Impacts of a New Greenway on Older Adult Mobility: A Mixed-Methods Analysis in Vancouver, BC

by

Caitlin Pugh

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Approval

Name:	**Caitlin Pugh**
Degree:	**Master of Science (Health Sciences)**
Title:	***Impacts of a New Greenway on Older Adult Mobility: A Mixed-Methods Analysis in Vancouver, BC***
Examining Committee:	**Chair:** Kanna Hayashi Assistant Professor

Meghan Winters
Senior Supervisor
Assistant Professor

Scott Lear
Supervisor
Professor

Joanie Sims-Gould
Supervisor
Assistant Professor
Department of Family Practice
University of British Columbia

Dawn Mackey
External Examiner
Assistant Professor
Department of Biomedical Physiology
and Kinesiology

Date Defended/Approved: April 19, 2017

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The author, whose name appears on the title page of this work, has obtained, for the research described in this work, either:

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Abstract

Our population is aging, and life expectancies are increasing globally. One strategy to promote healthy aging is by creating environments that support physical activity. Using a natural experiment study design, this dissertation takes a mixed-methods approach to capture the impacts of a built environment intervention aimed to increase active transportation among community-dwelling older adults. We captured location-specific travel and physical activity using accelerometers and GPS monitors one year before and after the Comox-Helmcken Greenway was developed, and measured change in weekly transportation-related activity, specific activity along the Greenway, and activity along a comparison corridor. Secondly, we interviewed a subset of these older adults to capture their perceptions of the Greenway. We found no change in weekly physical activity levels, but a decrease in the number of trips along the Greenway. Our interview data suggests this may result from confusion of messaging, the steep slope, and a lack of destinations.

Keywords: older adults; mobility; physical activity; natural experiment; built environment

I dedicate this thesis to my grandparents:

Eleanor, your joy for life shaped me into the person I am today;

Elmer, I will always remember your laugh;

Arthur, you motivated me to keep pursuing my dreams; and

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List of Acronyms

ASAP	Active Streets, Active People Study
BC	British Columbia
GIS	Geographic Information System
GPS	Global Positioning System
MVPA	Moderate-to-Vigorous Physical Activity
PA	Physical Activity
SWEAT - R	Senior Walking Environmental Assessment Tool - Revised
UN	United Nations
WHO	World Health Organization

Glossary

Active Transportation/ Active Travel	Any form of human-powered transportation, such as walking and cycling
Greenspace	Natural areas such as parks, forests, or community gardens
Greenway	A linear open space that connects parks with populated areas, designed for bikes and/or pedestrians to use
Mobility	The ability to move oneself (either independently or by using assistive devices or transportation) within environments that expand from one's home to the neighbourhood and to regions beyond
Physical Activity	Any bodily movement produced by skeletal muscle that requires energy expenditure
Transportation-Related Physical Activity	Trip-based physical activity during outdoor travel (walking and cycling)
Trips	Outdoor travel trips (walking and cycling)
Walkability	A measure of how friendly an area is to walking, and how well an area supports people to walk
Walk Score®	A measure of the presence of nearby amenities/destinations, block length, and street connectivity

Chapter 1.

Introduction

1.1. Background

Our population is aging, and life expectancies are increasing around the globe (UN Department of Economic and Social Affairs, 2007). The United Nations predicts that the population of those aged 60 years and older will double by 2050, from 1 billion to 2 billion people (UN Department of Economic and Social Affairs, 2007). Specifically in Canada, by the year 2041 nearly 25 percent of the population is predicted to be over the age of 65 (Health Canada, 2002). At the same time, most of North America's population growth has been occurring in the suburbs (Flint, 2006). Unfortunately, suburban settings may have negative impacts for aging populations. For example, sprawl may compound social isolation (Flint, 2006). Further, many older adults that live in the suburbs are "tethered to their cars – stuck in communities designed solely for driving, yet losing their capacity to drive, and so faced with the stark alternative of never leaving home" (Flint, 2006, p. 53). As one ages, daily travel tends to become closer to home, and there is an increasing dependence of the immediate neighbourhood environment (Yen et al., 2015). Regrettably, many neighbourhoods do not have sufficient amenities to support people growing old in their communities.

Mobility, which is the ability to move about in one's neighbourhood and maintain independence, is essential for the healthy aging of our older adult population (Webber, Porter, & Menec, 2010). One method to ensure healthy aging is by creating environments that support daily physical activity. Physical activity is defined as "any bodily movement produced by skeletal muscle that requires energy expenditure" (World Health Organization, 2015). Physical activity reduces cardiovascular disease risk and contributes to lowering depression levels in the population. Physical inactivity is one of the top four risk factors contributing to global mortality (World Health Organization, 2015), and as such, efforts to increase physical activity are crucial. Unfortunately, only 11% of Canadian older adults are meeting national physical activity guidelines of 150 minutes of moderate-to-vigorous physical activity (MVPA) per week (Statistics Canada, 2013; World Health Organization, 2015), based on accelerometry measurements.

There is established evidence to support a link between increased physical activity and features of the built environment (parks and natural environments, residential density, walkability, and traffic speed and/or volume) (Sallis et al., 2016). This is supported by the social-ecological model, which considers the relationships between individuals, communities (schools, workplaces, neighbourhoods), and societies (the broad societal factor; norms and policies). The model also highlights the many influences that individuals are faced with from their neighbourhoods and beyond (Centers for Disease Control and Prevention, 2015). The neighbourhood can influence behaviours and positively influence physical activity, for example if the design of the neighbourhood supports active modes of travel such as walking or bicycling (Klinkenberg, 2014).

Within the field of neighbourhood and health research, there is a growing focus on the aging population. For older adults, the research suggests that well-designed neighbourhoods can provide important opportunities for older adults to walk, and to be active and engaged in their communities (Rosso, Auchincloss, & Michael, 2011). A recent systematic review found strong associations between the built environment and active transportation (i.e. walking, cycling) among older adults, in particular the importance of residential density, street connectivity, and access to destinations for older adult active travel (Cerin, Nathan, Van Cauwenberg, Barnett, & Barnett, 2017). Additionally, most people express a desire to ‘age in place’, and as such, it is important to understand what makes a neighbourhood a good place to grow old (Morley, 2012). Features of the environment that support older adults to ‘age in place’ were examined in a review by Yen and colleagues, and they found that safety considerations, street connectivity, and retail destinations were the most prominent in the literature (2014).

However, there are two main methodological challenges in the current literature that examine physical activity and the built environment. First, most studies use very generalized metrics of place, with a focus on the residential environment. Few capture location-based physical activity, that is, the specific locations where people spend their time, and their level of activity. There is a need for examining location-specific physical activity among older adults, as place and location have a large influence on health (Jankowska, Schipperijn, & Kerr, 2015). Capturing location-specific physical activity is becoming easier with technological advances in global positioning systems (GPS) and accelerometry, so researchers can better characterize where people go, and how active they are.

The second challenge in the literature is that the bulk of evidence is derived from cross-sectional studies (Gell, Rosenberg, Carlson, Kerr, & Belza, 2015; Kolbe-Alexander, Pacheco, Tomaz, Karpul, & Lambert, 2015), which limits the ability to draw causal conclusions. Self-selection is also a prominent issue in cross-sectional studies. For example, individuals who enjoy walking for transportation might choose to live in neighbourhoods that are conducive to walking. Since neighbourhood design is shaped by planners and practitioners, it is an opportunity to intervene to promote physical activity; however, we need better evidence from longitudinal studies to indicate what changes to neighbourhood features might create positive impacts on mobility.

In response to a need for longitudinal designs, researchers are encouraged to undertake natural experiment studies (MRC Population Health Sciences Research Network, 2010). Natural experiment studies are used “to evaluate interventions intended to improve health, where they had contributed to expanding the stock of evidence” (MRC Population Health Sciences Research Network, 2010, p. 6). Natural experiment studies provide a unique opportunity to measure the impact of changes to the built environment on older adult mobility. They provide an experimental opportunity when it is not possible to manipulate exposures in a controlled research setting (Craig et al., 2011). In cross-sectional observational studies, researchers are unable to measure the impacts of new built environment infrastructure on mobility, or directly assess policy-relevant changes (Mayne, Auchincloss, & Michael, 2015).

However, within the emerging studies of built environment interventions, there are conflicting results. For example, recent studies on greenway[1] interventions show conflicting results with regards to their impact on physical activity. Two cross-sectional studies did not provide conclusive evidence about mobility change along greenways (Dorwart, 2015; Price, Reed, & Muthukrishnan, 2012), and two longitudinal studies reported no significant increase in activity levels among their population (all ages) after the construction of a greenway in North Carolina, USA (West & Shores, 2011, 2015). Two other studies, one of a new walking and cycling route in Brazil (Pazin et al., 2016) and another of a community greenway in Northern Ireland (Dallat et al., 2013), found significant increases in physical activity, but their sample populations consisted of adults aged 18 and 16 years or older, respectively. These conflicting results mean it is difficult to derive guidance for city planners on the value of such investments.

1.2. Research Context and Design

Using a natural experiment study design, this thesis uses a mixed-methods approach to capture the impacts of a built environment intervention aimed to increase active transportation – the development of a new Greenway – on the mobility of community-dwelling older adults. This thesis follows a sequential explanatory study design. We conducted the quantitative analysis first, followed by the qualitative analysis to supplement the quantitative findings and provide context for our interpretation.

1.2.1. The Comox-Helmcken Greenway

Greenways are one way to increase the walkability and accessibility of neighbourhoods, and they may take a number of different forms. In the literature, greenways have been formally defined as "linear open spaces" that connect parks with

[1] Throughout this thesis, when 'Greenway' is capitalized, this refers to the Comox-Helmcken Greenway in Vancouver, BC. When 'greenway' is not capitalized, this refers to all other greenways.

populated areas, designed for bikes and/or pedestrians to use (Little, 1995, p. 1). The City of Vancouver defines greenways as areas that “provide beautiful urban connections to important destinations throughout Vancouver for pedestrians and cyclists, and enhance the experience of walking and cycling by including improvements like expanded parks, increased landscaping, public art, and drinking fountains” (2017d).

