had not been analyzed in a significant way, nor had it ever been tested in the Greater Vancouver region. Research objectives for this study included assessing the utility of the survey tool itself. The NQLS survey had several significant benefits:

1) The survey tool was pre-developed by experts in the field of non-motorized transportation research;
2) Survey questions covered a very broad range of micro-scale urban form characteristics thought to influence rates of walking;
3) Responses were standardized in an objective way that enabled reasonable consistency in data collection across a large number of evaluators;
4) Responses were coded directly into software on a hand-held computer, thus facilitating data entry;
5) Response codes were very specific - most were entered in a binary yes/no format. This enables the individual analyzing the data to combine the binary responses to a level of detail suitable for a specific type of analysis while retaining a high level of detail in the raw data.
6) The survey is completed by individuals physically walking along each street segment which enables detailed data collection on a scale appropriate for pedestrian travel;

Reflecting on the process of data collection and analysis using this survey, it is clear there are certain limitations to quantifying the micro-scale pedestrian environment. Despite the extensive list of questions and possible responses, there are always details that are not fully captured by the survey. Nonetheless, the survey (and others like it) remains a valuable measurement tool that can provide a larger sample of data and a different type of analysis than could be done through more qualitative (e.g. image-based) research methods. Having said this, the use of the micro-scale survey for this study revealed some notable limitations. These are not thought to undermine the quality of the current analysis, but addressing them will improve data quality in future use of the survey tool. There is a high probability that refinements to the data collection and analysis methods will not produce more significant results in a regression analysis in the absence of a much more diverse sample of street types.

1. Road Width and Number of Lanes

The nature of the micro-scale survey is such that roads with dramatically different driving conditions (and thus different pedestrian environments) can receive very similar combined scores. The number of lanes is the variable with the greatest influence on this problem – an issue that may have arisen due to unique conditions in Greater Vancouver. This region has an abundance of streets that were constructed with only travel lanes but where local by-laws now allow on-street parking. This situation leaves only one functional lane width on streets with two-way traffic. Vehicles are obviously more constrained than on streets with two lanes in each direction plus an additional parking lane. However, both receive the same score (one lane on each side plus on-street parking). Photos 6.1a, b and c illustrate some streets with identical scores but a different overall look and feel due to their road width.

Photo 6.1a Draper Street in front of Hatzic Elementary School (Mission) has one lane of travel in each direction and no sidewalks. A paved should and adjacent gravel parking strip widen the street significantly for the purposes of crossing, and encourage higher speeds. (Photo: Ren Thomas)

Photo 6.1b Calverhall St. looking south from Kennard (Brooksbank, North Vancouver). Vehicular travel is allowed in both directions and there is no sidewalk. However, parking on either side of the street restricts the width of travel to only one lane when parking on both sides is utilized. The reduced space and visibility may singificantly decrease vehicle speeds compared to Photo 6.1a. Pedestrian safety is also compromised by forcing pedestrians to walk directly in the vehicle space. (Photo: Peter Giles)

Photo 6.1c Willet St. is a short dead-end street in the Hatzic catchment area. It has no sidewalks, allowance for travel in both directions, and on-street parking allowed by municipal by-law. The speed of traffic on this street will be restricted due to its short length. Traffic volumes will also be dramatically lower than Photos 6.1a and b because there are only 2 houses on the street.

A possible solution to this problem is to add an overall road width measure to the survey, and/or a lane width measure – perhaps mid-segment as well as at the intersection. Road and lane widths can influence the time required to cross an intersection, the average speed of traffic, and the amount of space available for cyclists.

2. Traffic Controls at Intersections

The survey requires data regarding crosswalk markings, crosswalk signage, and access for wheeled mobility aids for each separate leg of an intersection. This is particularly useful in Greater Vancouver because there are many intersections where major and minor streets intersect and the crosswalk treatments are different depending which street is being crossed. However the survey only records the type of traffic control once for the intersection rather that for each leg. This makes it unclear whether a stop-sign is 1-way (at a t-intersection), 2-way (at a 4-way intersection), or all-way. The Lower Mainland also has a lot of intersections with lights in one direction and stop signs in another. Although the survey allows for recording more than one traffic control device, it is unknown which street crossing has which type of control device. Photos 6.2a and 6.2b illustrate two different intersections that would receive the same traffic control score with the current survey. Photo 6.2c illustrates an intersection controlled by both lights and stop signs.

Photo 6.2a This 4-way intersection in the Walter Moberly catchment has a stop sign only in the north-south direction.

Photo 6.2b This 4-way intersection in the Boundary catchment area has stop signs in all directions. The intersections in these two photos differ in other ways (e.g. crosswalk markings) but the difference between the 2-way and 4-way stops is the most significant.

Photo 6.2c The intersection of Graveley and Willingdon in the Brentwood catchment illustrates the case (common in Greater Vancouver) where vehicles traveling on the major street are controlled by lights (activated by a pedestrian button), but there is only a stop sign for vehicles at the cross street.

Changing the survey to incorporate leg-specific traffic control data should not be difficult since most other variables are already collected at that level of detail. This lack of detail regarding traffic controls led to a decreased variability of intersection scores. Combining leg-specific traffic control data with GIS technology could dramatically increase the specificity of route equations for each child by indicating the exact points at which they cross certain streets. The drawback to more detailed intersection analysis is that it would become more difficult to impute data between intersections.

3. Geo-Reference Points

The survey tool is linked to a Geographical Positioning System (GPS) device which provides geographical coordinates for the location of each street segment and intersection. The coordinate reference is taken at the start of the segment and again halfway through the survey, but it is not clear if the second reference is meant to be at the end of the street segment. Without a beginning and end reference point it is impossible to compare certain features of the micro-scale survey. For example, the number street lights, trees, and furniture will vary depending on street segment length, regardless of their frequency per unit of distance. GIS technology was not used in the current analysis so this observation does not have implications for the quality of results. It should be noted however that this additional level of detail (and every additional variable included in the analysis) makes data imputation between street segments more difficult to complete with any accuracy.

4. Fitting the Data to the Methodology

Previous research on walking for transportation and recreation has assigned unique built-form scores based on average scores for a specific network radius around an individual's home. The current study is the first to examine travel mode choice based on one specific route between the origin and destination. Working at this scale and level of detail, there is a risk that assumptions regarding route choice are too specific for the level of detail available in the data. The lack of leg-specific traffic control information is one example of this where the difference between a 4-way and a 2-way stop on a major street could impact the comfort level of the pedestrian. Another example is that street segment scores were not adjusted to reflect their relative lengths. Nonetheless, it is believed that the approach used in this analysis is a good start to understanding the opportunities and limitations of a route-specific scoring system for the pedestrian environment. Further refinement of the micro-scale survey tool, combined with effective use of GIS technology will produce more accurate pedestrian environment scores – which may or not may not produce more significant results.

6.7 Summary and Recommendations for Further Research

This study has applied a route-specific research methodology focusing on micro-scale urban form that is unique within the existing literature on travel choice. Results are consistent with the literature on children's travel, and travel choice in general that distance[13] and vehicle ownership[14] are very significant influences on the choice to use non-motorized forms of transport. As in other studies[15], parental perceptions of safety from traffic and strangers and bullies are also significant influences, but to lesser degree than the influence of distance. Parental perceptions of safety from traffic are significantly associated with the lowest pedestrian friendliness score in this study. Improvements to the micro-scale pedestrian environment may alleviate these fears and increase rates of walking - particularly among children living less than half a kilometre from school.

Previous research on children's travel to school is inconclusive about the overall effect of macro-scale urban form variables on rates of walking[16]; one recent study on children's travel for all purposes found macro-scale measures to be significant.[17] These contrasting results suggest that the non-discretionary nature of the journey to school, and other factors such as the time of day at which it takes place may make the travel to school unique compared to more discretionary journeys throughout the day. This study found the links between micro-scale variables and children's travel to school to be significant at distances of 500m or less, but may be more significant at longer distance when considering trips for all purposes. The literature suggests that the influence of certain variables differs between age groups.[18] A study sample that includes a broader age range of children is likely to reveal relationships not identified for the age 9 and 10 cohorts.

The finding that children's travel to school is influenced by a wide range of variables is consistent with the ecological model of behaviour that recognizes the overlapping influences of intra- and inter-personal factors, environmental factors, and trip characteristics.[19] This underscores the importance of applying a multi-faceted approach[20] to increasing the number of children walking to school by simultaneously addressing each of the significant variables to encourage more children to walk to school. Decreasing the barriers and increasing the incentives to walk will require complimentary strategies to improve the micro-scale pedestrian environment, alleviate parental safety concerns, and overcome the habitual nature of automobile use.

Further research should aim to find neighbourhoods with a broader diversity of micro-scale urban form measures to further test the threshold levels of significance for the micro-scale environment. In addition perception of safety variables and convenience should be explored in more detail to understand how parents define these concepts and the degree to which they influence mode choice for travel to school. Sub-components of safety and convenience include whether a child has an adult or older sibling available to walk with them and the influence of such a chaperone on the decision to use an active travel mode. With respect to convenience, further research should explore the role of trip-chaining before and after school (e.g. to coincide with sports or other extra-curricular activities and the travel needs of other members of the family). All of these questions could begin to be explored to some degree with the existing dataset, although refinement of the travel survey and further data collection would also be valuable.

The use of this Micro-Scale Survey tool is still quite new and it would be educational to attempt to calibrate it against actual pedestrian safety data and the opinions of various user groups. This could be done using survey methods or focus groups to respond to representative photos; for example asking parents to rate their perceptions of safety for themselves and for their children on street segments and at intersections that manifest different combinations of the measured characteristics. Would they allow or encourage their child to walk in this place? Calibration could also be conducted by comparing the intersection scores to actual traffic accident data to see which factors (if any) are empirically linked to accidents. This strategy may improve the scoring system used to develop quantitative scores from the categorical pedestrian environment data.

Finally, the U.S. state and national Safe Routes to School programs have resulted in some studies empirically examining the affect of micro-scale infrastructure improvements on the safety and numbers of children walking to school.[21] It would also be valuable from a public investment perspective to empirically evaluate the outcomes of walk to school programs based more on social-marketing strategies.

6.8 Policy Recommendations

The intent of this study was to better understand the factors influencing travel mode choice for children's trips to school. Main policy recommendations arising from this study are directed at increasing the number of children using non-motorized modes of transportation in some or all of their journey to school. Recommendations are differentially addressed to the 7 schools included in the study and school administrations in general.

To encourage more children to be active en route to school, schools included in this study should:

- Focus on activities to identify and address perceived safety concerns (as well other issues identified by local parents) that are currently barriers to children walking to school.
- Identify specific street segments and intersections within a 500m radius of the school to target for infrastructure improvements. These targets could be based on the "lowest pedestrian friendliness score" utilized in this study. Where necessary, work with local municipal governments on the implementation of these infrastructure improvements. Ensure that the improvements and how they will make children safer en route to school are communicated effectively to parents of students attending the schools.

School boards and local governments in all jurisdictions should:

- Apply a multi-faceted approach to encourage more children to be active in traveling to school. Develop multi-stakeholder committees to discuss the specific barriers to walking faced by children in each community and apply a combination of institutional, programmatic, and infrastructural tactics to increase rates of walking.
- Require new developments to include pedestrian and cyclist-friendly transportation routes from the start, particularly connecting to schools.
- Require the installation of sidewalks, crosswalks, and other pedestrian and cycling amenities in conjunction with any major maintenance projects (such as road resurfacing) to leverage opportunities for retrofits; incorporate the need for pedestrian amenities into criteria for prioritizing such maintenance or retrofit projects.

- Design new neighbourhoods in a way that maximizes the proportion of prospective students living within 500 metres of the school, followed by within 1km of the school.
- Incorporate opportunities for children to walk to school into long-term strategic planning for school boards. This may involve (for example) prioritizing the preservation of local neighbourhood schools over building larger centralized schools.

Although the 500 metre network radius around schools is the key target for pedestrian environment improvements related to children walking to school, it is reasonable to assume that similar improvements in all residential areas will increase children's non-motorized travel for trips for all purposes. Local governments are recommended to invest in high-quality pedestrian micro-scale environments and to require pedestrian amenities in new private developments regardless of proximity to schools or other destinations frequented by children.

Applying the multi-faceted approach advocated by the ecological model of environment,[22] policies to increase the proportion of children walking to school would include a combination of social-marketing programs and pedestrian infrastructure improvements. Schools, school boards, and parental advisory committees should advocate for funding and collaborate with local and higher-order governments to achieve these complimentary objectives. Unfortunately the lack of any national or (excepting British Columbia) provincial funding in Canada for safe routes to school programs suggests that lower-cost alternatives are a more immediate priority. In Toronto the cost of installing new traffic lights at one intersection is estimated to be $100,000. Such an investment may improve walking conditions for a small proportion of children at one school, while the same money could provide a year of funding for a social marketing program that stimulates activities at numerous schools in one jurisdiction and leverages the work of community leaders (police officers, school officials) and parent volunteers. Considering the current funding environment, pursuing social-marketing programs would appear to be the best strategy for the immediate term, while maintaining advocacy efforts to influence the nature of pedestrian environments in existing and new developments.

Finally, there is a moral obligation to protect the safety of children (and adults) already using non-motorized transportation, regardless of the degree to which improved pedestrian infrastructure might increase rates of walking. Despite the decline in recent decades in the rates of children walking to school, children and youth still represent the most significant proportion of people using non-motorized transport. In the Greater Toronto Area children and youth account for more than 50% of weekday walking and cycling trips, and over 20% of weekday transit trips.[23] The design of any municipal transportation infrastructure project should be evaluated from the perspective of pedestrian safety and convenience.