This thesis examines the impacts of one Greenway, the Comox-Helmcken Greenway (the “Greenway”) located in the West End neighbourhood of Vancouver, BC. The Greenway route was approved by the City of Vancouver Council as part of the 2002 Downtown Transportation Plan (City of Vancouver, 2017a). The Greenway is part of Vancouver’s City Greenway network, and is about 2 km in length. With Section 1 completed in June 2013, it connects Stanley Park to Downtown Vancouver and is a multi-modal corridor from Stanley Park Drive to Hornby Street (City of Vancouver, 2017). The City of Vancouver invested $5.4 million in Section 1 of the Greenway. It consists of one-way streets for vehicle traffic along with bike lanes and large sidewalks for pedestrians (City of Vancouver, 2017). Vancouver is committed to becoming a “green city” (City of Vancouver, 2017c), and the Greenway is part of their green transportation goal; the city wants to “make walking, cycling, and public transit the preferred transportation option” (City of Vancouver, 2017b). The City of Vancouver’s goals for this Greenway were to increase active transportation levels of people of all ages in the area, connect parks and community centres through Downtown Vancouver, improve safety, and provide places to sit and socialize (2017a).

The project started officially in 2011. In the fall of 2011, City of Vancouver staff consulted with businesses, seniors, children, youth and others. They received feedback in the proposed Greenway through open houses, walking tours (guided and self-guided), workshops, a survey, and community and stakeholder meetings.

Figure 1.1 Map of the West End neighbourhood of Vancouver and the Greenway
(City of Vancouver, 2017. Contains information licensed under the Open Government Licence – Vancouver.)

1.2.2. Vancouver, BC

Vancouver is the largest city in British Columbia, Canada, with a population of 631,486 (2016) (Statistics Canada, 2017). Vancouver's population is aging, and as of 2011, 14% of Vancouver's population was 65 or older and this number is increasing (City of Vancouver, 2012). Vancouver aims to be one of the greenest cities in the world, and is currently ranking first in the list of most walkable cities in Canada (Walk Score®, 2017).

The Greenway is in Vancouver's West End neighbourhood, located between Downtown Vancouver and Stanley Park (see Figure 1.1). With a Walk Score® of 94 (out of a possible 100), this area is considered a “Walker’s Paradise”, and is the second most walkable neighbourhood in Vancouver (Walk Score®, 2017). Similar to the City of Vancouver, 13% of the West End neighbourhood’s population was 65 or older as of 2011 (City of Vancouver, 2012).

1.2.3. Active Streets, Active People (ASAP) study

The Active Streets, Active People (ASAP) study was a partnership between researchers at the Centre for Hip Health and Mobility and the City of Vancouver to better understand how the Greenway development impacted older adult health and mobility. In this section, I will briefly review the ASAP study methods. In Chapter 2, I will go into more detail about the specific measurements that I used for the quantitative analysis of my thesis, and in Chapter 3 I will provide more detail about the qualitative methodology. ASAP was a longitudinal natural experiment study that used a mixed-methods approach. The research team collected quantitative data including surveys, GPS, and accelerometry, and also conducted qualitative research to explore themes related to mobility, social interactions, and the built environment.

The ASAP study team recruited 193 older adults aged 60 years or older living within 400 m of the Greenway. The ASAP study team acquired the sampling frame from a marketing firm (infoCANADA), and with a goal to recruit 200 participants they mailed introductory letters to 3,402 households that were within 400 m of the Greenway. One week later, research assistants telephoned potential participants with up to five follow-up calls (ASAP response rate = 14%, see Appendix E for recruitment flowchart). Because the study focused on the built environment, eligibility criteria included that participants left their homes most days of the week, and did not intend to move in coming years. The ASAP study team obtained informed consent from the participants prior to the measurement sessions (see Appendix F for the ASAP Consent form).

Measurement sessions occurred in September and October 2012 prior to the Greenway development, and in September and October 2014 after the Greenway was completed. During the 1.5-hour measurement session, participants completed questionnaires about their health, physical activity, neighbourhood environment, and social connections. The ASAP study team also asked participants to wear an accelerometer (to measure duration and intensity of daily physical activity) and a GPS monitor (to capture where they went) and also to record daily travel in a travel diary for the seven days following the in-person assessment. Research assistants matched data from accelerometers with the GPS data by their date and time stamps to provide a dataset that included time, location, and physical activity intensity (sedentary, light, or MVPA).

In addition, the ASAP study team recruited 27 participants for participation in the qualitative arm of the study for 2012, and 22 were available for follow-up interviews in 2014. Interviews lasted approximately 60-90 minutes and used a semi-structured interview guide. Webber, Porter and Menec's conceptual framework on older adult mobility informed the interview guide (Webber et al., 2010).

Street audits

Another component of the ASAP study included an environmental street audit using the Senior Walking Environmental Assessment Tool-Revised (SWEAT - R) (Michael et al., 2009). The ASAP research team used this tool to measure the microscale design features of the built environment on 112 street blocks ("street segments") along the Greenway and surrounding areas, both before and after development (Summer 2012 and 2014). SWEAT - R consists of 152 items categorized into four domains (functionality, safety, aesthetics, and destinations) and has a focus on features relevant to older adults (see Appendix C for the SWEAT - R tool) (Michael et al., 2009). The SWEAT - R audit documented specific changes along the Greenway (see Figures 1.2 and 1.3) including: a 70% increase in the number of street segments with signs for traffic activity; a 62% increase in segments with high quality public spaces (i.e. cleaner streets and areas that are inviting for people such as public parks, plazas, and well maintained buildings); as well as marked crosswalks (38% increase), benches (15% increase), pedestrian streetlights (11% increase), and bike lanes (6% increase).

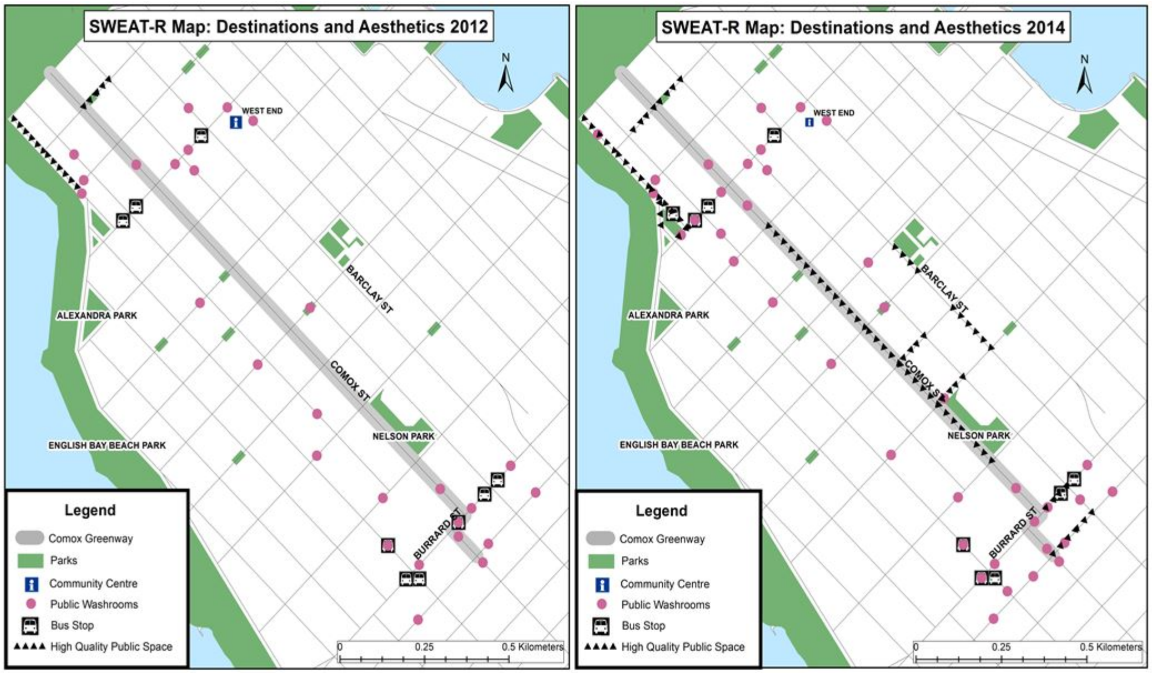

Figure 1.2 SWEAT-R changes to destinations and aesthetics from 2012 to 2014
Destinations and aesthetics included in these maps are community centres, public washrooms, bus stops, and high quality public spaces.

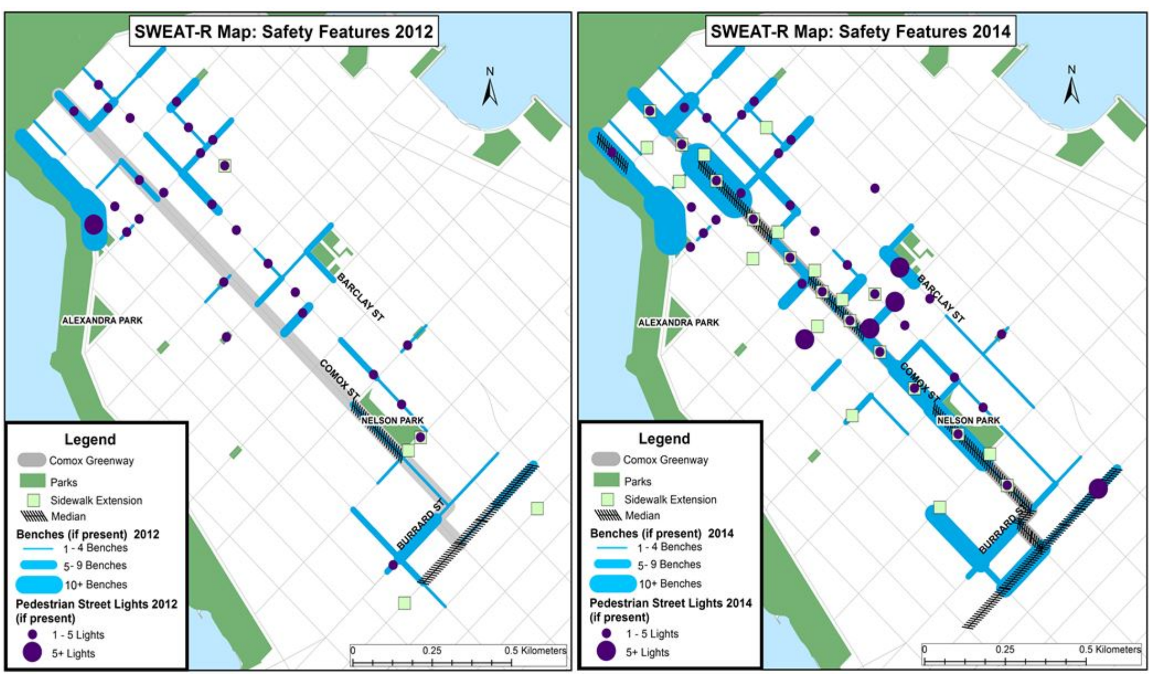

Figure 1.3 SWEAT-R changes to safety features from 2012 to 2014
Safety features included in these maps are sidewalk extensions, medians, benches, and pedestrian street lights.

Recent findings from ASAP

Several papers have already been published from the ASAP study. One examined the travel behaviours (trip purpose, mode, and frequency) using the travel diary data from the 2012 survey (Winters et al., 2015). Winters et al. reported that the most common destinations older adults visited were grocery stores, restaurants, and malls, and that surprisingly, two-thirds of their trips were made by active modes (walking and cycling) (2015). Voss et al. analyzed GPS data from 2012 to characterize the physical activity accrued during daily travel, with a focus on public transportation (2016). Public transit trips led to similar amounts of physical activity compared to walking trips, and among community-dwelling older adults, using public transportation provided "a meaningful source of physical activity" (Voss et al., 2016, p. 198). The most recent ASAP article discussed the importance of benches for mobility and social health among older adults (Ottoni, Sims-Gould, Winters, Heijnen, & McKay, 2016). This research provided insight into the importance of this microscale feature through the qualitative interviews that the ASAP study team conducted in 2012 and 2014 (Ottoni et al., 2016).

ASAP results have also been presented at conferences nationally and internationally. Here I mention only my own research, which was presented at the International Medical Geography Symposium in 2015. In the process of completing my thesis, I conducted a spatial analysis of older adult walking patterns using the 2012 ASAP GPS and accelerometry data (see Figure 1.4) (Pugh, Voss, Zimmermann, McKay, & Winters, 2015). This analysis aimed to characterize the types of areas where older adults are active within their neighbourhoods. We joined the GPS and accelerometry data points to land use data using geographic information system (GIS) software (ArcGIS v. 10.1; ESRI Inc., CA). We found that half of all travel was done on foot, and nearly a third of the walking (31%) occurred in parks and greenspace (natural areas such as forests), far less than for travel by car (13%) or transit (7%). When walking in greenspace areas, 74% of the time was MVPA, whereas only 64% was MVPA for walking through areas with other land uses. With this analysis, we found that walking is an important source of daily physical activity among older adults living in the West End neighbourhood of Vancouver, and greenspaces are important city spaces that appear to yield high levels of health-related physical activity.

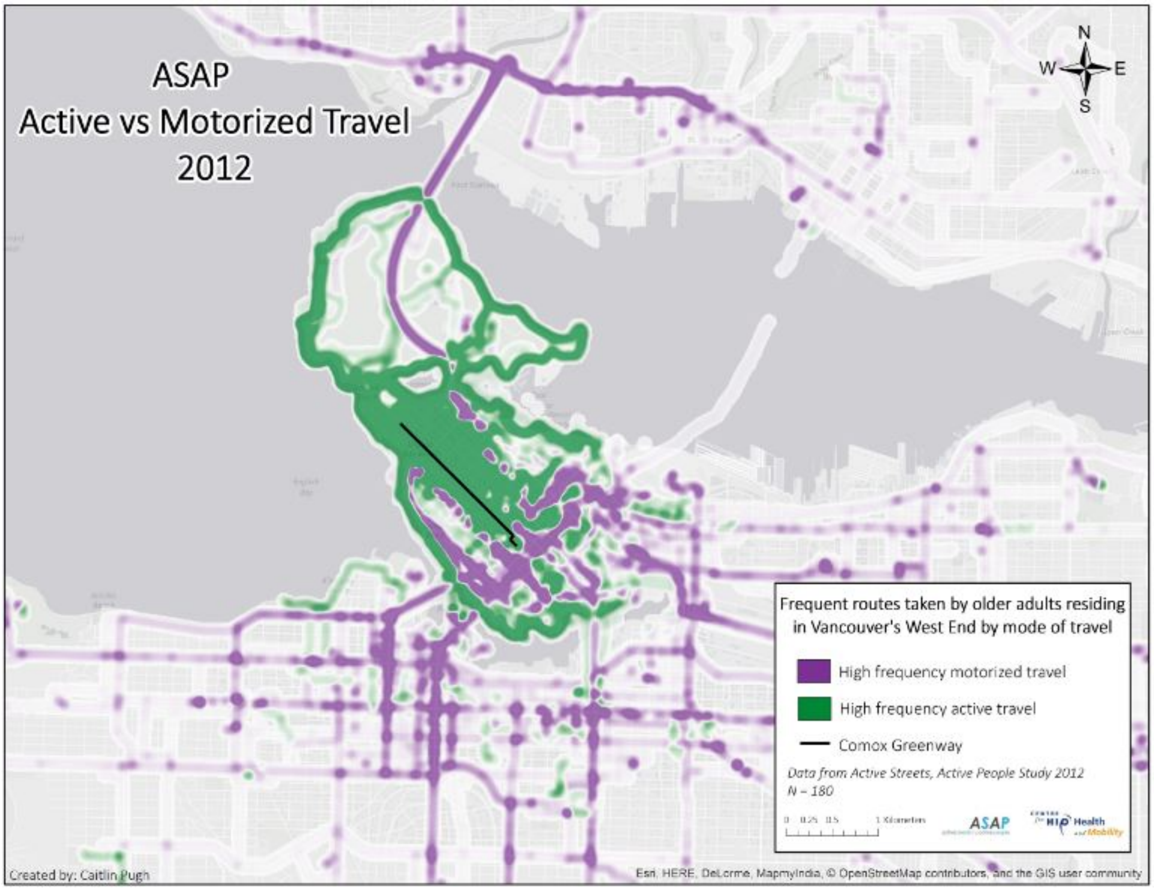

Figure 1.4 Kernel density map of frequent routes taken by ASAP participants in 2012

Green areas symbolize the frequency of active travel (walking, cycling). Purple areas symbolize the frequency of motorized travel.

In addition to these past publications, the ASAP study is also a unique opportunity to address existing gaps in the current literature (cross-sectional studies, lack of spatial specificity). In this natural experiment study of the Greenway corridor, we are able to capture location-specific travel and physical activity behaviours of older adults living nearby.

Thesis objectives

This thesis uses a mixed-methods approach to understand the impacts of the Greenway on the mobility of community-dwelling older adults (aged ≥ 60) by measuring changes in transportation-related activity before and after development, and interviewing participants regarding their perceptions of this built environment intervention.

In Chapter 2, I examine the impacts of the Greenway on transportation-related activity outcomes (trips and transportation-related physical activity) among older adults living nearby. I capture location-specific travel and physical activity using accelerometers and GPS monitors, and measure changes in weekly transportation-related activity; specific activity along the Greenway; and activity along a comparison corridor. I assess if older adults change their transportation-related activity over time, if their travel along the Greenway changes over time, and if older adults use the Greenway more than other routes.

In Chapter 3, I complement the quantitative results of Chapter 2 by analyzing interview data from a subset of these older adults before and after the Greenway was developed, to capture their perceptions of changes in their neighbourhood. Lastly in Chapter 4, I discuss the benefits of this mixed-methods research, and conclude by integrating the findings from Chapters 2 and 3.

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Chapter 2.

Changes in Transportation-Related Activity Among Older Adults After a New Greenway Development in Vancouver, BC

2.1. Introduction

Life expectancies are increasing globally, with the population aged 60 years and older expected to double by 2050, from 1 billion to 2 billion people (UN Department of Economic and Social Affairs, 2007). Within Canada in particular, the proportion of adults 65 and older has increased by 14% from 2006 to 2011 (Statistics Canada, 2012). Maintaining mobility is a vital concept for active aging (World Health Organization, 2007), and in this paper we define mobility as “the ability to move oneself (either independently or by using assistive devices or transportation) within environments that expand from one’s home to the neighbourhood and to regions beyond” (Webber et al., 2010, p. 444). Physical activity is one component of mobility. Based on objective data, only 11% of Canadian older adults meet national physical activity guidelines of 150 minutes of MVPA per week (Statistics Canada, 2013; World Health Organization, 2015). As inactivity is one of the top four risk factors contributing to global mortality (World Health Organization, 2015), multifaceted efforts are essential to tackle physical inactivity and mobility for older adults (Kohl et al., 2012).

There has been a call for action at the environmental and policy level to enhance progress beyond what can be achieved by individual behaviour change approaches (Kohl et al., 2012). There is also increasing evidence surrounding the importance of neighbourhood design for health and wellbeing, and substantial evidence links supportive built environments with physical activity levels (Sallis et al., 2016; van Cauwenberg et al., 2010). More specifically, neighbourhood built environments have been associated with the use of active transportation, such as walking and cycling (Cerin et al., 2017). In particular, neighbourhoods may be a promising strategy to promote mobility and health of older adults, given they spend a greater proportion of time near their homes (Takemoto et al., 2015). However, the body of evidence is predominantly cross-sectional studies (Gell et al., 2015; Kolbe-Alexander et al., 2015), and many call for longitudinal evidence to identify causal relationships (Sallis et al., 2016).

Natural experiment studies are opportunities to study the impacts of built environment interventions such as greenways, but the results from recent articles have been mixed (Mayne et al., 2015). Two recent natural experiment studies reported no significant increase in activity levels among their population (all ages) after the construction of a greenway in North Carolina, USA (West & Shores, 2011, 2015). Another study examining the impacts of a neighbourhood trail on physical activity (individuals aged ≥ 5 years) in Utah, USA, also found no significant increases (Burbidge & Goulias, 2008). Three other studies, one of a new walking and cycling route in Brazil (Pazin et al., 2016), one of a community greenway in Northern Ireland (Dallat et al., 2013), and another examining the impacts of a new urban trail in Tennessee, USA (Fitzhugh, Bassett, & Evans, 2010) found significant increases in physical activity. For example, individuals who lived near the new walking and cycling route in Brazil increased their leisure-time walking by 15 minutes per week (Pazin et al., 2016). Dallat et al.'s research found that 10% of individuals who were classified as 'inactive' prior to the development of the greenway became 'active' after (2013), and Fitzhugh et al. saw a significant increase in their 2-hour physical activity counts (2010). However, these studies did not examine older adults specifically, but rather individuals aged 16 years or older (Dallat et al., 2013), 18 years or older (Pazin et al., 2016), or all ages (Fitzhugh et al., 2010).

We address the gap in longitudinal data by using a natural experiment study to assess change in transportation-related activity among older adults after the development of a Greenway. Specifically, we study the impacts of the Comox-Helmcken Greenway (the "Greenway", developed in June 2013), a 2 km corridor through Vancouver's West End neighbourhood, which aimed to increase active transportation among all populations in Vancouver, while also providing places to sit, rest, and socialize

(City of Vancouver, 2017). We measure the change in transportation-related activity one year before and one year after the development of the Greenway (2012, 2014). We have three specific research questions:

1) Did older adults change their transportation-related activity after the development of the Greenway?

2) Did older adults change their travel along the Greenway route after it was developed?