ENDNOTES

CHAPTER 1

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CHAPTER 2

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18 DiGuiseppi et al., 1998; Eichelberger et al., 1990; McMillan, 2005.
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20 Kouri, 1999
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CHAPTER 4

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CHAPTER 5

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APPENDIX A:
PARENT AND CHILD TRAVEL SURVEYS

SURVEY FOR PARENTS - Fall 2005

Please respond in relation to your child who is participating in the Action! Schools BC Physical Activity Questionnaire.

Child's Name: ______________________________ Child's School: ________________________
_

1. What is your postal code? _____________

2. Is your child: O male O female

3. How old is your child who is participating in this survey? ______________

4. What is the distance (in kilometres) between your house and your child's school?

O Less than ½ kilometre (500 metres) O ½ to 1 kilometres
O 1 to 2 kilometres O 2 to 3 kilometres
O more than 3 kilometres

5. How many vehicles does your household own? Include all cars, trucks, vans, SUVs, and motorcycles.

O none O 1 O 2 O 3 O more than three

6. How many people in your household have a driver's license?

O none O 1 O 2 O 3 O more than three

7. How do you usually get to work? ("Usually" means 3 or more times per week.)

O walk O ride a bicycle

O roller blade/skateboard/scooter/other physical activity

O drive by myself O carpool (as driver)

O carpool (as passenger) O public transit (Translink or West Coast Express)

0 work from home O don't work outside the home

O other ______________________________

8. How does your child usually get to school? ("Usually" means 3 or more times per week.)

O walks by him/herself O walks with a brother/sister/friend

O walks with a parent or other adult O rides his/her bicycle

O roller blades, scooters, or skateboards O walks to the school bus stop

O driven to the school bus stop O public transit (Translink)

O driven to school by him/herself or with brothers and sisters

0 driven to school with friends (carpool)

O other ______________________________

9. How does your child usually get home from school? (“Usually” means 3 or more times per week.)

O walks by him/herself
O walks with a brother/sister/friend
O walks with a parent or other adult
O rides his/her bicycle
O roller blades, scooters, or skateboards
O walks to the school bus stop
O driven to the school bus stop
O public transit (Translink)
O driven to school by him/herself or with brothers and sisters
O driven to school with friends (carpool)

O other ______________________________

10. What are the TWO MAIN REASONS that your child usually gets to/from school this way?

O convenience
O cost
O only option
O safety from traffic
O distance
O opportunity for exercise
O safety from strangers or bullies
O better for the environment
O easiest way to organize daily schedules
O my child prefers this way

O other ______________________________

11. If your child is driven to school, does the person driving usually...

O only drive the child to school
O drive the child to school on their way to work
O drive the child to school on their way to somewhere else (not work)

12. If your child takes the school bus or Translink, what is the distance from your home to your child's school bus or Translink stop?

O less than 0.2km (200m) O 0.2 to 0.5km (200-500m)

O 0.5 to 1.0 km (500m – 1km) O greater than 1 km

13. Does your family ever use walking or jogging, riding bicycles, roller-blading, skateboarding, or use a scooter to get places other than school?

O Yes – less than 1 time per week O Yes - 1 to 3 times per week

O Yes - 4 or more times per week O No – we never get to places in these ways

14. Have you ever talked with your child about the safest way for them to walk or ride their bicycle to school?

O Yes O No

15. Use the numbers below to show how much you agree with the following statements about your neighbourhood.

I believe...	1 strongly agree	2 some what agree	2 some what disagree	3 strongly disagree
My neighbourhood is a safe place for my child to walk.	O	O	O	O
My child is safe from traffic while walking to school or waiting for the school bus/public transit.	O	O	O	O
My child is safe from strangers and bullies while walking to school or waiting for the school bus/public transit.	O	O	O	O

I believe...	1 strongly agree	2 some what agree	2 some what disagree	3 strongly disagree
Walking to school is a good way for my child to learn independence and get exercise.	O	O	O	O
Driving my child to school is a good opportunity for us to talk because we are often busy.	O	O	O	O
Driving my child to school is an important part of my responsibility as a parent.	O	O	O	O
Our house is too far away from school for my child to walk or ride their bicycle.	O	O	O	O

16. Please comment on any other factors that influence your decisions on how your child gets to school.

____

____

____

17. What is your approximate annual household income?

O under $19,999 O $20,000 - $29, 999 O $30,000 - $39,999
O $40,000 - $49,999 O $50,000 - $59,999 O $60,000 - $69,000
O $70,000 - $79,999 O $80,000 - $89,999 O $90,000-$99,999
O $100,000 or greater

Barriers to walking and biking to school for your child

Please circle the answer that best applies to your child.

1a. Is your child's school within a 30 minute walk or bike from your home?	Yes	No
1b. Does your child walk or bike to school, either alone or with someone (at least once week)?	Yes	No

Do you agree or disagree with the following statements:

It is difficult for my child to walk or bike to school (alone or with someone) because…

	1 strongly disagree	2 somewhat disagree	3 somewhat agree	4 strongly agree
2. There are too many hills along the way	1	2	3	4
3. There are no sidewalks or bike lanes	1	2	3	4
4. The route is boring	1	2	3	4
5. The route does not have good lighting	1	2	3	4
6. There is too much traffic along the route	1	2	3	4
7. There is one or more dangerous crossings	1	2	3	4
8. My child gets too hot and sweaty	1	2	3	4
9. No other children walk or bike to school	1	2	3	4
	1 strongly disagree	2 somewhat disagree	3 somewhat agree	4 strongly agree
10. It's not considered cool to walk or bike	1	2	3	4
11. My child has too much stuff to carry	1	2	3	4
12. It is easier for me to drive my child here on the way to something else	1	2	3	4
13. It involves too much planning ahead	1	2	3	4
14. It is unsafe because of crime (strangers, gangs, drugs)	1	2	3	4
15. My child gets bullied, teased, harassed	1	2	3	4
16. There is nowhere to leave a bike safely	1	2	3	4
17. There are stray dogs	1	2	3	4
18. It is too far	1	2	3	4

For the next few questions, tell us how much you agree or disagree with each statement. Please circle your answers				
	strongly disagree	somewhat disagree	somewhat agree	strongly agree
19. Other kids my child’s age walk or bike to school by themselves	1	2	3	4
20. Other kids my child’s age walk or bike to school with a parent or other adult	1	2	3	4
21. Other kids my child’s age think walking or biking to school is “cool”	1	2	3	4
22. At my child’s school, the older kids think walking or biking to school is “cool”	1	2	3	4
23. My child enjoys walking or biking to school	1	2	3	4
24. My child enjoys walking or biking to school with friends	1	2	3	4
25. My child enjoys walking or biking to school with a parent or other adult	1	2	3	4

The Active Transportation Collaboratory

SURVEY FOR KIDS - Fall 2005

Name: ______________________________ School: ______________________________

1. Are you a:

   O Boy   O Girl

2. How do you usually get *to school*?

   O walk by myself
   O walk with a brother/sister/friend
   O walk with a parent or other adult
   O ride my bicycle
   O roller blade, scooter, or skateboard
   O walk to the school bus stop
   O driven to the school bus stop
   O public transit (Translink)
   O driven to school by myself or with my brothers/sisters
   O driven to school with friends (carpool)
   O other ______________________________

3. How do you usually get *home from school*?

   O walk by myself
   O walk with a brother/sister/friend
   O walk with a parent or other adult
   O ride my bicycle
   O roller blade, scooter, or skateboard
   O walk to the school bus stop
   O driven to the school bus stop
   O public transit (Translink)
   O driven to school by myself or with my brothers/sisters
   O driven to school with friends (carpool)
   O other ______________________________

4. If you ever walk, bike, roller blade, scooter, or skateboard to school, how many days per week do you do it?

______________ days per week

5 a. How did you get to school today?

O walk by myself

O walk with a brother/sister/friend

O walk with a parent or other adult

O ride my bicycle

O roller blade, scooter, or skateboard

O walk to the school bus stop

O driven to the school bus stop

O public transit (Translink)

O driven to school by myself or with my brothers/sisters

O driven to school with friends (carpool)

O other ____

5 b. If today was different from how you usually get to school, why was it different?

____

6. If you are driven to school, does the person driving you usually...

O only drive you to school

O drive you to school on their way to work

O drive you to school on their way to somewhere else (not work)

7. Is the person that takes you to school your parent?

O Yes O No

8. What is your favourite way to get to school?

O walk by myself

O walk with a brother/sister/friend

O walk with a parent or other adult

O ride my bicycle

O roller blade, scooter, or skateboard

O walk to the school bus stop

O driven to the school bus stop

O public transit (Translink)

O driven to school by myself or with my brothers/sisters

O driven to school with friends (carpool)

O other ____________________

9. Do you ever walk or jog, ride your bicycle, roller blade, skateboard or use a scooter to get to places other than school?

O Yes – less than 1 time per week

O Yes – 1 to 3 times per week

O Yes – 4 or more times per week

O No - I never go places this way

10. Have the teachers at your school ever encouraged you to walk, bike, jog, roller blade, skateboard, or use a scooter to get to school?

O Yes O No

11. Have you ever talked with your parents or teacher about the safest way to walk or ride your bicycle to school?

O Yes O No

12. Use the numbers 1, 2, or 3 to show how much you agree with the following statements about walking or biking to your school.

1 - means you agree a lot

2 – means you agree a little

3 – means you don't agree at all

When I walk or bike in my neighbourhood...

	1 Agree a lot	2 Agree a little	3 Don't agree
I feel safe from cars.	O	O	O
I feel safe from strangers and bullies.	O	O	O
It is easy and fun to walk.	O	O	O
It is easy and fun to ride my bicycle.	O	O	O
I feel safe walking by myself.	O	O	O
It is boring.	O	O	O
It takes too long to get places.	O	O	O
Other kids make fun of me.	O	O	O

APPENDIX B:
MICRO-SCALE BUILT ENVIRONMENT SURVEY

A. INTERSECTION

1. Intersection design. Check one answer.
T-shaped (3 legs) = 1
Cross-shaped (4 legs) = 2
Star-shaped (5 legs) = 3

2. Type of Traffic Control. Check all that apply. Yes = 1; No = 0
No traffic control
Stop sign
Traffic signal
Yield sign
Roundabout or traffic circle

3. Special Use Lanes. Check all that apply. Yes= 1; No= 0
No special use lanes
Right turn lane
Continuous right turn lane
Single left turn lane
Double left turn lane
Bike Lane
Dedicated bus lane
Taxi queue
Other: specify ________________________

4. Crosswalk Characteristics: Ask Questions A-D for number of intersection legs based on Question #1, Intersection Design.

A. Crosswalk Marking for Intersection Leg X. Check all that apply. Yes= 1; No= 0
None
Designated or marked
Raised
Textured pavement

B. Crosswalk Setback for Intersection Leg X. Check one answer.
0 feet =1
1 - 4 feet =2
> 4 feet =3

CONTINUED....

C. Crosswalk Signage for Intersection Leg X. Check all that apply. Yes= 1; No= 0
None
Flashing lights
Pedestrian caution sign

a. **Is there a pedestrian signal? Yes No** Yes= 1; No= 0

b. **Is it button activated? Yes No** Yes= 1; No= 0

1. **Signal Timing – Number of Seconds of Solid Time _________seconds**
2. **Signal Timing – Number of Seconds of Flashing Time ______ seconds**

D. Crosswalk Curb condition for Intersection Leg X. Check all that apply.
Yes= 1; No= 0
None
Raised median or island
Curb cuts /wheelchair ramps

B. ROADWAY

1a. Left Street Segment: Number of Vehicular Travel Lanes in one direction. Check one answer.
0 lanes = 0
1 lane = 1
2 lanes = 2
3 lanes = 3
4+ lanes =4

1b. Right Street Segment: Number of Vehicular Travel Lanes in one direction. Check one answer.
0 lanes = 0
1 lane = 1
2 lanes = 2
3 lanes = 3
4+ lanes =4

2a. Left Street Segment: Number of Driveways. Check one answer.
0 driveways = 0
1 - 2 driveways = 1
3 - 5 driveways =2
> 5 driveways = 3

2b. Right Street Segment: Number of Driveways. Check one answer.
0 driveways = 0
1 - 2 driveways = 1
3 - 5 driveways =2
> 5 driveways = 3

3a. Left Street Segment: Type of Curb. Check all that apply. Yes= 1; No= 0
No curb
Right angle or square
Rolled

3b. Right Street Segment: Type of Curb. Check all that apply. Yes= 1; No= 0
No curb
Right angle or square
Rolled

CONTINUED....

4a. Left Street Segment: Parking. Check all that apply. Yes= 1; No= 0
No parking
Angled parking
On-street 90 degree
Parallel to curb
Surface parking in front of building
Surface parking on the side of building
Surface parking behind building
Parking garage
Pay or metered parking

4b. Right Street Segment: Parking. Check all that apply. Yes= 1; No= 0

No parking
Angled parking
On-street 90 degree
Parallel to curb
Surface parking lot in front of building
Surface parking lot on the side of building
Surface parking lot behind building
Parking garage
Pay or metered parking

5. Roadway grade. Check one answer.

No grade or flat = 0
Slight grade = 1
Moderate grade = 2
Steep grade = 3

C. TRAFFIC CALMING

1. Presence of Speed Table or Hump. Check one answer.
Present = 1 Not present = 0

2. Presence of Signs to Reduce Speed. Check one answer.
Present = 1 Not present = 0

3. Presence of Traffic Circle. Check one answer.
Present = 1 Not present = 0

4. Presence of Curb Extension. Check one answer.
Present = 1 Not present = 0

5. Presence of Textured Pavement. Check one answer.
Present = 1 Not present = 0

6. Presence of Full or partial Road Closure. Check one answer.
Present = 1 Not present = 0

7. Presence of Neckdown or Narrowing of road mid-block. Check one answer.
Present = 1 Not present = 0

CONTINUED....