3) Did older adults travel along the Greenway more than other routes?

We captured location-specific travel and physical activity objectively using accelerometers and GPS monitors to measure transportation-related activity (total trips and total physical activity), as well as specific activity along the Greenway and a comparison corridor. We hypothesize that participants' activity will be maintained over time (rather than expected age-related declines) and participants will spend more time along the Greenway route after its development.

2.2. Methods

2.2.1. Study design and sample

Study participants are part of the Active Streets, Active People (ASAP) study, which is described in Chapter 1 and also in detail elsewhere (Winters et al., 2015). In brief, the ASAP study is a natural experiment study, which aims to assess the impacts of the Greenway development on the mobility of older adults. Using an age and geographically targeted mail-out (list provided by InfoCanada), we recruited 193 adults aged 60 years and older who lived within 400 m of the Greenway. Figure 2.1 shows the study area and home boundary of participants. We obtained institutional ethics approval (University of British Columbia Behavioural Research Ethics Board: H12-00593 and Simon Fraser University Research Ethics Board: 2012s0435).

Figure 2.1 Map of geographic coverage of sampling area, the Greenway, and the comparison corridor

Participant home locations are represented by density surface for confidentiality reasons.

2.2.2. Intervention

The Greenway was approved by the City of Vancouver in 2002 as part of Vancouver's Downtown Transportation Plan (City of Vancouver, 2017). After public consultations from 2011-2012, the City of Vancouver began construction along Comox Street in January 2013 and finished the development of the Greenway in June 2013. The main goals of the Greenway were to connect Downtown Vancouver to Stanley Park for pedestrians and cyclists, encourage people of all ages to walk and cycle through the neighbourhoods, improve safety for cyclists and pedestrians, and provide green areas and gardens for people to sit and socialize (City of Vancouver, 2017). The Greenway development included adding more benches, pedestrian streetlights, marked crosswalks, bike lanes, and signs for traffic activity.

2.2.3. Data collection protocol

Measurement sessions occurred in September and October 2012 (prior to the Greenway development) and in September and October 2014 (after development). During the 1.5-hour measurement session, participants completed questionnaires about their health, physical activity, neighbourhood environment, and social connections. We included a question in the survey asking about their perceptions of the Greenway development. Participants were also asked to wear an accelerometer (to measure duration and intensity of daily physical activity; GT3X+, ActiGraph LLC, FL; 1 second epoch), and a GPS monitor (to capture where they went; Qstarz BT-Q1000XT, QStarz International Co. Ltd., Taiwan; 1 second epoch), and to record daily travel in a travel diary for the seven days following the in-person assessment. They were instructed to wear both of the monitors for seven days, and to only remove them during water-based activities (showering, swimming) and during their sleep. Chargers for the GPS monitors were only given out in 2014, which resulted in more days of GPS data acquired in 2014 compared to 2012 (2012: 4.3 ± 1.2 days, 2014: 5.6 ± 1.4 days). In this analysis, we used a sub-sample of participants who had GPS-recorded outdoor travel data for both time periods (2012 and 2014, n=121).

2.2.4. Outcomes

Our analysis on transportation-related activity focused on two outcomes: 1) change in the number of outdoor trips per week (**Trips**) and 2) change in total minutes of trip-based physical activity per week (**Transportation-related physical activity**).

We combined the GPS and accelerometry data using date and time stamps and imported the data into GIS software for analysis (ArcGIS v. 10.1; ESRI Inc., CA). Our final dataset consisted of over 3 million seconds of trip data in 2012 alone, from 3,597 weekly trips made by our 121 participants. As per our published methods (Voss et al., 2016), we used the ArcGIS Tracking Analyst tool to identify individual trips, and assigned a mode of travel (walk, bike, car, transit, etc.) based on distance, speed, and physical activity level. We classified physical activity using cutpoints defined by Freedson et al. (light physical activity (Light PA) < 1952 counts per minute; MVPA ≥ 1952 counts per minute) (1998). We defined trips as movements of ≥ 30 s duration and ≥ 100 m distance, with speeds of ≥ 1 km/h, and we based trip ends on changes in these criteria. We assigned pauses that were ≥ 5 minutes also as trip ends, although we allowed longer pauses for transit trips due to the wait times.

We identified trips as 'walking' trips when the speeds were ≥ 1 km/h and < 10 km/h. We identified 'bicycle' trips when speeds were ≥ 1 km/h and < 30 km/h with light or sedentary physical activity levels, because accelerometers are unable to accurately measure physical activity during gliding motions. We identified 'car' trips when the speeds were ≥ 10 km/h. We identified 'transit' travel if: a) some walking occurred at the beginning and/or end of the trip to a transit stop, b) there was a pause > 30 s between walking and motorized trip segments, and c) the motorized trip segment followed a transit route (verified against the transit route shapefile in ArcGIS) with frequent pauses during the motorized segment (i.e., stopping at transit stops along the route). For each trip, we extracted the participant ID, date, trip start and end times, primary trip mode (walk, bike, car, transit, other), mean speed (km/h), total distance (km), total steps (count), and total physical activity (minutes of Light PA + MVPA). For the purposes of this analysis on older adult mobility, we included data from active transportation travel (i.e., walking and cycling) for both outcomes (trips and transportation-related physical activity), and excluded data from motorized travel (i.e., cars and public transportation).

2.2.5. Statistical analyses

Question 1: Did older adults change their transportation-related activity after the development of the Greenway?

For our first research question, we wanted to examine if our older adult participants had a change in their transportation-related activity (weekly number of trips and minutes of physical activity) from 2012 to 2014. To answer this question, we derived summary data for each participant in each time point (2012, 2014) for each of our outcomes (trips (trips/week), and transportation-related physical activity (min/week)). Since there was variation in the number of days with valid GPS and accelerometry data per participant, we normalized the outcome by dividing by the number of their valid days, and multiplying by seven to estimate a weekly average. Two participants were missing accelerometry data for 2012, and two others in 2014. They are included in the trips analysis (valid GPS data, total sample n=121), but excluded from the transportation-related physical activity analysis due to lack of accelerometry data (total sample n=117).

We examined the mean change in trips and transportation-related physical activity among all participants. Due to the non-normality of our outcome data, we examined the difference between the mean values of outcomes before and after the Greenway was developed using the Wilcoxon nonparametric test, and calculated the level of significance with p-values and 95% confidence intervals (results in Table 2.2).

We then used two fixed-effects linear regression models to estimate within-person changes in our two outcomes (trips and transportation-related physical activity) across the two-year time period. A fixed-effects approach controls for all stable characteristics of a participant, even the unmeasured characteristics (Allison, 2006). In observational studies, fixed-effects models are a method of controlling for unmeasured within-person time-invariant variables (e.g., willingness to walk, perceptions of safety, or the need to get from place to place). In our statistical models, we included both a time-varying covariate (proximity to the Greenway) and a time-invariant covariate (baseline age). We used survey responses for age and distance to the Greenway (home address). We calculated proximity to the Greenway (for 2014) as the distance between participants' geocoded addresses and the nearest point on the Greenway (in meters) using the Euclidean raster distance tool in ArcGIS. Model 1a looks at the change in the number of trips per week, and adjusts for year and proximity to the Greenway. Model 1b also looks at the change in the number of trips per week, but further adjusts for the baseline age interaction with time to examine the effect of trips with age at baseline (a time-invariant characteristic). Models 1c and 1d mirror the first two models, but examine the second outcome: change in transportation-related physical activity.

Question 2: Did older adults change their travel along the Greenway route after it was developed?

We were also interested in how frequently older adults travelled along the Greenway specifically, and how much physical activity they attained along that route. We hypothesized that older adults would use the Greenway more, leading to an increase in the number of trips per week along the Greenway.

We examined the mean change in trips and transportation-related physical activity along the Greenway among all participants. To do this, we extracted data for travel specifically along the Greenway. We flagged travel along the Greenway in ArcGIS, by selecting all travel data (1 second GPS data points) within a 25 m buffer of the Greenway. We then examined the difference in the mean outcomes, before and after the Greenway was developed, using the Wilcoxon nonparametric test, and calculated the level of significance with p-values and 95% confidence intervals (results in Table 2.4).

We then used two fixed-effects linear regression models to estimate if the development of the Greenway was associated with within-person changes in our two outcomes (trips and transportation-related physical activity) across the two-year time period, controlling for both age at baseline and distance to the Greenway. Model 2a looks at the change in the number of trips per week along the Greenway, and adjusts for year and proximity to the Greenway. Model 2b also looks at the change in the number of trips per week along the Greenway, but further adjusts for the baseline age interaction with time to examine the effect of trips with age (a time-invariant characteristic). Models 2c and 2d mirror the first two models, but examine the second outcome: change in transportation-related physical activity along the Greenway.

Question 3: Did older adults travel along the Greenway more than other routes?

We were also interested whether the change in trips and transportation-related physical activity was seen along other routes as well, so we assessed trips and transportation-related physical activity along a parallel corridor for comparison. We wanted to see if older adults used the Greenway more or less than a nearby street that was not developed into a Greenway. The comparison corridor we chose was Barclay

Street, which is a parallel street 220 m north of the Greenway. We flagged travel along the comparison corridor in ArcGIS by selecting all travel data (1 second GPS data points) within a 25 m buffer of the comparison corridor. We then examined the difference between the mean outcomes in 2012 and 2014 using the Wilcoxon nonparametric test, and calculated the level of significance with p-values and 95% confidence intervals (results in Table 2.6). We examined the mean trip and transportation-related physical activity change along the comparison corridor among all participants.

We then used two fixed-effects linear regression models to estimate if the development of the Greenway was associated with within-person changes in our two outcomes (trips and transportation-related physical activity) along the comparison corridor across the two-year time period, controlling for both age at baseline and distance to the Greenway. Model 3a looks at the change in the number of trips per week along the comparison corridor, and adjusts for year and proximity to the Greenway. Model 3b also looks at the change in the number of trips per week along the comparison corridor, but further adjusts for the baseline age interaction with time to examine the effect of trips with age (a time-invariant characteristic). Models 3c and 3d mirror the first two models, but examine the second outcome: change in transportation-related physical activity along the comparison corridor. All analyses were completed in 2016 with RStudio (version 0.99.451, RStudio, Inc. 2015).