D. BUFFER

Is there a Buffer on the left side of the street? Yes No Yes= 1; No= 0

1a. Left Street Segment: Types of Buffers between vehicular and pedestrian areas. Check all that apply. Yes= 1; No= 0
Brick
Dirt
Grass
Shrubs
Trees
Paved shoulder
Gravel shoulder

2a. Left Street Segment: Percentage of Street with Buffer. Check one answer.
1 - 25% = 1
26 - 50% =2
51 - 75% = 3
76 - 99% = 4
100% = 5

3a. Left Street Segment: Buffer Width. Check one answer.
< 4 feet = 1
4 – 6 feet = 2
>6 - 8 feet = 3
> 8 feet = 4

Is there a Buffer on the right side of the street? Yes No Yes= 1; No= 0

1b. Right Street Segment: Types of Buffers between vehicular and pedestrian areas. Check all that apply. Yes= 1; No= 0
Brick
Dirt
Grass
Shrubs
Trees
Paved shoulder
Gravel shoulder

2b. Right Street Segment: Percentage of Street with Buffer. Check one answer.
1 - 25% = 1
26 - 50% =2
51 - 75% = 3
76 - 99% = 4
100% = 5

3b. Right Street Segment: Buffer Width. Check one answer.
< 4 feet = 1
4 – 6 feet = 2
>6 - 8 feet = 3
> 8 feet = 4

CONTINUED....

E. STREET FURNITURE

1a. Left Street Segment: Street Furniture. Check all that apply. Yes= 1; No= 0
None of these
Benches
Bike racks
Bollards
Bus shelters
Bus stops
Drinking fountains
Flower planters
Kiosks
Newspaper boxes
Pay telephones
Pedestrian oriented maps

None of these
Public Art
Public toilet facilities
Sidewalk cafe or food vendor
Street lighting
Street name signs
Trash or recycling cans
Utility / electric poles
Other: specify ________________

1b. Right Street Segment: Street Furniture. Check all that apply. Yes= 1; No= 0
None of these
Benches
Bike racks
Bollards
Bus shelters
Bus stops
Drinking fountains
Flower planters
Kiosks
Newspaper boxes
Pay telephones
Pedestrian oriented maps

None of these
Public Art
Public toilet facilities
Sidewalk cafe or food vendor
Street lighting
Street name signs
Trash or recycling cans
Utility / electric poles
Other: specify ________________

2a. Left Street Segment: Spacing of Street Lights. Check one answer.
0 lights = 0
1 light = 1
Evenly spaced = 2
Irregularly spaced = 3

3a. Left Street Segment: Number of Street Lights. Please fill in answer.
Number of street lights on street segment: ____

CONTINUED....

.

2b. Right Street Segment: Spacing of Street Lights. Check one answer.
0 lights = 0
1 light = 1
Evenly spaced = 2
Irregularly spaced = 3

3b. Right Street Segment: Number of street lights. Please fill in answer.

Number of street lights on street segment: ____

<u>F. TREES and SHADING</u>

1a. Left Street Segment: Number of Trees in buffer. Check one answer.
0 or 1 tree = 0
2 - 5 trees = 1
6 - 10 trees = 2
11 - 20 trees = 3
21+ trees = 4

2a. Left Street Segment: Tree Spacing in the buffer. Check one answer.
Evenly spaced = 1
Irregularly spaced = 2

3a. Left Street Segment: Percentage of the Total Area of the Walkway that is covered by Tree Canopy, Awnings, or Other Structures. Check one answer.
No coverage = 0
1- 25% = 1
26 - 50% = 2
51 - 75% = 3
76 - 100% = 4

1b. Right Street Segment: Number of Trees in buffer. Check one answer.
0 or 1 tree = 0
2 - 5 trees = 1
6 - 10 trees = 2
11 - 20 trees = 3
21+ trees = 4

2b. Right Street Segment: Tree Spacing in the buffer. Check one answer.
Evenly spaced = 1
Irregularly spaced = 2

3b. Right Street Segment: Percentage of the Total Area of the Walkway that is covered by Tree Canopy, Awnings, or Other Structures. Check one answer.
No coverage = 0
1- 25% = 1
26 - 50% = 2
51 - 75% = 3
76 - 100% = 4

<u>G. SIDEWALKS</u>

1a. Left Street Segment: Percentage of street with Sidewalk. Check one answer.
No sidewalk = 0
1 - 25% = 1
26 - 50% =2
51 - 75% = 3
76 - 99% = 4
100% = 5

CONTINUED....

2a. Left Street Segment: Predominant Sidewalk Material. Check one answer.
Asphalt = 1
Concrete = 2
Brick = 3
Stone = 4
Dirt path = 5
Gravel shoulder = 6
Multiple materials = 7

2a1. Left Street Segment: Surface Continuity. Check one answer.
Some portion paved or surfaced =1
Mostly paved or surfaced = 2
Continuously paved or surfaced = 3

3a. Left Street Segment: Sidewalk Quality. Check all that apply. Yes= 1; No= 0
Mainly broken surface material
Small areas of broken surface materials
Uneven surface
Uniform

4a. Left Street Segment: Sidewalk Width not including buffer. Check one answer.
< 4 feet = 1
4 – 6 feet = 2
>6 - 8 feet = 3
> 8 feet = 4

5a. Left Street Segment: Sidewalk Obstructions. Check one answer.
No sidewalk obstructions = 0
Permanent = 1
Temporary = 2
Permanent and temporary = 3

1b. Right Street Segment: Percentage of Street with Sidewalk. Check one answer.
No sidewalk = 0
1 - 25% = 1
26 - 50% =2
51 - 75% = 3
76 - 99% = 4
100% = 5

2b. Right Street Segment: Predominant Sidewalk Material. Check one answer.
Asphalt = 1
Concrete = 2
Brick = 3
Stone = 4
Dirt path = 5
Gravel shoulder = 6
Multiple materials = 7

2a2. Right Street Segment: Surface Continuity. Check one answer.
Some portion paved or surfaced - 1
Mostly paved or surfaced - 2
Continuously paved or surfaced - 3

3b. Right Street Segment: Sidewalk Quality. Check all that apply. Yes= 1; No= 0

Mainly broken surface material
Small areas of broken surface material
Uneven surface
Uniform

CONTINUED....

4b. Right Street Segment: Sidewalk Width not including Buffer. Check one answer.
< 4 feet = 1
4 – 6 feet = 2
>6 - 8 feet = 3
> 8 feet = 4

5b. Right Street Segment: Sidewalk Obstructions. Check one answer.
No sidewalk obstructions = 0
Permanent = 1
Temporary = 2
Permanent and temporary = 3

H. PRIVATE DEVELOPMENT

1a. Left Street Segment: Smallest Setback From Walkway. Check one answer.
No building =0
< 10 feet =1
10 - 20 feet=2
21 - 50 feet =3
51 - 100 feet =4
> 100 feet =5

2a. Left Street Segment: Largest Setback. Check one answer.
< 10 feet =1
10 - 20 feet =2
21 - 50 =3
51 - 100 feet =4
> 100 feet =5

3a. Left Street Segment: Setback Consistency. Check one answer.
Mostly consistent =1
Mostly inconsistent =2

4a. Left Street Segment: Setback Usage. Check all that apply. Yes= 1; No= 0
None of these
Private yard
Awning
Bike racks
Building ledge or benches
Driveways for delivery vehicles
Dumpster
Fences or walls (can see through)
Fences or walls (obstructing view)
Landscaping or planter boxes
Outdoor patio for restaurant or cafe
Park/open space
Parking lot or space
Pedestrian walkway
Signs
Other: specify ________________________

5a. Left Street Segment: Shortest Building Height. Check one answer.
1 - 2 stories =1
3 - 5 stories =2
6 - 15 stories =3
16 + stories =4

CONTINUED....

6a. Left Street Segment: Tallest Building Height. Check one answer.
1 - 2 stories =1
3 - 5 stories =2
6 - 15 stories =3
16 + stories =4

7a. Left Street Segment: Facade Step Back. Check one answer.
Yes =1
No =0

8a. Left Street Segment: Percentage of Buildings in Disrepair. Check one answer.
0% =0
1 – 25% =1
26 - 50% =2
51 - 75% =3
76 - 100% =4

9a. Left Street Segment: Percentage of Visible Street Level Interior. Check one answer.
0% =0
1 - 33% =1
34 - 66% =2
67 - 100% =3

10a. Left Street Segment: Perceived Eyes on Street from Windows, Porches, and Verandas. Check one answer.
0% =0
1 - 33% =1
34 - 66% =2
67 - 100% =3

11a. Left Street Segment: Building Uses. Check all that are present. Yes= 1; No= 0
None of these
ATM free standing
Auto-oriented stores (car parts, car repairs, etc)
Bank
Bar
Cafe or coffee shop
Chain convenience store
Community center
Convenience store “Mom and Pop”
Day care
Dry cleaning/coin laundry
Dwelling - single-family
Dwelling - multi-family
Food Market

CONTINUED....

11a continued...

None of these
Furniture or appliance store
Gas station
Grocery store
Hotel
Library
Liquor Store
Multiple commercial uses
Offices – government
Offices – unspecified/misc
Photocopy store
Post office
Professional services (doctor, lawyer, etc)
None of these
Retail store – big box large chain
Retail store - small chain
Salon, barber shop
School
Specialty shop/ local gift
Video store
Other: specify ____________________________

12b. Left Street Segment: Number of Fast Food Uses. Write in Number observed: ____

12c. Left Street Segment: Number of Food Drive-Thru Windows. Write in Number: ____

1b. Right Street Segment: Smallest Setback From Walkway. Check one answer.
No building =0
< 10 feet =1
10 - 20 feet=2
21 - 50 feet =3
51 - 100 feet =4
> 100 feet =5

2b. Right Street Segment: Largest Setback. Check one answer.
< 10 feet =1
10 - 20 feet =2
21 - 50 =3
51 - 100 feet =4
> 100 feet =5

3b. Right Street Segment: Setback Consistency. Check one answer.
Mostly consistent =1
Mostly inconsistent =2

CONTINUED....

4b. Right Street Segment: Setback Usage. Check all that apply.
None of these
Private yard
Awning
Bike racks
Building ledge or benches
Driveways for delivery vehicles
Dumpster
Fences or walls (can see through)
Fences or walls (obstructing view)
Landscaping or planter boxes
Outdoor patio for restaurant or cafe
Park/open space
Parking lot or space
Pedestrian walkway
Signs
Other: specify ________________________

5b. Right Street Segment: Shortest Building Height. Check one answer.
1 - 2 stories =1
3 - 5 stories =2
6 - 15 stories =3
16 + stories =4

6b. Right Street Segment: Tallest Building Height. Check one answer.
1 - 2 stories =1
3 - 5 stories =2
6 - 15 stories =3
16 + stories =4

7b. Right Street Segment: Facade Step Back. Check one answer.
Yes =1
No =0

8b. Right Street Segment: Percentage of Buildings in Disrepair. Check one answer.
0% =0
1 – 25% =1
26 - 50% =2
51 - 75% =3
76 - 100% =4

9b. Right Street Segment: Percentage of Visible Street Level Interior. Check one answer.
0% =0
1 - 33% =1
34 - 66% =2
67 - 100% =3

10b. Right Street Segment: Perceived Eyes on Street from Windows, Porches, and Verandas. Check one answer.
0% =0
1 - 33% =1
34 - 66% =2
67 - 100% =3

CONTINUED....

11b. Right Street Segment: Building Uses. Check all that are present. Yes= 1; No= 0
None of these
ATM free standing
Auto-oriented stores (car parts, car repairs, etc)
Bank
Bar
Cafe or coffee shop
Chain convenience store
Community center
Convenience store "Mom and Pop"
Day care
Dry cleaning/coin laundry
Dwelling - single-family
Dwelling - multi-family
Food Market

None of these
Furniture or appliance store
Gas station
Grocery store
Hotel
Library
Liquor Store
Multiple commercial uses
Offices – government
Offices – unspecified/misc
Photocopy store
Post office
Professional services (doctor, lawyer, etc)

None of these
Retail store – big box large chaing
Retail store - small chain
Salon, barber shop
School
Specialty shop/ local gift
Video store
Other: specify ______________________________

12b. Right Street Segment: Number of Fast Food Uses.
Write in Number observed: _______
12c. Right Street Segment: Number of Food Drive-Thru Windows.

Write in Number observed: _______

I. COMMUNITY OPEN SPACE

1a. Left Street Segment: Types of Open/Public Space Adjacent to the Street. Check all that apply. Yes= 1; No= 0
None
A park
A community garden
A courtyard
Recreation facilities, courts, or playing fields
Agricultural land
Forest

CONTINUED....

1b. Right Street Segment: Types of Open/Public Space Adjacent to the Street. Check all that apply. Yes= 1; No= 0
None
A park
A community garden
A courtyard
Recreation facilities, courts, or playing fields
Agricultural land
Forest

2a. Left Street Segment: Open/Public Space Amenities Accessible From the Street. Check all that apply. Yes= 1; No= 0
None
Benches
Drinking fountains
Play structures
Tennis courts
Swimming pool
Walking path, paved or unpaved
Bike path, paved or unpaved

2b. Right Street Segment: Open/Public Space Amenities Accessible From the Street. Check all that apply. Yes= 1; No= 0
None
Benches
Drinking fountains
Play structures
Tennis courts
Swimming pool
Walking path, paved or unpaved
Bike path, paved or unpaved

3a. Left Street Segment: Presence of Other Pedestrian Routes Connected to the Sidewalk. Check all that apply. Yes= 1; No= 0
No other routes
Path/ alley thru park/ vacant lot
Alley between buildings
Path from end of cul-de-sac

3b. Right Street Segment: Presence of Other Pedestrian Routes Connected to the Sidewalk. Check all that apply. Yes= 1; No= 0
No other routes
Path/ alley thru park/ vacant lot
Alley between buildings
Path from end of cul-de-sac

CONTINUED....

J. NEGATIVELY PERCEIVED CHARACTERISTICS

1a. Left Street Segment: Presence of Incivilities. Check all that apply. Yes= 1; No= 0
None
Graffiti
Posters/stickers (unauthorized)

1b. Right Street Segment: Presence of Incivilities. Check all that apply. Yes= 1; No= 0
None
Graffiti
Posters/stickers (unauthorized)

2a. Left Street Segment: Maintenance and Cleanliness. Check all that apply. Yes= 1; No= 0
None
Structures with cosmetic disrepair
Substantial litter
Abandoned, boarded-up buildings
Abandoned vehicles

2b.Right Street Segment: Maintenance and Cleanliness. Check all that apply. Yes= 1; No= 0
None
Structures with cosmetic disrepair
Substantial litter
Abandoned, boarded-up buildings
Abandoned vehicles

APPENDIX C:

UBC BEHAVIOURAL RESEARCH ETHICS BOARD

CERTIFICATE OF APPROVAL

The University of British Columbia
Office of Research Services and Administration
Behavioural Research Ethics Board

Certificate of Approval

PRINCIPAL INVESTIGATOR	DEPARTMENT	NUMBER
McKay, H.A.	Orthopaedics	B05-0585

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT

CO-INVESTIGATORS

Bredin, Shannon, Human Kinetics; Frank, Lawrence, ; Manske, Stephen, ; Naylor, Patti-Jean, ; Rhodes, Ryan, ; Warburton, Darren, Human Kinetics; Wharf-Higgins, Joan,

SPONSORING AGENCIES

Faculty of Education Graduate Student Research Grant

TITLE:

The Risk of Cardiovascular Disease in Canadian Children: Implications from a Fundamental Motor Skills Perspective for School and Community Based Physical Activity Interventions

APPROVAL DATE	TERM (YEARS)	AMENDMENT	AMENDMENT APPROVED
05-08-22 (yr/mo/day)	1	Nov. 9, 2005, Title / Sponsor	NOV 16 2005

CERTIFICATION

The protocol describing the above-named project has been reviewed by the Committee and the experimental procedures were found to be acceptable on ethical grounds for research involving human subjects.

Susan Rowley

Approved on behalf of the Behavioural Research Ethics Board
by one of the following:
Dr. Peter Suedfeld, Chair,
Dr. Susan Rowley, Associate Chair

This Certificate of Approval is valid for the above term provided there is no change in the experimental procedures

APPENDIX D:
COVER LETTERS ACCOMPANYING TRAVEL SURVEYS

THE UNIVERSITY OF BRITISH COLUMBIA

Department of Orthopaedics
Academic Head Office
Faculty of Medicine
The University of British Columbia
Room 3114, 910 West 10th Avenue
Vancouver, B.C. Canada V5Z 4E3

Tel: (604) 875-4192
Fax: (604) 875-4677

Fall 2005

Dear Parents,

Measurement in your child's school is now underway for the Action Schools! BC Rollout Evaluation. We would like to take this opportunity to thank you and your child for participating.

As part of the evaluation we would like to ask you questions about the community that you live in and how "walkable" that community is. We invite you to complete the "Survey for Parents" (salmon) questionnaire and your child to complete the "Survey for Kids" (orange) questionnaire. Please put them into the self addressed stamped envelope provided and place it in the mail.

If you have any questions, comments or concerns please feel free to contact **Sharon Storoschuk**, Research Coordinator for the evaluation at **604-875-4111 extension 62005**.

Thank you again for your participation! We look forward to learning from you and your child.

Best regards,

Sharon Storoschuk

Sharon Storoschuk, MS, MPH
Research Coordinator

THE UNIVERSITY OF BRITISH COLUMBIA

Department of Orthopaedics
Academic Head Office
Faculty of Medicine
The University of British Columbia
Room 3114, 910 West 10th Avenue
Vancouver, B.C. Canada V5Z 4E3

Tel: (604) 875-4192
Fax: (604) 875-4677

Winter 2006

Dear Parents,

Thank you for your participation in the "Action Schools! BC Rollout Evaluation". The study is well underway with tremendous support from parents and students alike.

Before the holiday season, you received a questionnaire regarding how your child travels to school and your perceptions of your neighbourhood. We understand that it is easy to misplace or lose track of paper correspondence during this busy time of the year. If you have not already done so, we kindly ask you for five minutes of your time to complete the questionnaire. Once completed, please put the two documents, "Survey for Parents" (salmon coloured) and "Survey for Kids" (orange), in the self addressed stamped envelope provided and place it in the mail. If you already returned the survey, please disregard this letter.

If you have any questions, comments or concerns, please feel free to contact **Sharon Storoschuk**, Research Coordinator for the evaluation at **604-875-4111 extension 62005**.

Thank you once again for your participation! We look forward to learning from you and your child.

Best regards,

Sharon Storoschuk

Sharon Storoschuk, MS, MPH
Research Coordinator
604-875-4111, extension 62005

APPENDIX E:
SUMMARY OF INTER-RATER RELIABILITY (KAPPA) TESTS

1 = 100% agreement (when calculated, and when both were constants)							
Yellow marked cells are calculated as simple % agreement (one variable was constant)							
By number of cases							
kappa score	**B'BANK**	**BOUNDARY**	**B'WOOD**	**HATZIC**	**M'BOROUGH**	**MISSION**	**MOBERLY**
100%	70.00	57.00	74.00	68.00	63.00	53.00	61.00
80-99%	1.00	0.00	1.00	1.00	1.00	3.00	2.00
65-80%	1.00	0.00	2.00	0.00	1.00	5.00	0.00
<65%	3.00	9.00	2.00	4.00	2.00	9.00	11.00
couldn't calculate	5.00	14.00	1.00	7.00	13.00	10.00	6.00
	80.00	80.00	80.00	80.00	80.00	80.00	80.00
By percent of cases							
kappa score	**B'BANK**	**BOUNDARY**	**B'WOOD**	**HATZIC**	**M'BOROUGH**	**MISSION**	**MOBERLY**
100%	0.88	0.71	0.93	0.85	0.79	0.66	0.76
80-100%	0.01	0.00	0.01	0.01	0.01	0.04	0.03
65-80%	0.01	0.00	0.03	0.00	0.01	0.06	0.00
<65%	0.04	0.11	0.03	0.05	0.03	0.11	0.14
couldn't calculate	0.06	0.18	0.01	0.09	0.16	0.13	0.08
Variable Name	**B'BANK**	**BOUNDARY**	**B'WOOD**	**HATZIC**	**M'BOROUGH**	**MISSION**	**MOBERLY**
Intersection Type	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3-Leg Intersections							
Traffic Control							
Type 0	1.00	1.00	1.00	0.28	1.00	1.00	1.00
Type 1	1.00	1.00	1.00	0.30	1.00	1.00	1.00
Type 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 4	1.00	1.00	1.00	1.00	1.00	1.00	1.00
XW Marking - Leg 1							
Type 0	1.00	0.91	1.00	0.91	1.00	1.00	1.00
Type 1	1.00	0.91	1.00	1.00	1.00	1.00	1.00
Type 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	1.00	1.00	1.00	0.91	1.00	1.00	1.00
XW Signage - Leg 1							
Type 0	1.00	0.91	1.00	1.00	0.83	1.00	0.57
Type 1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 2	1.00	0.91	1.00	1.00	0.83	1.00	0.57
Pedestrian Button - Leg 1	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Variable Name	B'BANK	BOUNDARY	B'WOOD	HATZIC	M'BOROUGH	MISSION	MOBERLY
XW Marking - Leg 2							
Type 0	1.00	0.62	1.00	1.00	1.00	0.60	1.00
Type 1	1.00	0.62	1.00	1.00	1.00	0.60	1.00
Type 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	1.00	1.00	1.00	1.00	1.00	1.00	1.00
XW Signage - Leg 2							
Type 0	1.00	0.62	1.00	0.82	1.00	1.00	1.00
Type 1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 2	1.00	0.62	1.00	0.82	1.00	1.00	1.00
Pedestrian Button - Leg 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
XW Marking - Leg 3							
Type 0	1.00	1.00	1.00	1.00	0.57	1.00	1.00
Type 1	1.00	1.00	1.00	1.00	0.57	1.00	1.00
Type 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	1.00	1.00	1.00	1.00	1.00	1.00	1.00
XW Signage - Leg 3							
Type 0	1.00	1.00	1.00	1.00	1.00	0.55	1.00
Type 1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 2	1.00	1.00	1.00	1.00	1.00	0.55	1.00
Pedestrian Button - Leg 3	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4-Leg Intersections							
Traffic Control							
Type 0	0.83	1.00	1.00	1.00	1.00	0.67	1.00
Type 1	0.43	1.00	0.60	1.00	1.00	0.27	0.25
Type 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	0.92	1.00	1.00	1.00	1.00	1.00	1.00
Type 4	1.00	1.00	1.00	1.00	1.00	1.00	1.00
XW Marking Leg 1							
Type 0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	1.00	1.00	1.00	1.00	1.00	1.00	1.00
XW Signage Leg 1							
Type 0	1.00	0.80	1.00	1.00	0.71	0.61	0.61
Type 1	1.00	1.00	1.00	1.00	0.71	0.89	1.00
Type 2	1.00	0.80	1.00	1.00	1.00	1.00	0.61
Pedestrian Button - Leg 1	0.92	1.00	0.60	1.00	1.00	1.00	1.00
XW Marking Leg 2							
Type 0	1.00	0.55	0.71	1.00	1.00	0.36	1.00
Type 1	1.00	0.55	0.71	1.00	1.00	0.36	1.00
Type 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Variable Name	B'BANK	BOUNDARY	B'WOOD	HATZIC	M'BOROUGH	MISSION	MOBERLY
XW Signage Leg 2							
Type 0	1.00	0.80	1.00	1.00	0.71	0.78	0.61
Type 1	1.00	1.00	1.00	1.00	0.71	0.89	0.89
Type 2	1.00	0.80	1.00	1.00	1.00	0.89	1.00
Pedestrian Button - Leg 2	1.00	0.80	1.00	1.00	1.00	1.00	1.00
XW Marking Leg 3							
Type 0	1.00	1.00	1.00	1.00	1.00	0.77	0.61
Type 1	1.00	1.00	1.00	1.00	1.00	0.77	0.61
Type 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	1.00	1.00	1.00	1.00	1.00	1.00	1.00
XW Signage Leg 3							
Type 0	1.00	0.80	1.00	1.00	0.86	0.60	1.00
Type 1	1.00	1.00	1.00	1.00	0.86	0.89	1.00
Type 2	1.00	0.80	1.00	1.00	1.00	0.61	1.00
XW Marking Leg 4							
Type 0	1.00	1.00	1.00	1.00	1.00	0.77	1.00
Type 1	1.00	1.00	1.00	1.00	1.00	0.77	1.00
Type 2	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Type 3	1.00	1.00	1.00	1.00	1.00	1.00	1.00
XW Signage Leg 4							
Type 0	1.00	1.00	1.00	1.00	0.71	0.55	0.61
Type 1	1.00	1.00	1.00	1.00	0.71	0.89	0.89
Type 2	1.00	1.00	1.00	1.00	1.00	0.77	1.00
Street Segments							
Buffer - Left Side	1.00	1.00	1.00	0.18	1.00	1.00	1.00
Buffer - Right Side	1.00	1.00	1.00	0.45	1.00	0.81	1.00
Number Lanes - Left Side	1.00	0.64	1.00	1.00	0.92	1.00	0.81
Number Lanes - Right Side	1.00	1.00	1.00	1.00	0.83	1.00	0.81
Percent Sidewalk - Left Side	0.70	0.74	1.00	0.92	0.92	0.81	0.89
Percent Sidewalk - Right Side	0.86	0.89	1.00	0.92	0.92	0.87	0.89
Street Grade	0.53	0.36	1.00	0.54	0.77	0.36	0.54
Traffic Calming	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Traffic Circle	0.93	1.00	1.00	1.00	1.00	1.00	0.83
Curb Extension	1.00	0.95	1.00	1.00	1.00	1.00	1.00
Road Closure	0.93	1.00	0.94	1.00	1.00	1.00	0.94
Traffic Hump	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Neck Down	1.00	0.95	1.00	1.00	1.00	1.00	1.00
Slow Speed Signs	0.33	0.48	0.85	0.81	1.00	0.92	0.34
Textured Pavement	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Variable Name	B'BANK	BOUNDARY	B'WOOD	HATZIC	M'BOROUGH	MISSION	MOBERLY
Other Pedestrian Routes - Left Side							
Type 0	0.57	-0.22	0.88	0.85	0.64	0.68	0.89
Type 1	0.87	-0.09	0.94	0.85	0.40	0.44	-0.06
Type 2	0.70	-0.08	0.88	1.00	0.57	1.00	0.89
Type 3	0.93	1.00	1.00	1.00	0.92	0.44	0.94
Other Pedestrian Routes - Right Side							
Type 0	0.86	0.22	1.00	0.53	0.57	0.69	0.89
Type 1	0.93	0.35	0.82	0.35	0.40	0.81	0.33
Type 2	0.86	0.95	1.00	1.00	0.58	1.00	0.77
Type 3	1.00	0.95	1.00	0.92	0.63	0.92	1.00