2.3. Results

2.3.1. Participant demographics

We included n=121 participants (64% women; 69.9 ± 6.6 years at baseline) with GPS trip data from both time periods (2012 and 2014). Descriptive characteristics of the sample are in Table 2.1. We found no significant differences in demographic characteristics between the participants in the larger ASAP study (n=193) and the sub-sample used in this analysis (n=121; all $p > 0.05$). On average, the participants lived 124 ± 102.5 meters from the Greenway and have lived in the neighbourhood for 19 ± 13 years. From the 2014 measurement session questionnaire, we found that half of the participants (n=61) found the changes to the Greenway positive, 17% (n=20) found them neutral, 28% (n=34) found them negative, and 5% (n=6) were not aware of the changes.

Table 2.1 Participant demographics (n=121) at baseline (2012)

	n (%)
Gender	
Female	78 (64%)
Male	43 (36%)
Age (years)	
60-64	28 (23%)
65-69	36 (30%)
70-74	30 (25%)
≥ 75	27 (22%)
Education	
Secondary or less	17 (14%)
Some trade	22 (18%)
Some university	82 (68%)
Income	
< $25,000	26 (21%)
$25,000-49,999	39 (32%)
$50,000-74,999	25 (21%)
≥ $75,000	23 (19%)
No response	8 (7%)
Living Arrangement	
Alone	71 (59%)
Not Alone	50 (41%)
Working Status	
Retired	93 (77%)
Working	28 (23%)
Home Location	**mean ± SD**
Years living in neighbourhood	19 ± 13
Proximity to Greenway (meters)	124 ± 103
Total Weekly Physical Activity (mins/week)[a]	**median (p25, p75)**
2012	
Light PA	1612 (1383, 1904)
MVPA	248 (119, 412)
2014	
Light PA	1514 (1270, 1794)
MVPA	215 (86, 375)

[a]This includes all physical activity collected by the accelerometers, not just the transportation-related physical activity.

2.3.2. Question 1: Did older adults change their transportation-related activity after the development of the Greenway?

Participants were highly active in their daily travel (Table 2.2). They accrued 237 minutes of transportation-related physical activity per week, on average, prior to the development of the Greenway (2012), and 218 minutes, on average, after (2014). In unadjusted analyses, the number of trips taken per week did not change significantly from 2012 to 2014, but we can see a trend in declining levels of transportation-related physical activity over time.

Table 2.2 Mean change in trips and transportation-related physical activity from all travel from 2012 to 2014

	2012	2014			
	Mean ± SD	**Mean ± SD**	**Change (2014-2012)**	**95% CI**	***p* value[a]**
All Travel					
Trips per week	20.3 ± 11.6	18.9 ± 10.7	-1.4	(-3.1, 0.6)	0.17
Transportation-related physical activity (minutes per week)	236.6 ± 207.3	217.6 ± 181.2	-19.0	(-46.3, 6.5)	0.14

[a]The p values are derived from the Wilcoxon nonparametric test for differences.

We also looked at within-person changes, which allowed us to look at the impacts of age or distance to the Greenway, in addition to the effect of time. Table 2.3 shows results of the fixed-effects models for the change in trips and transportation-related physical activity per week among all travel. There was no significant change in the number of trips from 2012 to 2014. We also found no significant change in transportation-related physical activity over time.

Table 2.3 Fixed-effects linear regression results of the change in trips and transportation-related physical activity per week from all travel (2014 compared to 2012)

	Change in trips per week		Change in transportation-related physical activity (minutes per week)	
	Model 1A	**Model 1B**	**Model 1C**	**Model 1D**
Time	-2.7 (-7.8, 2.4)	-4.9 (-23.8, 13.9)	-4.9 (-96.2, 86.3)	91.2 (-245.7, 428.0)
Distance to Greenway (meters)	0.0 (-0.2, 0.1)	-0.0 (-0.2, 0.1)	0.5 (-2.6, 3.6)	0.4 (-2.8, 3.5)
Baseline Age*Time	----	0.0 (-0.2, 0.3)	----	-1.4 (-6.3, 3.4)

Results are represented as: Estimate (95% CI).

2.3.3. Question 2: Did older adults change their travel along the Greenway route after it was developed?

When we examined travel specifically along the Greenway using the Wilcoxon nonparametric test, we found no significant change in the number of trips or the amount of transportation-related physical activity per week, on average (Table 2.4).

Table 2.4 Mean change in trips and transportation-related physical activity along the Greenway from 2012 to 2014

	2012	2014			
	Mean ± SD	**Mean ± SD**	**Change (2014-2012)**	**95% CI**	***p* value[a]**
Travel along the Greenway					
Trips per week	7.1 ± 6.1	6.8 ± 5.5	-0.3	(-1.3, 1.0)	0.72
Transportation-related physical activity (minutes per week)	17.5 ± 23.0	14.7 ± 16.8	-2.8	(-4.9, 1.0)	0.19

[a]The p values are derived from the Wilcoxon nonparametric test for differences.

However, when we controlled for baseline age and distance to the Greenway with the fixed-effects regression models, we saw a significant decrease in the number of trips per week along the Greenway (12.3 trips/week). However, those who were older at baseline had a slightly smaller decrease in weekly Greenway trips over time, as shown in Table 2.5 Model 2b.

Table 2.5 Fixed-effects linear regression results of the change in trips and transportation-related physical activity per week along the Greenway (2014 compared to 2012)

	Change in trips per week		Change in transportation-related physical activity (minutes per week)	
	Model 2A	**Model 2B**	**Model 2C**	**Model 2D**
Time	1.4 (-1.6, 4.4)	**-12.3 (-23.2, -1.4)**	3.8 (-8.0, 15.6)	-2.1 (-45.6, 41.4)
Distance to Greenway (meters)	0.1 (-0.0, 0.2)	0.1 (-0.0, 0.2)	0.2 (-0.2, 0.6)	0.2 (-0.2, 0.7)
Baseline Age*Time	----	**0.2 (0.05, 0.4)**	----	0.1 (-0.5, 0.7)

Results are represented as: Estimate (95% CI).

2.3.4. Question 3: Did older adults travel along the Greenway more than other routes?

We wanted to examine the change in physical activity along the Greenway with a comparison corridor to see if similar changes occurred along parallel streets. We wanted to understand if this was a generalized or location-specific effect. We found a similar number of trips per week along both the Greenway and the comparison corridor in 2012 and 2014: an average of 7 trips along the Greenway and 6 trips along the comparison corridor in both time periods. We also saw higher amounts of transportation-related physical activity minutes per week along the Greenway than along the comparison corridor in both 2012 and 2014, although an overlap in confidence intervals (2012: 17.5 vs. 9.9, and 2014: 14.7 vs. 9.2).

Table 2.6 Mean change in trips and transportation-related physical activity along the comparison corridor from 2012 to 2014

	2012	2014			
	Mean ± SD	**Mean ± SD**	**Change (2014-2012)**	**95% CI**	***p* value[a]**
Travel along comparison corridor					
Trips per week	6.1 ± 5.9	5.6 ± 5.2	-0.4	(-1.4, 0.5)	0.35
Transportation-related physical activity (minutes per week)	9.9 ± 14.5	9.2 ± 17.5	-0.7	(-2.6, 0.4)	0.15

[a]The p values are derived from the Wilcoxon nonparametric test for differences.

When we assessed the within-person changes of trips and transportation-related physical activity along the comparison corridor we found no significant change over time

(Table 2.7). However, when we compared the amount of travel along the Greenway (Table 2.4) and along the comparison corridor (Table 2.6), we saw more activity (trips and transportation-related physical activity per week) along the Greenway.

Table 2.7 Fixed-effects linear regression results of the change in trips and transportation-related physical activity per week along the comparison corridor (2014 compared to 2012)

	Change in trips per week		Change in transportation-related physical activity (minutes per week)	
	Model 3A	**Model 3B**	**Model 3C**	**Model 3D**
Time	0.2 (-2.3, 2.8)	-1.2 (-10.5, 8.0)	-0.4 (-7.3, 8.2)	14.0 (-14.5, 42.5)
Distance to Greenway (meters)	0.0 (-0.1, 0.1)	0.0 (-0.1, 0.1)	0.0 (-0.2, 0.3)	0.0 (-0.2, 0.3)
Baseline Age*Time	----	0.0 (-0.1,0.2)	----	-0.2 (-0.6, 0.2)

Results are represented as: Estimate (95% CI).

2.4. Discussion

Through a partnership with the City of Vancouver, we were able to undertake a longitudinal natural experiment study of a major built environment change – a $5.4 million investment in a Greenway. Among a group of community-dwelling older adults, the development of a new Greenway in their neighbourhood was not associated with a change in transportation-related physical activity. We assessed within-person changes using fixed-effects linear regression models over a two-year time-period (one year before and one year after a Greenway development), and found a decrease in the number of trips per week along the Greenway after controlling for distance to the Greenway and age at baseline. However, when comparing the amount of travel along the Greenway and along a parallel comparison corridor, more activity (trips and transportation-related physical activity per week) was seen along the Greenway compared to the other corridor. These results could represent a lag between infrastructure and adaptive behavioural changes.

The City of Vancouver developed this Greenway in order to encourage walking and cycling among people of all ages, and to enhance the safety features of the neighbourhood (City of Vancouver, 2017). There was an increase in traffic signs, public spaces, marked crosswalks, benches, pedestrian streetlights, and bike lanes in 2014 after the Greenway was developed. Most natural experiment studies have been on new transit stations and trails (e.g., a new light-rail stop, a multi-use trail development) (Brown & Werner, 2007; Burbidge & Goulias, 2008; Evenson, Herring, & Huston, 2005; Merom, Bauman, Vita, & Close, 2003; Miller et al., 2015; Panter, Heinen, Mackett, & Ogilvie, 2016), and none look at new greenways that were developed in an area already considered a "Walker's Paradise", like our study (Walk Scores® of 94 - 97/100 are termed "Walker's Paradise") (Walk Score®, 2017). It is possible that among these older adults, their physical activity is saturated by living in a "Walker's Paradise", and changes to the built environment, no matter what they are, may have little impact on their transportation-related physical activity. Additionally, since we had no control group of participants to compare these results with, it is unknown whether a decline in activity (trips and transportation-related physical activity), as could be expected with ageing, would have been observed over this 2-year time period if the Greenway was not developed. It is possible that the Greenway helped to maintain, or reduce the magnitude of decline, in activity among older adults in the West End neighbourhood.