APPENDIX F:
SUMMARY OF DESCRIPTIVE STATISTICS

TOTAL SAMPLE N=239

Demographics				
Variable	Category	Frequency	Percent	Central Tendency
Gender	Boys	117	49.0	n/a
	Girls	122	51.0	
Age	8	4	1.7	Mean = 9.61
	9	112	46.9	
	10	115	48.1	
	11	8	3.3	
Distance From School	<500m	95	39.7	Mode = 500-1km
	500m-1km	110	46.0	
	1-1.5km	24	10.0	
	1.5-2km	7	2.9	
	2-2.5km	3	1.3	
HH Income	<$19,999	25	10.5	Mean = $40-$49,000
	$20,000-$29,999	28	11.7	
	$30,000-$39,999	31	13.0	
	$40,000-$49,999	35	14.6	
	$50,000-$59,999	28	11.7	
	$60,000-$69,999	27	11.3	
	$70,000-$79,999	14	5.9	
	$80,000-$89,999	13	5.4	
	$90,000-$99,999	11	4.6	
	>$100,000	27	11.3	
Number HH Vehicles	None	7	2.9	Mean = 1.49
	1 vehicle	103	43.1	Mode = 1
	2 vehicles	101	42.3	
	3 vehicles	20	8.4	
	4 or more vehicles	8	3.3	

TOTAL SAMPLE N=239

Travel Behaviour				
Variable	Category	Frequency	Percent	Central Tendency
Mode of Travel To School	Walk	116	48.5	Mode = walk
	Driven	101	42.3	
	School Bus	2	0.8	
	Other Active Mode	3	1.3	
	Public Transit	0	0.0	
	Other	1	0.4	
	Multiple Selections	16	6.7	
Mode of Travel From School	Walk	134	56.1	Mode = walk
	Driven	84	35.1	
	School Bus	3	1.3	
	Other Active Mode	2	0.8	
	Public Transit	0	0.0	
	Other	1	0.4	
	Multiple Selections	15	6.3	
Favourite Mode of Travel	Walk	140	58.6	Mode = walk
	Drive	56	23.4	
	School bus	1	0.4	
	Bike or other active mode	36	15.1	
	Multiple responses	6	2.5	
Active Travel	Active one or two ways	152	63.6	n/a
	Never active	87	36.4	
Reasons Cited for Travel Choice	convenience	91	38.1	
	only option	22	9.2	
	distance	66	27.6	
	safety from strangers or bullies	49	20.5	
	easiest daily schedule	39	16.3	
	cost	1	0.4	
	safety from traffic	30	12.6	
	opportunity for exercise	39	16.3	
	better for environment	9	3.8	
	child's preference	33	13.8	
	other	1	0.4	
Active Non-School Trips	never	53	22.2	Mode = <1 time per week
	< 1 time per week	81	33.9	
	1-3 times per week	78	32.6	
	4 or more times per week	27	11.3	

TOTAL SAMPLE N=239

Variable	Category	Frequency	Percent	Central
Parental Perception Questions				
Neighbourhood safe for child to walk.	1 - strongly agree	80	33.5	Mean = 1.86
	2 - somewhat agree	127	53.1	
	3 - somewhat disagree	22	9.2	
	4 - strongly disagree	10	4.2	
Child safe from traffic while walking to school.	1 - strongly agree	56	23.4	Mean = 2.12
	2 - somewhat agree	110	46.0	
	3 - somewhat disagree	51	21.3	
	4 - strongly disagree	22	9.2	
Child safe from strangers/bullies while walking to school.	1 - strongly agree	40	16.7	Mean = 2.33
	2 - somewhat agree	124	51.9	
	3 - somewhat disagree	47	19.7	
	4 - strongly disagree	28	11.7	
Driving my child is an important responsibility as a parent.	1 - strongly agree	79	33.1	Mean = 1.65
	2 - somewhat agree	77	32.2	
	3 - somewhat disagree	52	21.8	
	4 - strongly disagree	31	13.0	
Our house is too far from school for my child to walk or ride their bicycle.	1 - strongly agree	12	5.0	Mean = 3.37
	2 - somewhat agree	22	9.2	
	3 - somewhat disagree	50	20.9	
	4 - strongly disagree	115	48.1	
Child's Perception Questions				
Have your teachers encouraged you to walk, cycle or other active mode to get to school?	Yes	111	46.4	n/a
	No	128	53.6	
When I walk in my neighbourhood:				
I feel safe from cars	Agree a lot	103	43.1	Mean = 1.67
	Agree a little	103	43.1	
	Don't agree	33	13.8	
I feel safe from strangers and bullies.	Agree a lot	73	30.5	Mean = 2.00
	Agree a little	92	38.5	
	Don't agree	74	31.0	
It is easy and fun to walk.	Agree a lot	176	73.6	Mean = 1.27
	Agree a little	55	23.0	
	Don't agree	8	3.3	
I feel safe walking by myself.	Agree a lot	52	21.8	Mean = 2.29
	Agree a little	107	44.8	
	Don't agree	80	33.5	

TOTAL SAMPLE

MICRO-SCALE BUILT ENVIRONMENT				
Street Segments		**n=198**		
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Total Lanes	2	171	2.280	0.786
	3	8		
	4	14		
	5	1		
	6	4		
Street Grade	Flat	52	2.280	0.964
	Slight	75		
	Moderate	48		
	Steep	23		
Traffic Calming	No elements	149	0.303	0.587
	1 element	40		
	2 elements	7		
	3 elements	2		
Buffer	None	113	0.692	0.86149
	One side	33		
	Both sides	52		
Sidewalk (longest side)	None	56	3.430	2.267
	1-25%	4		
	26-50%	3		
	51-75%	1		
	76-99%	3		
	100%	131		
Intersections		**n=192**		
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Intersection Type	T-type	96	1.500	0.501
	4-way	96		
Traffic Control	None	14	1.927	0.643
	Yeild or roundabout	5		
	Stop sign	154		
	Lights	19		
Crosswalk Marking (proportion of legs with)	None	145	15.451	31.238
	1 of 4	9		
	1 of 3	8		
	2 of 4	7		
	2 of 3	3		
	3 of 4	3		
	All	17		
Crosswalk Signage (proportion of legs with)	None	163	6.554	17.82866
	1 of 4	12		
	1 of 3	5		
	2 of 4	5		
	2 of 3	4		
	3 of 4	1		
	All	2		

TOTAL SAMPLE

Intersections Continued Variable	Category	Frequency	Mean	Std Dev
Pedestrian Button (proportion of legs with)	None	172	7.899	24.88688
	1 of 3	3		
	2 of 4	5		
	2 of 3	1		
	All	11		

Built Environment Scores n=239 Variable	Quartiled Score	Frequency Frequency	Percent Mean	Central Tendency Std Dev
Walkability Score (Quartiled)	1	25	10.5	Mean = 2.55
	2	101	42.3	
	3	70	29.3	
	4	43	18.0	
Lowest Walkability Score (Quartiled)	1	38	15.9	Mean = 2.38
	2	105	43.9	
	3	34	14.2	
	4	32	13.4	

BROOKSBANK ELEMENTARY N=33

DEMOGRAPHICS				
Variable	Category	Frequency	Percent	Central Tendency
Gender	Boys	19	57.6	N/A
	Girls	14	42.4	
Age	8	0	0.0	Mean = 9.57
	9	15	45.5	
	10	16	48.5	
	11	2	6.1	
Distance From School	<500m	3	9.1	500-1km
	500m-1km	17	51.5	
	1-1.5km	10	30.3	
	1.5-2km	3	9.1	
	2-2.5km	0	0.0	
HH Income	<$19,999	0	0.0	Mean = $60-$69,000
	$20,000-$29,999	0	0.0	
	$30,000-$39,999	3	9.1	
	$40,000-$49,999	3	9.1	
	$50,000-$59,999	8	24.2	
	$60,000-$69,999	5	15.2	
	$70,000-$79,999	4	12.1	
	$80,000-$89,999	3	9.1	
	$90,000-$99,999	3	9.1	
	>$100,000	4	12.1	
Number HH Vehicles	None	0	0.0	Mean = 1.94
	1 vehicle	9	27.3	Mode = 2
	2 vehicles	19	57.6	
	3 vehicles	4	12.1	
	4 or more vehicles	1	3.0	

BROOKSBANK ELEMENTARY   N=33

TRAVEL BEHAVIOUR				
Variable	Category	Frequency	Percent	Central Tendency
Mode of Travel To School	Walk	9	27.3	Mode = driven by car
	Driven	21	63.6	
	School Bus	0	0.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	1	3.0	
	Multiple Selections	2	6.1	
Mode of Travel From School	Walk	17	51.5	Mode = walk
	Driven	14	42.4	
	School Bus	0	0.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	2	6.1	
Favourite Mode of Travel	Walk	17	51.5	Mode = walk
	Drive	12	36.4	
	School bus	1	3.0	
	Bike or other active mode	2	6.1	
	Multiple responses	1	3.0	
Active Travel	Active one or two ways	18	54.5	n/a
	Never active	15	45.5	
Reasons Cited for Travel Choice	convenience	12	34.3	
	only option	1	2.9	
	distance	8	22.9	
	safety from strangers or bul	8	22.9	
	easiest daily schedule	13	37.1	
	cost	0	0	
	safety from traffic	2	5.7	
	opportunity for exercise	6	17.1	
	better for environment	2	5.7	
	child's preference	5	14.3	
	other	0	0	
Active Non-School Trips	never	9	27.3	Mode = < 1time per week
	< 1 time per week	12	36.4	
	1-3 times per week	11	33.3	
	4 or more times per week	1	3.0	

BROOKSBANK ELEMENTARY N=33

PERCEPTION OF SAFETY				
Variable	Category	Frequency	Percent	Central Tendency
Parental Perception Questions				
Neighbourhood safe for child to walk.	1 - strongly agree	9	27.3	Mean = 1.74
	2 - somewhat agree	23	69.7	
	3 - somewhat disagree	1	3.0	
	4 - strongly disagree	0	0.0	
Child safe from traffic while walking to school.	1 - strongly agree	7	21.2	Mean = 2.11
	2 - somewhat agree	17	51.5	
	3 - somewhat disagree	7	21.2	
	4 - strongly disagree	2	6.1	
Child safe from strangers/bullies while walking to school.	1 - strongly agree	4	12.1	Mean = 2.11
	2 - somewhat agree	23	69.7	
	3 - somewhat disagree	5	15.2	
	4 - strongly disagree	1	3.0	
Driving my child is an important responsibility as a parent.	1 - strongly agree	8	24.2	Mean = 2.14
	2 - somewhat agree	12	36.4	
	3 - somewhat disagree	10	30.3	
	4 - strongly disagree	3	9.1	
Our house is too far from school for my child to walk or ride their bicycle	1 - strongly agree	2	6.1	Mean = 3.20
	2 - somewhat agree	7	21.2	
	3 - somewhat disagree	6	18.2	
	4 - strongly disagree	18	54.5	
Child's Perception Questions				
Have your teachers encouraged you to walk, cycle or other active mode to get to school?	Yes	13	39.4	n/a
	No	20	60.6	
When I walk in my neighbourhood:				
I feel safe from cars	Agree a lot	15	45.5	Mean = 1.57
	Agree a little	16	48.5	
	Don't agree	2	5.7	
I feel safe from strangers and bullies.	Agree a lot	10	30.3	Mean = 1.91
	Agree a little	16	48.5	
	Don't agree	7	21.2	
It is easy and fun to walk.	Agree a lot	22	66.7	Mean = 1.31
	Agree a little	11	33.3	
	Don't agree	0	0.0	
I feel safe walking by myself.	Agree a lot	12	36.4	Mean = 1.89
	Agree a little	14	42.4	
	Don't agree	7	21.2	

BROOKSBANK ELEMENTARY

MICRO-SCALE BUILT ENVIRONMENT				
Street Segments n=31				
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Total Lanes	2	29	2.060	0.25
	3	2		
	4	0		
	5	0		
	6	0		
Street Grade	Flat	5	1.516	0.996
	Slight	11		
	Moderate	9		
	Steep	6		
Traffic Calming	No elements	23	0.355	0.661
	1 element	5		
	2 elements	3		
	3 elements	0		
Buffer	None	27	0.129	0.341
	One side	4		
	Both sides	0		
Sidewalk (longest side)	None	12	3.065	2.476
	1-25%	0		
	26-50%	0		
	51-75%	0		
	76-99%	0		
	100%	19		
Intersections	n=32			
Intersection Type	T-type	12	1.630	0.492
	4-way	20		
Traffic Control	None	2	1.875	0.554
	Yeild or roundabout	1		
	Stop sign	28		
	Lights	1		
Crosswalk Marking (proportion of legs with)	None	29	3.906	13.551
	1 of 4	1		
	1 of 3	1		
	2 of 4	0		
	2 of 3	1		
	3 of 4	0		
	All	0		
Crosswalk Signage (proportion of legs with)	None	30	1.823	7.251
	1 of 4	1		
	1 of 3	1		
	2 of 4	0		
	2 of 3	0		
	3 of 4	0		
	All	0		

Intersections Continued				
Variable	Category	Frequency	Mean	Std Dev
Pedestrian Button (proportion of legs with)	None	31	1.042	5.893
	1 of 3	1		
	2 of 4	0		
	2 of 3	0		
	All	0		
Built Environment Scores n=33		Frequency	Percent	Central Tendency
Walkability Score (Quartiled)	1	23	69.7	1.3
	2	10	30.3	
	3	0	0.0	
	4	0	0.0	
Lowest Walkability Score (Quartiled)	1	21	63.6	1.4
	2	11	33.3	
	3	1	3.0	
	4	0	0.0	

BOUNDARY ELEMENTARY   N=34

DEMOGRAPHICS				
Variable	**Category**	**Frequency**	**Percent**	**Central Tendency**
Gender	Boys	14	41.2	n/a
	Girls	20	58.8	
Age	8	1	2.9	Mean = 9.5
	9	15	44.1	
	10	18	52.9	
	11	0	0.0	
Distance From School	<500m	15	44.1	Mode = < 500m
	500m-1km	17	50.0	
	1-1.5km	2	5.9	
	1.5-2km	0	0.0	
	2-2.5km	0	0.0	
HH Income	<$19,999	2	5.9	Mean = $60-$69,000
	$20,000-$29,999	2	5.9	
	$30,000-$39,999	1	2.9	
	$40,000-$49,999	5	14.7	
	$50,000-$59,999	2	5.9	
	$60,000-$69,999	3	8.8	
	$70,000-$79,999	3	8.8	
	$80,000-$89,999	3	8.8	
	$90,000-$99,999	2	5.9	
	>$100,000	11	32.4	
Number HH Vehicles	None	0	0.0	Mean = 2.09
	1 vehicle	10	29.4	Mode = 2
	2 vehicles	14	41.2	
	3 vehicles	7	20.6	
	4 or more vehicles	3	8.8	

BOUNDARY ELEMENTARY N=34

TRAVEL BEHAVIOUR				
Variable	Category	Frequency	Percent	Central Tendency
Mode of Travel To School	Walk	14	41.2	Mode = Driven by car
	Driven	16	47.1	
	School Bus	0	0.0	
	Other Active Mode	1	2.9	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	3	8.8	
Mode of Travel From School	Walk	17	50.0	Mode = walk
	Driven	14	41.2	
	School Bus	0	0.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	3	8.8	
Favourite Mode of Travel	Walk	21	61.8	Mode = walk
	Drive	3	8.8	
	School bus	0	0.0	
	Bike or other active mode	10	29.4	
	Multiple responses	0	0.0	
Active Travel	Active one or two ways	19	55.9	n/a
	Never active	15	44.1	
Reasons Cited for Travel Choice	convenience	13	38.2	
	only option	2	5.9	
	distance	9	26.5	
	safety from strangers or bul	4	11.8	
	easiest daily schedule	8	23.5	
	cost	0	0.0	
	safety from traffic	6	17.6	
	opportunity for exercise	5	14.7	
	better for environment	4	11.8	
	child's preference	5	14.7	
	other	0	0.0	
Active Non-School Trips	never	5	14.7	Mode = <1 time per week
	< 1 time per week	13	38.2	
	1-3 times per week	12	35.3	
	4 or more times per week	4	11.8	

BOUNDARY ELEMENTARY N=34

PERCEPTION OF SAFETY				
Variable	**Category**	**Frequency**	**Percent**	**Central Tendency**
Parental Perception Questions				
Neighbourhood safe for child to walk.	1 - strongly agree	15	44.1	Mean = 1.68
	2 - somewhat agree	15	44.1	
	3 - somewhat disagree	4	11.8	
	4 - strongly disagree	0	0.0	
Child safe from traffic while walking to school.	1 - strongly agree	10	29.4	Mean = 2.12
	2 - somewhat agree	13	38.2	
	3 - somewhat disagree	8	23.5	
	4 - strongly disagree	3	8.8	
Child safe from strangers/bullies while walking to school.	1 - strongly agree	7	20.6	Mean = 1.94
	2 - somewhat agree	22	64.7	
	3 - somewhat disagree	5	14.7	
	4 - strongly disagree	0	0.0	
Driving my child is an important responsibility as a parent.	1 - strongly agree	7	20.6	Mean = 2.47
	2 - somewhat agree	11	32.4	
	3 - somewhat disagree	9	26.5	
	4 - strongly disagree	7	20.6	
Our house is too far from school for my child to walk or ride their bicycle	1 - strongly agree	0	0.0	Mean = 3.79
	2 - somewhat agree	1	2.9	
	3 - somewhat disagree	5	14.7	
	4 - strongly disagree	28	82.4	
Child's Perception Questions			0.0	
Have your teachers encouraged you to walk, cycle or other active mode to get to school?	Yes	28	82.4	n/a
	No	6	17.6	
When I walk in my neighbourhood:			0.0	
I feel safe from cars	Agree a lot	13	38.2	1.68
	Agree a little	19	55.9	
	Don't agree	2	5.9	
I feel safe from strangers and bullies.	Agree a lot	14	41.2	1.82
	Agree a little	12	35.3	
	Don't agree	8	23.5	
It is easy and fun to walk.	Agree a lot	29	85.3	1.18
	Agree a little	4	11.8	
	Don't agree	1	2.9	
I feel safe walking by myself.	Agree a lot	5	14.7	2.15
	Agree a little	19	55.9	
	Don't agree	10	29.4	

BOUNDARY ELEMENTARY

MICRO-SCALE BUILT ENVIRONMENT				
Street Segments	**n=31**			
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Total Lanes	2	25	2.2	0.63
	3	0		
	4	3		
	5	0		
	6	0		
Street Grade	Flat	3	1.250	0.7514
	Slight	17		
	Moderate	6		
	Steep	2		
Traffic Calming	No elements	24	0.179	0.4756
	1 element	3		
	2 elements	1		
	3 elements	0		
Buffer	None	27	0.036	0.189
	One side	1		
	Both sides	0		
Sidewalk (longest side)	None	9	3.286	2.37
	1-25%	0		
	26-50%	1		
	51-75%	0		
	76-99%	0		
	100%	18		
Intersections	n=26			
Intersection Type	T-type	17	1.4	0.485
	4-way	9		
Traffic Control	None	2	1.923	0.628
	Yeild or roundabout	0		
	Stop sign	22		
	Lights	2		
Crosswalk Marking (proportion of legs with)	None	20	13.782	29.901
	1 of 4	1		
	1 of 3	2		
	2 of 4	0		
	2 of 3	1		
	3 of 4	0		
	All	2		
Crosswalk Signage (proportion of legs with)	None	22	8.013	20.613
	1 of 4	0		
	1 of 3	2		
	2 of 4	0		
	2 of 3	1		
	3 of 4	1		
	All	0		

BOUNDARY ELEMENTARY

Intersections Continued

Variable	Category	Frequency	Mean	Std Dev
Pedestrian Button (proportion of legs with)	None	21	6.410	23.131
	1 of 3	0		
	2 of 4	1		
	2 of 3	0		
	All	3		

Built Environment Scores n=34		Frequency	Percent	Central Tendency
Walkability Score (Quartiled)	1	0	0.0	Mean = 2.29
	2	24	70.6	
	3	10	29.4	
	4	0	0.0	
Lowest Walkability Score (Quartiled)	1	3	8.8	Mean = 2.23
	2	20	58.8	
	3	11	32.4	
	4	0	0.0	

BRENTWOOD PARK ELEMENTARY N=33

DEMOGRAPHICS				
Variable	Category	Frequency	Percent	Central Tendency
Gender	Boys	17	51.5	n/a
	Girls	16	48.5	
Age	8	0	0.0	Mean = 9.6
	9	15	45.5	
	10	16	48.5	
	11	2	6.1	
Distance From School	<500m	5	15.2	Mode = 500m-1km
	500m-1km	23	69.7	
	1-1.5km	5	15.2	
	1.5-2km	0	0.0	
	2-2.5km	0	0.0	
HH Income	<$19,999	3	9.1	Mean = $40-$49,000
	$20,000-$29,999	6	18.2	
	$30,000-$39,999	9	27.3	
	$40,000-$49,999	3	9.1	
	$50,000-$59,999	4	12.1	
	$60,000-$69,999	4	12.1	
	$70,000-$79,999	0	0.0	
	$80,000-$89,999	1	3.0	
	$90,000-$99,999	1	3.0	
	>$100,000	2	6.1	
Number HH Vehicles	None	0	0.0	Mean = 1.52
	1 vehicle	19	57.6	Mode = 1
	2 vehicles	11	33.3	
	3 vehicles	3	9.1	
	4 or more vehicles	0	0.0	

BRENTWOOD PARK ELEMENTARY   N=33

TRAVEL BEHAVIOUR				
Variable	Category	Frequency	Percent	Central Tendency
Mode of Travel To School	Walk	17	51.5	Mode = walk
	Driven	13	39.4	
	School Bus	0	0.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	3	9.1	
Mode of Travel From School	Walk	19	57.6	Mode = walk
	Driven	10	30.3	
	School Bus	0	0.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	4	12.1	
Favourite Mode of Travel	Walk	20	60.6	Mode = walk
	Drive	4	12.1	
	School bus	0	0.0	
	Bike or other active mode	7	21.2	
	Multiple responses	2	6.1	
Active Travel	Active one or two ways	21	63.6	n/a
	Never active	12	36.4	
Reasons Cited for Travel Choice	convenience	14	42.4	
	only option	2	6.1	
	distance	8	24.2	
	safety from strangers or bul	9	27.3	
	easiest daily schedule	3	9.1	
	cost	0	0.0	
	safety from traffic	4	12.1	
	opportunity for exercise	7	21.2	
	better for environment	1	3.0	
	child's preference	3	9.1	
	other	0	0.0	
Active Non-School Trips	never	7	21.2	Mode = <1 time per week
	< 1 time per week	10	30.3	
	1-3 times per week	14	42.4	
	4 or more times per week	2	6.1	

BRENTWOOD PARK ELEMENTARY N=33

PERCEPTION OF SAFETY				
Variable	**Category**	**Frequency**	**Percent**	**Central Tendency**
Parental Perception Questions				
Neighbourhood safe for child to walk.	1 - strongly agree	9	27.3	Mean = 1.91
	2 - somewhat agree	19	57.6	
	3 - somewhat disagree	4	12.1	
	4 - strongly disagree	1	3.0	
Child safe from traffic while walking to school.	1 - strongly agree	3	9.1	Mean = 2.30
	2 - somewhat agree	18	54.5	
	3 - somewhat disagree	11	33.3	
	4 - strongly disagree	1	3.0	
Child safe from strangers/bullies while walking to school.	1 - strongly agree	4	12.1	Mean = 2.45
	2 - somewhat agree	16	48.5	
	3 - somewhat disagree	7	21.2	
	4 - strongly disagree	6	18.2	
Driving my child is an important responsibility as a parent.	1 - strongly agree	11	33.3	Mean = 2.18
	2 - somewhat agree	9	27.3	
	3 - somewhat disagree	9	27.3	
	4 - strongly disagree	4	12.1	
Our house is too far from school for my child to walk or ride their bicycle	1 - strongly agree	1	3.0	Mean = 3.42
	2 - somewhat agree	5	15.2	
	3 - somewhat disagree	6	18.2	
	4 - strongly disagree	21	63.6	
Child's Perception Questions				
Have your teachers encouraged you to walk, cycle or other active mode to get to school?	Yes	16	48.5	n/a
	No	17	51.5	
When I walk in my neighbourhood:				
I feel safe from cars	Agree a lot	11	33.3	1.97
	Agree a little	12	36.4	
	Don't agree	10	30.3	
I feel safe from strangers and bullies.	Agree a lot	5	15.2	2.24
	Agree a little	15	45.5	
	Don't agree	13	39.4	
It is easy and fun to walk.	Agree a lot	22	66.7	1.39
	Agree a little	9	27.3	
	Don't agree	2	6.1	
I feel safe walking by myself.	Agree a lot	6	18.2	2.12
	Agree a little	17	51.5	
	Don't agree	10	30.3	

BRENTWOOD PARK ELEMENTARY

MICRO-SCALE BUILT ENVIRONMENT				
Street Segments	**n=31**			
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Total Lanes	2	25	2.290	0.897
	3	0		
	4	2		
	5	0		
	6	1		
Street Grade	Flat	6	1.179	0.863
	Slight	13		
	Moderate	7		
	Steep	2		
Traffic Calming	No elements	18	0.393	0.56695
	1 element	9		
	2 elements	1		
	3 elements			
Buffer	None	23	0.179	0.39
	One side	5		
	Both sides	0		
Sidewalk (longest side)	None	3	4.464	1.575
	1-25%	0		
	26-50%	0		
	51-75%	0		
	76-99%	0		
	100%	25		
Intersections	n=28			
Intersection Type	T-type	12	1.570	0.504
	4-way	16		
Traffic Control	None	1	2.071	0.539
	Yeild or roundabout	0		
	Stop sign	23		
	Lights	4		
Crosswalk Marking (proportion of legs with)	None	23	13.393	32.262
	1 of 4	1		
	1 of 3	0		
	2 of 4	1		
	2 of 3	0		
	3 of 4	0		
	All	3		
Crosswalk Signage (proportion of legs with)	None	28	0.000	0
	1 of 4	0		
	1 of 3	0		
	2 of 4	0		
	2 of 3	0		
	3 of 4	0		
	All	0		

Intersections Continued

Variable	Category	Frequency	Mean	Std Dev
Pedestrian Button (proportion of legs with)	None	24	12.500	32.275
	1 of 3	0		
	2 of 4	1		
	2 of 3	0		
	All	3		
Built Environment Scores n=33		**Frequency**	**Percent**	**Central Tendency**
Walkability Score (Quartiled)	1	0	0.0	Mean = 2.09
	2	30	90.9	
	3	3	9.1	
	4	0	0.0	
Lowest Walkability Score (Quartiled)	1	0	0.0	Mean = 2.30
	2	23	69.7	
	3	10	30.3	
	4	0	0.0	