By using GPS and accelerometry data we were able to identify trips and transportation-related physical activity that occurred specifically along the Greenway. In recent natural experiment studies, only two used these devices (Brown & Werner, 2007; Miller et al., 2015). Both of these articles examined new transit infrastructure and found an increase in either ridership (Brown & Werner, 2007) or new physical activity (Miller et al., 2015). The natural experiment studies that look at greenways or urban trails and physical activity use self-reported physical activity outcomes (Burbidge & Goulias, 2008; Evenson et al., 2005; Fitzhugh et al., 2010; Goodman, Sahlqvist, & Ogilvie, 2014; Merom et al., 2003; Panter et al., 2016; Pazin et al., 2016; West & Shores, 2015). Self-report measures of physical activity are susceptible to recall bias or social desirability bias (Prince et al., 2008; Van De Mortel, 2008), and short, yet routine, walking trips could be missed with interviews or questionnaires about daily travel patterns. Other studies have used just accelerometers (no GPS monitors) as an objective measure of physical activity (Carson, Salmon, Crawford, Hinkley, & Hesketh, 2016; Ding et al., 2014). This method cannot differentiate between the different domains of physical activity (e.g., for transportation, for leisure) that would be influenced directly by built environment characteristics. Using GPS monitors and accelerometers, we were able to contextualize where older adults were travelling in their neighbourhood and we could see that one third of our participants' trips touched the Greenway (participant average n=7/20 in 2012 and n=7/19 in 2014).

Recent natural experiment studies have found mixed results when looking at the relationship between physical activity and greenways, new trails, or new transit infrastructure. The studies that examined associations of physical activity and the development of a new light-rail transit line, stop, or "Busway" found an increase in either cycling (Merom et al., 2003), walking (Brown & Werner, 2007), active commuting (Panter et al., 2016), or physical activity (Miller et al., 2015). Contrasting results were found in different natural experiment studies; for example, neighbourhood trail interventions found no effect on physical activity (Burbidge & Goulias, 2008; Evenson et al., 2005). Two recent studies similarly looking at the impacts of an urban greenway development on physical activity found no effect one year post-intervention, which align with the results of our study (Goodman et al., 2014; West & Shores, 2015). However, none of these studies examined the older adult population specifically. Two other greenway natural experiment studies found an increase in observed physical activity, but their research was not older adult specific and their methods differed from ours (self-report physical activity and observation of activity along the route) (Fitzhugh et al., 2010; Pazin et al., 2016).

Given the aging demographic, it is vital for research teams to explore methods to increase mobility among older adults through changes to the built environment. In Canada, only 11% of older adults meet national physical activity guidelines of 150 minutes of MVPA per week, based on accelerometry data (Statistics Canada, 2013; World Health Organization, 2015). Participants in our study were highly active compared to the national rates; 71% (83/117) of our participants in 2012 met weekly MVPA guidelines, while 56% (66/117) of participants in 2014 met the weekly guidelines. Additionally, two-thirds of our participants' trips were made by active transportation modes (i.e., walking and cycling). In studies of older adults, it might have been expected to see age-related declines in physical activity across the two-year time period (Sallis, 2000). However, the overall number of weekly trips and transportation-related physical activity showed no significant change. This suggests that our participants are still active in their communities at follow-up. There is a lack of longitudinal research focusing on older adults and changes to the built environment with which to compare our results. However, the few studies that are present show that sharp declines in physical activity are expected among the aging population (Davis et al., 2011). We add to the growing research on the topic of mobility and the built environment by examining the change in transportation-related activity among community-dwelling older adults.

2.4.1. Strengths and limitations

We captured location-specific physical activity in an older adult population living in a highly walkable neighbourhood. This study is distinct, as it is the first to objectively measure physical activity along a specific route using GPS monitors and accelerometers. Further, our study is longitudinal, with the same participants measured before and after the Greenway was developed (the ASAP study 2014 re-recruitment rate was 80.3%, see Appendix E for further details).

We also acknowledge that our study has limitations. Due to practical constraints (i.e., budget, lack of comparable setting) the ASAP study does not have a control group of participants living away from the Greenway. Our follow-up time point was one year after the development, which may not be sufficient for change of behaviour to occur. Future studies may wish to measure changes over longer periods of time after a built environment intervention. Additionally, the number of participants in this study is small, but falls within the range of previous studies using GPS data (recent longitudinal studies have sample sizes ranging from 34-550 participants) (Costa et al., 2015; Klinker, Schipperijn, Toftager, Kerr, & Troelsen, 2015; Mahendran, Kuys, & Brauer, 2016; Miller et al., 2015). And finally, due to the battery power of the GPS monitors and accelerometers, the number of observation days varies from person to person and from each time period (see Appendix H for further details on the number of participants with valid GPS and accelerometry data from 2012 and 2014).

2.4.2. Conclusion

Our analysis found that the development of a Greenway in a highly walkable neighbourhood did not demonstrate a significant change in transportation-related physical activity among community-dwelling older adults. New infrastructure that encourages active transportation may not directly impact those who are already highly active, and therefore future research is needed among less active populations. Future work is also needed among different demographic groups, and in neighbourhoods with differing levels of walkability, as greenway interventions may have differential impacts in certain populations and neighbourhoods.

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Chapter 3.

'I Try to Walk Where the Walking is Easy': Older Adult Perceptions of a New Greenway

3.1. Introduction

As our population ages, it is imperative to focus our efforts to maintain and improve the mobility of older adults. One way we can accomplish this is by creating healthy built environments for people of all ages. Mobility among older adults is a topic that is influenced by many social and environmental factors (Centers for Disease Control and Prevention, 2015). According to Webber, Porter, and Menec's framework, mobility is the ability to move about in one's neighbourhood and maintain independence (2010). With almost 40% of adults over the age of 45 years having difficulties with mobility and physical movement (Rosenberg, Huang, Simonovich, & Belza, 2012), it is important to have an in-depth understanding on how to facilitate movement and mobility.

There is evidence to support the importance of neighbourhood design for health and individual wellbeing. The neighbourhood can promote physical activity; for example, parks, trails, and mixed-land use areas support active modes of travel (BC Healthy Communities Society, 2016; Klinkenberg, 2014). This is supported by the social-ecological model, which considers the relationships between individuals, communities (schools, workplaces, neighbourhoods), and societies (the broad societal factor; norms and policies) (Centers for Disease Control and Prevention, 2015). Substantial evidence links the built environment with self-reported physical activity levels as well as walking and cycling (Dallat et al., 2013; Dorwart, 2015; Evenson et al., 2005; Li, Fisher, Brownson, & Bosworth, 2005; Michael, Beard, Choi, Farquhar, & Carlson, 2006; Price et al., 2012; West & Shores, 2015).

A specific focus on older adult mobility is critical given the aging demographic (UN Department of Economic and Social Affairs, 2007). Currently, the proportion of adults aged 65 and older in Canada is growing at a more rapid rate (a 14.1% increase from 2006 to 2011) than both children (0.5% increase) and adults aged 15-64 (5.7% increase) (Statistics Canada, 2012). Therefore, it is becoming increasingly important for community planners to create neighbourhoods that support our aging population. Recent studies have examined connections between the built environment and older adult mobility (Cerin et al., 2017; Chippendale & Boltz, 2014; Dorwart, 2015; Eisenberg, Vanderbom, & Vasudevan, 2017; Kolbe-Alexander et al., 2015; Rosso et al., 2011; Van Holle et al., 2014; Winters et al., 2015; Ying, Ning, & Xin, 2015). Some highlight the importance of pedestrian-friendly facilities (such as parks and grocery stores) near older adult residences, since they might increase short, routine, walking trips (Van Holle et al., 2014). It is important to understand the older adult perspectives of what makes a neighbourhood healthy and accessible, so that future city planners can tailor built environment interventions to benefit the aging population.

There is a host of knowledge surrounding the importance of the built environment for maintaining mobility, yet most of the research uses quantitative approaches and the reviews suggest mixed findings (Rosso et al., 2011; van Cauwenberg et al., 2010). While there is some recent research examining older adult perceptions of the built environment from cross-sectional studies (Lord, Després, & Ramadier, 2011; Mathews et al., 2010), more research is needed to gather a deeper understanding of impacts of built environment changes. Previous qualitative studies have found that accessible and safe neighbourhoods with many amenities are key when it comes to how much physical activity older adults attain (Chippendale & Boltz, 2014; Lord et al., 2011; Mathews et al., 2010; Rosenberg et al., 2012; Stathi et al., 2012). Older adults share through personal experiences the importance of living in a community where it is easy to walk for transportation. For example, a participant quote from a study in the United States reports that “it’s sad to drive somewhere to go take a walk” (Mathews et al., 2010, p. 130). For older adults, it can be challenging to make a conscious decision to walk if the environment does not make it easy and accessible (Mathews et al., 2010). Population-level changes, such as built environment interventions that make walking ‘the easy choice,’ may be one way to encourage walking for people of all ages, including older adults.

In our study, we aim to examine the perceptions of older adults on a newly developed Greenway. We use qualitative methods to examine how a new Greenway impacted older adult mobility. In the summer of 2013 in Vancouver, BC, the Comox-Helmcken Greenway (the “Greenway”) was built, which is a 2 km corridor through Vancouver’s West End neighbourhood. With this infrastructure, the City of Vancouver aimed to increase active transportation, and also to provide places to sit, rest, and socialize (City of Vancouver, 2017), for people of all ages and abilities. In our previous quantitative study, we found that the development of the Greenway was not associated with a change in transportation-related physical activity among older adults living nearby. In this study, we interview a subset of these older adults before and after the Greenway was developed. The focus of this analysis was to examine perceptions of the Greenway before and after it was developed. With this qualitative data we hope to inform city planners on the perceptions of this new built environment change: did the Greenway development positively impact older adults? Did the participants use the new infrastructure, and why or why not?

3.2. Methods

3.2.1. Study design and context

Study participants are a part of the Active Streets, Active People (ASAP) study, which is described in Chapter 1 and in detail elsewhere (Winters et al., 2015). In brief, the ASAP study is a mixed-methods natural experiment study, which aims to assess the impacts of the Greenway development on the mobility of older adults. Using an age and geographically targeted mail-out (list provided by InfoCanada), we recruited 193 adults aged 60 years and older who lived within 400 m of the Greenway. Eligibility criteria included that they left their homes most days of the week, and did not intend to move in coming years. We obtained institutional ethics approval (University of British Columbia Behavioural Research Ethics Board: H12-00593 and Simon Fraser University Research Ethics Board: 2012s0435).

Intervention

The City of Vancouver approved the Greenway in 2002 as part of Vancouver's Downtown Transportation Plan (City of Vancouver, 2017). After public consultations from 2011-2012, the City of Vancouver constructed the Greenway between January and June 2013. The main goals of the Greenway were to connect Downtown Vancouver to Stanley Park for pedestrians and cyclists, encourage people of all ages to walk and cycle through their neighbourhoods, improve safety for cyclists and pedestrians, and provide green areas and gardens for people to sit and socialize (City of Vancouver, 2017).