HATZIC ELEMENTARY N=20

		DEMOGRAPHICS		
Variable	Category	Frequency	Percent	Central Tendency
Gender	Boys	9	45.0	n/a
	Girls	11	55.0	
Age	8	0	0.0	Mean = 9.4
	9	13	65.0	
	10	6	30.0	
	11	1	5.0	
Distance From School	<500m	6	30.0	Mode = <500m
	500m-1km	5	25.0	
	1-1.5km	4	20.0	
	1.5-2km	2	10.0	
	2-2.5km	3	15.0	
HH Income	<$19,999	1	5.0	Mean = $60-$69,000
	$20,000-$29,999	0	0.0	
	$30,000-$39,999	1	5.0	
	$40,000-$49,999	1	5.0	
	$50,000-$59,999	2	10.0	
	$60,000-$69,999	6	30.0	
	$70,000-$79,999	1	5.0	
	$80,000-$89,999	3	15.0	
	$90,000-$99,999	1	5.0	
	>$100,000	4	20.0	
Number HH Vehicles	None	0	0.0	Mean = 2.3
	1 vehicle	3	15.0	Mode = 2
	2 vehicles	11	55.0	
	3 vehicles	3	15.0	
	4 or more vehicles	3	15.0	

HATZIC ELEMENTARY   N=20

TRAVEL BEHAVIOUR				
Variable	**Category**	**Frequency**	**Percent**	**Central Tendency**
Mode of Travel To School	Walk	8	40.0	Mode = Driven by car
	Driven	10	50.0	
	School Bus	0	0.0	
	Other Active Mode	2	10.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	0	0.0	
Mode of Travel From School	Walk	9	45.0	Mode = walk/drive tied
	Driven	9	45.0	
	School Bus	0	0.0	
	Other Active Mode	2	10.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	0	0.0	
Favourite Mode of Travel	Walk	10	50.0	Mode = walk
	Drive	6	30.0	
	School bus	0	0.0	
	Bike or other active mode	4	20.0	
	Multiple responses	0	0.0	
Active Travel	Active one or two ways	12	60.0	n/a
	Never active	8	40.0	
Reasons Cited for Travel Choice	convenience	11	55.0	
	only option	3	15.0	
	distance	7	35.0	
	safety from strangers or bul	4	20.0	
	easiest daily schedule	2	10.0	
	cost	0	0.0	
	safety from traffic	2	10.0	
	opportunity for exercise	4	20.0	
	better for environment	0	0.0	
	child's preference	3	15.0	
	other	0	0.0	
Active Non-School Trips	never	6	30.0	Mode = 1-3 times per week
	< 1 time per week	3	15.0	
	1-3 times per week	10	50.0	
	4 or more times per week	1	5.0	

HATZIC ELEMENTARY   N=20

PERCEPTION OF SAFETY				
Variable	Category	Frequency	Percent	Central Tendency
Parental Perception Questions				
Neighbourhood safe for child to walk.	1 - strongly agree	10	50.0	Mean = 1.55
	2 - somewhat agree	9	45.0	
	3 - somewhat disagree	1	5.0	
	4 - strongly disagree	0	0.0	
Child safe from traffic while walking to school.	1 - strongly agree	6	30.0	Mean = 1.95
	2 - somewhat agree	11	55.0	
	3 - somewhat disagree	1	5.0	
	4 - strongly disagree	2	10.0	
Child safe from strangers/bullies while walking to school.	1 - strongly agree	5	25.0	Mean = 1.95
	2 - somewhat agree	11	55.0	
	3 - somewhat disagree	4	20.0	
	4 - strongly disagree	0	0.0	
Driving my child is an important responsibility as a parent.	1 - strongly agree	3	15.0	Mean = 2.45
	2 - somewhat agree	9	45.0	
	3 - somewhat disagree	4	20.0	
	4 - strongly disagree	4	20.0	
Our house is too far from school for my child to walk or ride their bicycle	1 - strongly agree	2	10.0	Mean = 3.25
	2 - somewhat agree	3	15.0	
	3 - somewhat disagree	3	15.0	
	4 - strongly disagree	12	60.0	
Child's Perception Questions				
Have your teachers encouraged you to walk, cycle or other active mode to get to school?	Yes	11	55.0	n/a
	No	9	45.0	
When I walk in my neighbourhood:				
I feel safe from cars	Agree a lot	8	40.0	Mean = 1.70
	Agree a little	10	50.0	
	Don't agree	2	10.0	
I feel safe from strangers and bullies.	Agree a lot	3	15.0	Mean = 2.20
	Agree a little	10	50.0	
	Don't agree	7	35.0	
It is easy and fun to walk.	Agree a lot	16	80.0	Mean = 1.30
	Agree a little	2	10.0	
	Don't agree	2	10.0	
I feel safe walking by myself.	Agree a lot	5	25.0	Mean = 2.15
	Agree a little	7	35.0	
	Don't agree	8	40.0	

HATZIC ELEMENTARY

MICRO-SCALE BUILT ENVIRONMENT				
Street Segments n=31				
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Total Lanes	2	23	2.000	0
	3	0		
	4	0		
	5	0		
	6	0		
Street Grade	Flat	11	1.087	1.203
	Slight	3		
	Moderate	5		
	Steep	4		
Traffic Calming	No elements	19	0.261	0.689
	1 element	3		
	2 elements	0		
	3 elements	1		
Buffer	None	9	0.957	0.878
	One side	6		
	Both sides	8		
Sidewalk (longest side)	None	15	0.913	1.564
	1-25%	3		
	26-50%	1		
	51-75%	1		
	76-99%	2		
	100%	1		
Intersections	n=23			
Intersection Type	T-type	19	1.170	0.388
	4-way	4		
Traffic Control	None	5	1.522	0.846
	Yeild or roundabout	1		
	Stop sign	17		
	Lights	0		
Crosswalk Marking (proportion of legs with)	None	21	5.797	21.677
	1 of 4	0		
	1 of 3	1		
	2 of 4	0		
	2 of 3	0		
	3 of 4	0		
	All	1		
Crosswalk Signage (proportion of legs with)	None	22	4.348	20.851
	1 of 4	0		
	1 of 3	0		
	2 of 4	0		
	2 of 3	0		
	3 of 4	0		
	All	1		

HATZIC ELEMENTARY

Intersections Continued

Variable	Category	Frequency	Mean	Std Dev
Pedestrian Button (proportion of legs with)	None	23	0.000	0
	1 of 3	0		
	2 of 4	0		
	2 of 3	0		
	All	0		

Built Environment Scores n=20		Frequency	Percent	Central Tendency
Walkability Score (Quartiled)	1	2	10.0	Mean = 2.2
	2	12	60.0	
	3	6	30.0	
	4	0	0.0	
Lowest Walkability Score (Quartiled)	1	9	45.0	Mean = 1.55
	2	11	55.0	
	3	0	0.0	
	4	0	0.0	

MARLBOROUGH ELEMENTARY   N=47

	DEMOGRAPHICS			
Variable	Category	Frequency	Percent	Central Tendency
Gender	Boys	28	59.6	n/a
	Girls	19	40.4	
Age	8	2	4.3	Mean = 9.48
	9	20	42.6	
	10	25	53.2	
	11	0	0.0	
Distance From School	<500m	32	68.1	Mode = <500m
	500m-1km	15	31.9	
	1-1.5km	0	0.0	
	1.5-2km	0	0.0	
	2-2.5km	0	0.0	
HH Income	<$19,999	6	12.8	Mean = $40-$49,000
	$20,000-$29,999	8	17.0	
	$30,000-$39,999	8	17.0	
	$40,000-$49,999	10	21.3	
	$50,000-$59,999	3	6.4	
	$60,000-$69,999	6	12.8	
	$70,000-$79,999	2	4.3	
	$80,000-$89,999	0	0.0	
	$90,000-$99,999	2	4.3	
	>$100,000	2	4.3	
Number HH Vehicles	None	4	8.5	Mean = 1.26
	1 vehicle	27	57.4	Mode = 1
	2 vehicles	16	34.0	
	3 vehicles	0	0.0	
	4 or more vehicles	0	0.0	

MARLBOROUGH ELEMENTARY   N=47

TRAVEL BEHAVIOUR				
Variable	**Category**	**Frequency**	**Percent**	**Central Tendency**
Mode of Travel To School	Walk	29	61.7	Mode = walk
	Driven	14	29.8	
	School Bus	0	0.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	4	8.5	
Mode of Travel From School	Walk	32	68.1	Mode = walk
	Driven	13	27.7	
	School Bus	0	0.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	2	4.3	
Favourite Mode of Travel	Walk	33	70.2	Mode = walk
	Drive	6	12.8	
	School bus	0	0.0	
	Bike or other active mode	6	12.8	
	Multiple responses	2	4.3	
Active Travel	Active one or two ways	33	70.2	n/a
	Never active	14	29.8	
Reasons Cited for Travel Choice	convenience	20	43.5	
	only option	2	4.3	
	distance	20	43.5	
	safety from strangers or bul	10	21.7	
	easiest daily schedule	8	17.4	
	cost	1	2.2	
	safety from traffic	8	17.4	
	opportunity for exercise	7	15.2	
	better for environment	0	0.0	
	child's preference	0	0.0	
	other	0	0.0	
Active Non-School Trips	never	4	8.5	Mode = < 1 time per week
	< 1 time per week	17	36.2	
	1-3 times per week	19	40.4	
	4 or more times per week	7	14.9	

MARLBOROUGH ELEMENTARY N=47

PERCEPTION OF SAFETY				
Variable Parental Perception Questions	Category	Frequency	Percent	Central Tendency
Neighbourhood safe for child to walk.	1 - strongly agree	10	21.3	Mean = 1.98
	2 - somewhat agree	29	61.7	
	3 - somewhat disagree	6	12.8	
	4 - strongly disagree	2	4.3	
Child safe from traffic while walking to school.	1 - strongly agree	9	19.1	Mean = 2.26
	2 - somewhat agree	21	44.7	
	3 - somewhat disagree	12	25.5	
	4 - strongly disagree	5	10.6	
Child safe from strangers/bullies while walking to school.	1 - strongly agree	4	8.5	Mean = 2.50
	2 - somewhat agree	22	46.8	
	3 - somewhat disagree	14	29.8	
	4 - strongly disagree	7	14.9	
Driving my child is an important responsibility as a parent.	1 - strongly agree	15	31.9	Mean = 2.13
	2 - somewhat agree	17	36.2	
	3 - somewhat disagree	8	17.0	
	4 - strongly disagree	7	14.9	
Our house is too far from school for my child to walk or ride their bicycle	1 - strongly agree	0	0.0	Mean = 3.70
	2 - somewhat agree	3	6.4	
	3 - somewhat disagree	8	17.0	
	4 - strongly disagree	36	76.6	
Child's Perception Questions				
Have your teachers encouraged you to walk, cycle or other active mode to get to school?	Yes	12	25.5	n/a
	No	35	74.5	
When I walk in my neighbourhood:				
I feel safe from cars	Agree a lot	20	42.6	Mean = 1.65
	Agree a little	23	48.9	
	Don't agree	4	8.5	
I feel safe from strangers and bullies.	Agree a lot	13	27.7	Mean = 1.98
	Agree a little	21	44.7	
	Don't agree	13	27.7	
It is easy and fun to walk.	Agree a lot	34	72.3	Mean = 1.30
	Agree a little	12	25.5	
	Don't agree	1	2.1	
I feel safe walking by myself.	Agree a lot	12	25.5	Mean = 2.07
	Agree a little	20	42.6	
	Don't agree	15	31.9	

MARLBOROUGH ELEMENTARY

MICRO-SCALE BUILT ENVIRONMENT				
Street Segments	**n=31**			
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Total Lanes	2	19	2.720	1.131
	3	2		
	4	6		
	5	1		
	6	1		
Street Grade	Flat	8	1.103	0.86
	Slight	11		
	Moderate	9		
	Steep	1		
Traffic Calming	No elements	22	0.276	0.52757
	1 element	6		
	2 elements	1		
	3 elements	0		
Buffer	None	13	0.966	0.944
	One side	4		
	Both sides	12		
Sidewalk (longest side)	None	3	4.345	1.675
	1-25%	1		
	26-50%	0		
	51-75%	0		
	76-99%	0		
	100%	25		
Intersections	n=29			
Intersection Type	T-type	17	1.4	0.501
	4-way	12		
Traffic Control	None	1	2.103	0.618
	Yeild or roundabout	1		
	Stop sign	21		
	Lights	6		
Crosswalk Marking (proportion of legs with)	None	20	24.138	40.724
	1 of 4	0		
	1 of 3	3		
	2 of 4	0		
	2 of 3	0		
	3 of 4	0		
	All	6		
Crosswalk Signage (proportion of legs with)	None	28	2.299	12.38
	1 of 4	0		
	1 of 3	0		
	2 of 4	0		
	2 of 3	1		
	3 of 4	0		
	All	0		

Intersections Continued				
Variable	Category	Frequency	Mean	Std Dev
Pedestrian Button (proportion of legs with)	None	21	19.540	35.931
	1 of 3	2		
	2 of 4	2		
	2 of 3	0		
	All	4		
Built Environment Scores n=47		**Frequency**	**Percent**	**Central Tendency**
Walkability Score (Quartiled)	1	0	0.0	Mean = 3.06
	2	11	23.4	
	3	22	46.8	
	4	14	29.8	
Lowest Walkability Score (Quartiled)	1	0	0.0	Mean = 2.85
	2	20	42.6	
	3	14	29.8	
	4	13	27.7	