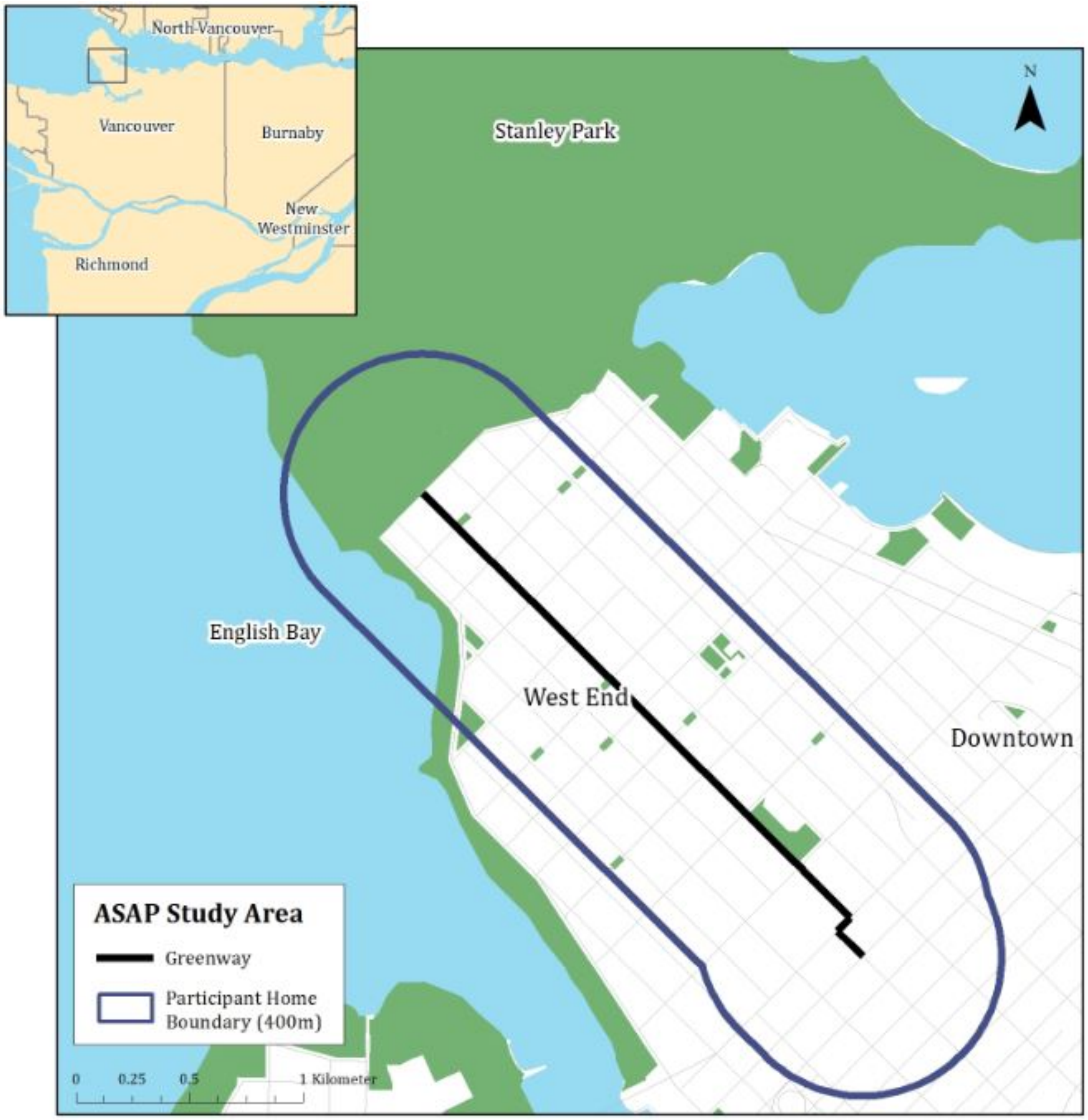

Figure 3.1 Active Streets, Active People study area and Greenway

Our research took place in the West End neighbourhood of Vancouver, BC. This neighbourhood is located between Downtown Vancouver and Stanley Park (see Figure 3.1). With a Walk Score® of 94 out of a possible 100, this area is considered a "Walker's Paradise", and is the second most walkable neighbourhood in Vancouver (Walk Score®, 2017). Walk Score® is calculated based on the presence of nearby amenities/destinations, block length, and street connectivity (Walk Score®, 2017). As of 2011, the West End neighbourhood had a similar proportion of older adults compared to

Vancouver overall (Vancouver: 14% of population aged 65 or older; West End: 13% of population aged 65 or older; City of Vancouver, 2012).

Figure 3.2 Location of West End neighbourhood in Vancouver, BC
(City of Vancouver, 2012. Contains information licensed under the Open Government Licence - Vancouver.)

Quantitative measurement sessions

To describe the participants we interviewed, we drew on data from quantitative measurement sessions. These occurred in September and October 2012 (prior to the Greenway development) and September and October 2014 (after the Greenway development). During the 1.5-hour measurement sessions, participants completed questionnaires about their health, physical activity, neighbourhood environment, and social connections. In 2012 and 2014, we asked participants in the measurement session questionnaire *"How much do you like to walk outside?"* With this question, we wanted to gain an understanding of the general perceptions of outdoor travel and see if this changed over time. We also asked participants to wear an accelerometer to measure duration and intensity of daily physical activity for the seven days following the in-person assessment.

Qualitative recruitment

After the completion of the quantitative assessment in 2012, we provided participants an envelope with information about voluntary follow-up interviews. This envelope included a letter of introduction about the qualitative portion of the study along with a consent form. One week following the sessions, we telephoned participants who had indicated on the original ASAP study consent form that they would like to be contacted in the future for further studies. Our goal was to recruit 30 participants for in-depth interviews. We recruited 27 participants for the 2012 interviews (October and November 2012), and of those, we re-recruited 22 in 2014 (October and November 2014).

3.2.2. Qualitative interviews

We conducted semi-structured in-depth interviews among community-dwelling older adults that lived within 400 m of the new Greenway development. The qualitative interviews lasted from 1-1.5 hours, and occurred in community centre rooms or participant homes. The interviews followed an interview guide that focused on older adult mobility, informed by Webber et al.'s conceptual framework (2010). In the interviews, we asked participants about their health, physical activity, travel behaviours, and the local built and social environments. Additionally, we asked about their perceptions of the new Greenway in their neighbourhoods. In 2012 prior to the Greenway development, we asked participants what they would like to see changed in their neighbourhoods, and what they thought about the Greenway plans. In 2014 after the Greenway was built, we asked participants to discuss their perceptions of the change, and if they chose the Greenway as a preferred walking route to get from place to place. We digitally recorded the interviews, and a professional transcription agency transcribed them verbatim.

3.2.3. Analysis

In this analysis, our inclusion criteria were as follows: 1) participation in the qualitative interviews for both time periods (2012 and 2014), and 2) inclusion in the previous quantitative analysis on transportation-related activity in Chapter 2.

We used framework analysis to code the interviews, followed by inductive analysis to examine detailed perceptions of the Greenway. Framework analysis is ideal for this research as it uses specific questions with a set time frame (i.e., one year before and after the Greenway was developed), a pre-designed sample (i.e., older adults aged ≥ 60) along with a priori topics (i.e., the Greenway and mobility) to address the research questions (Srivastava & Thomson, 2009). For the first stage of qualitative analysis, we sorted data based on key topics and themes using five steps: 1) familiarize, 2) identify a thematic framework, 3) index, 4) chart, and 5) map and interpret (Srivastava & Thomson, 2009). These five steps are further detailed in Ottoni et al.'s recent article (2016). Using NVivo, two ASAP study team members coded the interviews based on the thematic framework as full paragraphs so that contextual meaning was not lost. After the initial coding of all interviews from both time periods (2012 and 2014), we analyzed the interview data relating specifically to the Greenway in further detail using an inductive methodology of line by line coding. To reinforce the rigor of our study, we cross-checked full transcripts against original audio files for quality, and did reflexive memoing throughout the data generation and data analysis processes. While presenting the results and discussion in the following sections of this paper, we used pseudonyms to maintain confidentiality.

3.3. Results

3.3.1. Study participants

We included n=13 participants (69% female; mean age 73.8 in 2014) who participated in interviews in both 2012 and 2014 (before and after the Greenway was developed). These participants accrued an average of 6,842 ± 2,746 steps per day in 2012 and 5,489 ± 2,720 steps per day in 2014. Current guidelines suggest older adults strive for 6,000 to 8,500 steps per day to maintain a healthy lifestyle (Tudor-Locke et al., 2011). According to the accelerometry results, 55% (6/11) of participants in 2012 met daily step guidelines, while 42% (5/12) of participants in 2014 met daily step guidelines.

With regards to the questionnaire that asked about enjoyment levels of outdoor walking, 100% responded either *"somewhat"* or *"very much"* in 2012*,* while in 2014 85% responded *"very much"* while 15% responded either *"not much"* or *"neutral".* This gives some insight into older adults' overall perceptions with outdoor walking, and how these perceptions slightly changed over time among our participants. Detailed participant demographics are listed in Table 3.1.

The findings below are framed around three themes that arose from discussions about the Greenway: 1) Confusion with new infrastructure, 2) Destinations and the neighbourhood environment, and 3) Physical geography. Perceptions about the Greenway did not significantly change among participants over time; therefore, the themes below are from a combination of both the 2012 and 2014 interviews.

Table 3.1 Participant demographics (n=13) at baseline (2012)

	n (%)
Gender	
Female	9 (69%)
Male	4 (31%)
Age (years)	
< 75	9 (69%)
≥ 75	4 (31%)
Marital Status	
Single	4 (31%)
Married	6 (46%)
Divorced	3 (23%)
Income	
< $25,000	2 (15%)
$25,000-$74,999	7 (54%)
≥ $75,000	2 (15%)
No response	2 (15%)
Mobility Aid[a]	3 (23%)
Valid Driver's Licence	12 (92%)
Mean Weekly Step Count[b]	**mean ± SD**
2012[c]	6,842 ± 2,746
2014[c]	5,489 ± 2,720
Total Weekly Physical Activity (mins/week)[b]	**median (p25, p75)**
2012	
Light PA	850 (592, 945)
MVPA	255 (99, 420)
2014	
Light PA	1461 (1200, 1849)
MVPA	114 (28, 211)

[a]Mobility aid refers to individuals who indicated that they used a device designed to assist with their daily transportation (e.g., a walker or wheelchair).
[b]This includes all physical activity collected by the accelerometers, not just the transportation-related physical activity.
[c]In 2012, 11/13 participants wore accelerometers. In 2014, 12/13 wore them.