MISSION CENTRAL ELEMENTARY N=20

DEMOGRAPHICS				
Variable	**Category**	**Frequency**	**Percent**	**Central Tendency**
Gender	Boys	7	35.0	n/a
	Girls	13	65.0	
Age	8	1	5.0	Mean = 9.45
	9	9	45.0	
	10	10	50.0	
	11	0	0.0	
Distance From School	<500m	4	20.0	500-1km
	500m-1km	10	50.0	
	1-1.5km	3	15.0	
	1.5-2km	3	15.0	
	2-2.5km	0	0.0	
HH Income	<$19,999	4	20.0	Mean = $40-$49,000
	$20,000-$29,999	3	15.0	
	$30,000-$39,999	2	10.0	
	$40,000-$49,999	2	10.0	
	$50,000-$59,999	3	15.0	
	$60,000-$69,999	0	0.0	
	$70,000-$79,999	1	5.0	
	$80,000-$89,999	2	10.0	
	$90,000-$99,999	1	5.0	
	>$100,000	2	10.0	
Number HH Vehicles	None	2	10.0	Mean = 1.4
	1 vehicle	9	45.0	Mode = 1
	2 vehicles	8	40.0	
	3 vehicles	1	5.0	
	4 or more vehicles	0	0.0	

MISSION CENTRAL ELEMENTARY N=20

TRAVEL BEHAVIOUR				
Variable	Category	Frequency	Percent	Central Tendency
Mode of Travel To School	Walk	10	50.0	Mode = walk
	Driven	9	45.0	
	School Bus	1	5.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	0	0.0	
Mode of Travel From School	Walk	6	30.0	Mode = driven by car
	Driven	10	50.0	
	School Bus	3	15.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	1	5.0	
Favourite Mode of Travel	Walk	6	30.0	Mode = driven
	Drive	11	55.0	
	School bus	0	0.0	
	Bike or other active mode	3	15.0	
	Multiple responses	0	0.0	
Active Travel	Active one or two ways	10	50.0	n/a
	Never active	10	50.0	
Reasons Cited for Travel Choice	convenience	6	30.0	
	only option	5	25.0	
	distance	4	20.0	
	safety from strangers or bul	3	15.0	
	easiest daily schedule	2	10.0	
	cost	2	10.0	
	safety from traffic	1	5.0	
	opportunity for exercise	1	5.0	
	better for environment	4	20.0	
	child's preference	0	0.0	
	other	1	5.0	
Active Non-School Trips	never	5	25.0	Mode = 1-3 times per week
	< 1 time per week	5	25.0	
	1-3 times per week	7	35.0	
	4 or more times per week	3	15.0	

MISSION CENTRAL ELEMENTARY N=20

PERCEPTION OF SAFETY				
Variable	Category	Frequency	Percent	Central Tendency
Parental Perception Questions				
Neighbourhood safe for child to walk.	1 - strongly agree	6	30.0	Mean = 2.10
	2 - somewhat agree	9	45.0	
	3 - somewhat disagree	2	10.0	
	4 - strongly disagree	3	15.0	
Child safe from traffic while walking to school.	1 - strongly agree	6	30.0	Mean = 2.20
	2 - somewhat agree	8	40.0	
	3 - somewhat disagree	2	10.0	
	4 - strongly disagree	4	20.0	
Child safe from strangers/bullies while walking to school.	1 - strongly agree	4	20.0	Mean = 2.35
	2 - somewhat agree	8	40.0	
	3 - somewhat disagree	5	25.0	
	4 - strongly disagree	3	15.0	
Driving my child is an important responsibility as a parent.	1 - strongly agree	4	20.0	Mean = 2.50
	2 - somewhat agree	6	30.0	
	3 - somewhat disagree	6	30.0	
	4 - strongly disagree	4	20.0	
Our house is too far from school for my child to walk or ride their bicycle	1 - strongly agree	3	15.0	Mean = 3.25
	2 - somewhat agree	1	5.0	
	3 - somewhat disagree	4	20.0	
	4 - strongly disagree	12	60.0	
Child's Perception Questions			0.0	
Have your teachers encouraged you to walk, cycle or other active mode to get to school?	Yes	5	25.0	n/a
	No	15	75.0	
When I walk in my neighbourhood:			0.0	
I feel safe from cars	Agree a lot	9	45.0	Mean = 1.8
	Agree a little	6	30.0	
	Don't agree	5	25.0	
I feel safe from strangers and bullies.	Agree a lot	8	40.0	Mean = 1.95
	Agree a little	5	25.0	
	Don't agree	7	35.0	
It is easy and fun to walk.	Agree a lot	14	70.0	Mean = 1.35
	Agree a little	5	25.0	
	Don't agree	1	5.0	
I feel safe walking by myself.	Agree a lot	4	20.0	Mean = 2.10
	Agree a little	10	50.0	
	Don't agree	6	30.0	

MISSION CENTRAL ELEMENTARY

MICRO-SCALE BUILT ENVIRONMENT				
Street Segments	**n=31**			
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Total Lanes	2	25	2.200	0.484
	3	4		
	4	1		
	5	0		
	6	0		
Street Grade	Flat	6	1.300	0.988
	Slight	14		
	Moderate	5		
	Steep	5		
Traffic Calming	No elements	24	0.267	0.639
	1 element	5		
	2 elements	0		
	3 elements	1		
Buffer	None	12	0.900	0.845
	One side	9		
	Both sides	9		
Sidewalk (longest side)	None	13	2.830	2.52
	1-25%	0		
	26-50%	0		
	51-75%	0		
	76-99%	0		
	100%	25		
Intersections	n=30			
Intersection Type	T-type	10	1.670	0.479
	4-way	20		
Traffic Control	None	3	1.900	0.712
	Yeild or roundabout	0		
	Stop sign	24		
	Lights	3		
Crosswalk Marking (proportion of legs with)	None	13	11.458	25.515
	1 of 4	5		
	1 of 3	1		
	2 of 4	3		
	2 of 3	1		
	3 of 4	3		
	All	4		
Crosswalk Signage (proportion of legs with)	None	15	9.722	18.169
	1 of 4	9		
	1 of 3	1		
	2 of 4	2		
	2 of 3	2		
	3 of 4	0		
	All	1		

Intersections Continued

Variable	Category	Frequency	Mean	Std Dev
Pedestrian Button (proportion of legs with)	None	28	8.333	24.077
	1 of 3	0		
	2 of 4	0		
	2 of 3	0		
	All	1		

Built Environment Scores n=20		Frequency	Percent	Central Tendency
Walkability Score (Quartiled)	1	0	0.0	Mean = 2.4
	2	12	60.0	
	3	8	40.0	
	4	0	0.0	
Lowest Walkability Score (Quartiled)	1	5	25.0	Mean = 1.9
	2	12	60.0	
	3	3	15.0	
	4	0	0.0	

WALTER MOBERLY ELEMENTARY N=52

DEMOGRAPHICS				
Variable	**Category**	**Frequency**	**Percent**	**Central Tendency**
Gender	Boys	24	46.2	n/a
	Girls	28	53.8	
Age	8	0	0.0	Mean = 9.61
	9	24	46.2	
	10	25	48.1	
	11	3	5.8	
Distance From School	<500m	31	59.6	Mode = < 500m
	500m-1km	21	40.4	
	1-1.5km	0	0	
	1.5-2km	0	0	
	2-2.5km	0	0	
HH Income	<$19,999	9	17.3	Mean = $30-$39,000
	$20,000-$29,999	10	19.2	
	$30,000-$39,999	7	13.5	
	$40,000-$49,999	11	21.2	
	$50,000-$59,999	6	11.5	
	$60,000-$69,999	3	5.8	
	$70,000-$79,999	3	5.8	
	$80,000-$89,999	1	1.9	
	$90,000-$99,999	1	1.9	
	>$100,000	1	1.9	
Number HH Vehicles	None	1	1.9	Mean = 1.49
	1 vehicle	27	51.9	Mode = 1
	2 vehicles	21	40.4	
	3 vehicles	2	3.8	
	4 or more vehicles	1	1.9	

WALTER MOBERLY ELEMENTARY N=52

TRAVEL BEHAVIOUR				
Variable	Category	Frequency	Percent	Central Tendency
Mode of Travel To School	Walk	29	55.8	Mode = walk
	Driven	18	34.6	
	School Bus	1	1.9	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	0	0.0	
	Multiple Selections	4	7.7	
Mode of Travel From School	Walk	34	65.4	Mode = walk
	Driven	14	26.9	
	School Bus	0	0.0	
	Other Active Mode	0	0.0	
	Public Transit	0	0.0	
	Other	1	1.9	
	Multiple Selections	3	5.8	
Favourite Mode of Travel	Walk	32	61.5	Mode = walk
	Drive	15	28.8	
	School bus	0	0.0	
	Bike or other active mode	4	7.7	
	Multiple responses	1	1.9	
Active Travel	Active one or two ways	39	75.0	n/a
	Never active	13	25.0	
Reasons Cited for Travel Choice	convenience	15	29.4	
	only option	7	13.7	
	distance	9	17.6	
	safety from strangers or bul	11	21.6	
	easiest daily schedule	3	5.9	
	cost	0	0.0	
	safety from traffic	5	9.8	
	opportunity for exercise	9	17.6	
	better for environment	1	2.0	
	child's preference	13	25.5	
	other	1	2.0	
Active Non-School Trips	never	17	32.7	Mode = <1 time per week
	< 1 time per week	20	38.5	
	1-3 times per week	6	11.5	
	4 or more times per week	9	17.3	

WALTER MOBERLY ELEMENTARY N=52

PERCEPTION OF SAFETY				
Variable Parental Perception Questions	Category	Frequency	Percent	Central Tendency
Neighbourhood safe for child to walk.	1 - strongly agree	21	40.4	Mean = 1.86
	2 - somewhat agree	22	42.3	
	3 - somewhat disagree	5	9.6	
	4 - strongly disagree	4	7.7	
Child safe from traffic while walking to school.	1 - strongly agree	15	28.8	Mean = 2.12
	2 - somewhat agree	21	40.4	
	3 - somewhat disagree	11	21.2	
	4 - strongly disagree	5	9.6	
Child safe from strangers/bullies while walking to school.	1 - strongly agree	12	23.1	Mean = 2.33
	2 - somewhat agree	21	40.4	
	3 - somewhat disagree	8	15.4	
	4 - strongly disagree	11	21.2	
Driving my child is an important responsibility as a parent.	1 - strongly agree	30	57.7	Mean = 1.65
	2 - somewhat agree	13	25.0	
	3 - somewhat disagree	7	13.5	
	4 - strongly disagree	2	3.8	
Our house is too far from school for my child to walk or ride their bicycle	1 - strongly agree	4	7.7	Mean = 3.37
	2 - somewhat agree	2	3.8	
	3 - somewhat disagree	17	32.7	
	4 - strongly disagree	29	55.8	
Child's Perception Questions				
Have your teachers encouraged you to walk, cycle or other active mode to get to school?	Yes	25	48.1	n/a
	No	27	51.9	
When I walk in my neighbourhood:				
I feel safe from cars	Agree a lot	26	50.0	Mean = 1.67
	Agree a little	18	34.6	
	Don't agree	8	15.4	
I feel safe from strangers and bullies.	Agree a lot	20	38.5	Mean = 2.00
	Agree a little	12	23.1	
	Don't agree	20	38.5	
It is easy and fun to walk.	Agree a lot	39	75.0	Mean = 1.27
	Agree a little	12	23.1	
	Don't agree	1	1.9	
I feel safe walking by myself.	Agree a lot	8	15.4	Mean = 2.29
	Agree a little	21	40.4	
	Don't agree	23	44.2	

WALTER MOBERLY ELEMENTARY

MICRO-SCALE BUILT ENVIRONMENT				
Street Segments	**n=31**			
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Total Lanes	2	25	2.410	1.119
	3	0		
	4	2		
	5	0		
	6	2		
Street Grade	Flat	13	1.000	1.069
	Slight	6		
	Moderate	7		
	Steep	3		
Traffic Calming	No elements	19	0.379	0.561
	1 element	9		
	2 elements	1		
	3 elements	0		
Buffer	None	2	1.724	0.591
	One side	4		
	Both sides	23		
Sidewalk (longest side)	None	1	4.690	1.073
	1-25%	0		
	26-50%	1		
	51-75%	0		
	76-99%	1		
	100%	26		
Intersections	n=24			
Intersection Type	T-type	9	1.630	0.495
	4-way	15		
Traffic Control	None	0	2.042	0.464
	Yeild or roundabout	2		
	Stop sign	19		
	Lights	3		
Crosswalk Marking (proportion of legs with)	None	19	11.458	25.515
	1 of 4	1		
	1 of 3	0		
	2 of 4	3		
	2 of 3	0		
	3 of 4	0		
	All	1		
Crosswalk Signage (proportion of legs with)	None	18	9.722	18.169
	1 of 4	2		
	1 of 3	1		
	2 of 4	3		
	2 of 3	0		
	3 of 4	0		
	All	0		

Intersections Continued				
Variable	**Category**	**Frequency**	**Mean**	**Std Dev**
Pedestrian Button (proportion of legs with)	None	21	8.333	24.077
	1 of 3	0		
	2 of 4	2		
	2 of 3	0		
	All	1		
Built Environment Scores n=52		**Frequency**	**Percent**	**Central Tendency**
Walkability Score (Quartiled)	1	0	0.0	Mean = 3.5
	2	2	3.8	
	3	21	40.4	
	4	29	55.8	
Lowest Walkability Score (Quartiled)	1	0	0.0	Mean = 3.2
	2	8	15.4	
	3	25	48.1	
	4	19	36.5	