3.3.2. Confusion with new infrastructure

Older adults in our study spoke about some of the confusion they faced with the design of the new Greenway, across a number of topics. They discussed the importance of clear messaging when new infrastructure changes are implemented.

Vehicle traffic

One example of what participants found confusing was the implementation of new one-way street regulations. One-way streets were introduced along the Greenway in 2013 as part of the development, and drivers needed to adapt to the new traffic patterns. Many participants (n=6/13) discussed the new one-way street changes. Timothy (aged 79 years) discussed the new one-way streets along the Greenway, and described how traffic increased in his neighbourhood because of the confusing change:

> *Because they've blocked the in and out on Denman Street, you know, so cars can only go out from this side to make a right-hand turn. Coming the other way they only come out and go that way. So we find that there's a lot more cars in the neighbourhood because people can't turn down Denman. So they come in somewhere and they wind their way through to get where they're going.*

Simon (aged 87 years) mentioned that some vehicles were not able to follow the directionality of the new street:

> *People actually get lost now. Strangers try to go up and they can't. They've got to go down. So they go around the block and come around again to go up. And then they find that at the next intersection they can't go out at all. There's no way out.*

Nancy (aged 69 years) also added another perspective to the confusion of the one-way streets in relation to the emergency responders:

> *I think it's just - it's added a nuisance value to people who drive. And it's added a very strong nuisance value for our first responders. They're coming off to an emergency, they'll have, you know, they come down the wrong way because they have to come off of Denman Street up this way. So they have to navigate that.*

New cycling infrastructure

A second example that was confusing to participants was the new cycling infrastructure, which was built along the Greenway. For bicyclists such as Lane (aged 68 years), the bike lane was useful but perhaps unregulated by signs and messaging:

> *So I think that - and then there are motorized vehicles on the bike paths as well, scooters and small motorized vehicles. And I don't like that. I think that it's a bike path. It's for pedal power, right. So I feel that it's been an unregulated change.*

Leonie (aged 63 years) mentioned that when cycling in the area, the design of some blocks made routing unclear:

> *But for me, it's - I mean it hasn't made a gigantic difference in the sense that I mean when there was no traffic change I could still just go across and up the hill, and it was never a super busy street. And it's a bit of an adjustment, too. It feels a little unsafe going to the left-hand side of the road on occasion. No big deal. I just mean for me, I can't say - like if people from Downtown can go through to Stanley Park in an enjoyable way by bicycle that makes a huge difference to people. But so far, they haven't quite integrated the Stanley Park part. So you kind of get to here and there's nowhere to go. You have to sort of loop around. And I don't use that.*

3.3.3. Destinations and the neighbourhood environment

While the theme above addresses the confusion of new infrastructure, another major theme that arose from our discussions with our participants was the importance of destinations and the surrounding environment.

Walking with a purpose

Older adults in our study spoke about the importance of having an enticing destination to travel to and the idea of walking with a purpose. Residents in the West End are presented with many different route options to get from place to place, due to its high level of street connectivity and walkability (see Figure 3.3 for the detailed street layout of the West End neighbourhood). Many individuals in the interviews highlighted the importance of destinations along their travel routes. The Greenway along Comox Street leads directly to the local hospital, St. Paul's Hospital, a frequented destination by some of the participants. When Timothy (aged 79 years) was asked which route he chose to get from his home to the hospital, he replied:

> *Comox all the way through, yeah.*

He mentioned alternate routes that he was presented with, and how specific destinations such as bakeries are important factors that guided his decision:

> *And when I go that way I generally come back Davie because, you know, if there's anything - there's a bakery I go to up on Davie. So coming back, I'll go and get some cookies.*

When discussing travel routes with Nancy (aged 69 years), the presence of a public market brought her travel route along the Greenway on Comox:

> *The only time I walk up to the top of Comox, which again is a steep hill, is for the Farmers Market.*

Destinations may entice walkers to choose a certain travel route over the other.

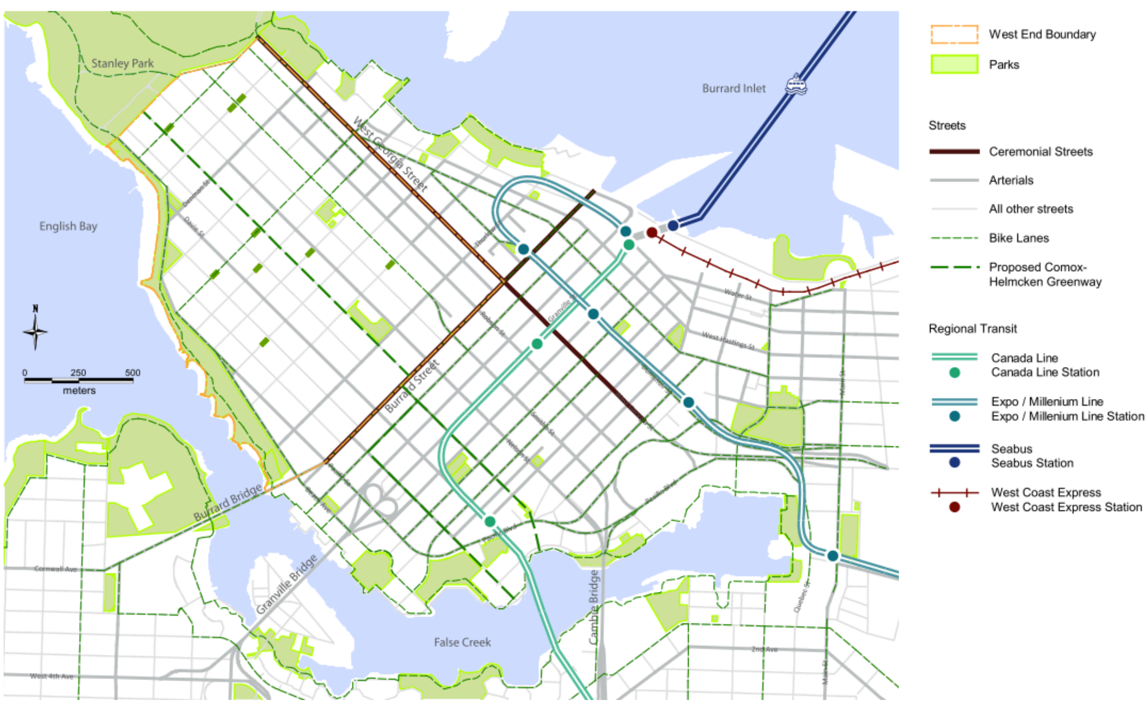

Figure 3.3 West End neighbourhood street and transit map
(City of Vancouver, 2012. Contains information licensed under the Open Government Licence – Vancouver.)

Aesthetics of environment

Our older adult participants frequently mentioned another appealing environmental attribute: the street's natural beauty, such as the presence of trees. When Lane (aged 68 years) described why she chose some walking routes over others, she described the natural beauty:

> *So I find the walkable routes are the ones that have the most natural beauty on them, trees, trees of different colours, cherry blossoms.*

Similarly, Leonie (aged 63 years) chose the Greenway to cycle to the grocery store because it was a direct route to her destination and had enjoyable aesthetic features:

> *Yes, it's the most quiet and direct. Is there any other reason? No, it's just prettier and quieter.*

Simon (aged 87 years) described how he and his partner had many different routes available to them when they went on their walks through their neighbourhood. He mentioned:

> *We only walk up different streets to mix up the walk, give it a bit of variety. You know you'll get there eventually…simple as that. But there's still some streets I like better than others.*

He added that the trees were an attractive feature, and also the seasonal nature of the neighbourhood aesthetics:

> *The more trees the better for me, and some of them are - in the early spring, up Comox it's almost all Japanese blossoms, you know, Japanese trees. Oh, they're fabulous. You can stand at the bottom and look up and it's just like a wonderland. It's gorgeous. Really. That's a good thing, but it only lasts 7 to 10 days and then they're all down.*

Destinations and appealing natural beauty are important features that may promote active transportation among older adults. However, from our qualitative interviews we found that the presence of these features was not always sufficient to encourage active transportation if the physical geography of the environment did not support walking or cycling.

3.3.4. Physical geography

There were barriers that were irrespective of the urban design features of the Greenway, such as the physical geography of the route. In the interviews, many individuals (n=7/13) in both 2012 and 2014 discussed the steep slope along the Greenway, and mentioned how it posed a deterrent when choosing walking and cycling routes.

Charlene (aged 72 years) described how walking up hills became more of a challenge as she got older:

> *Well, it's more of an effort, walking up a hill than it is on the flat…I mean, what senior is going to plod up that big hill?*

Charlene's partner, Bernard (aged 80 years) also mentioned the barrier of walking up hill:

> *I guess my legs get tired, that's mainly what it is.*

Beatrice (aged 85 years) enjoyed walking along Comox, but described how the slope sometimes led her to choose other streets when she was tired:

> *It is nice. I'm a bit more aware now that it is uphill for a bit. So if I don't feel like that I take the Beach Avenue.*

Older adults who experience limitations with their mobility, such as Diana (aged 76 years) who has osteoarthritis, have different priorities to consider when choosing where to walk than younger adults do. Diana described why she chose some walking routes over others:

> *Well, I choose Pendrell to go to church because the hill isn't quite as steep as going up Comox and then Robson's easy to walk on as well and as well as Denman. And these are easy walks, too, to go along here and then to go to Lost Lagoon down here…and I like the animals in Lost Lagoon. But I have arthritis in my knees, so* ***I try to walk where the walking is easy*** *and there are benches to sit on and, of course, safety.*

3.3.5. Different perspectives

While we did not see any differences in the way men and women answered questions about their mobility and the Greenway, we do note that those who cycle were more inclined to talk positively about the Greenway development compared with those who mainly walked or drove for transportation. Along with the many ways that our participants expressed shared perceptions of the Greenway, there were also points that differed among some of the older adults. Participants had conflicting perspectives on bike lanes. Some of the older adults who either drove or walked for their main form of transportation, stated that the bike lanes were taking away parking spots and disrupting the HandyDART services in their neighbourhood. HandyDART is a “door-to-door, shared ride service for passengers with physical or cognitive disabilities” operating in Vancouver (TransLink, 2017). Other participants who cycled occasionally thought the bike lanes were a nice addition to their neighbourhood, and thought that having less cars driving through their neighbourhood was beneficial.

3.4. Discussion

After discussing the new Greenway with older adult residents, we found three main themes from the qualitative interviews. First, residents found the new infrastructure to be confusing with regards to vehicle traffic and new biking regulations. Second, the importance of destinations was of high importance among older adults when choosing which routes to travel to get from point A to point B in their daily routines. And last, the physical geography (i.e., slope of the streets) comes into play when deciding how to travel through one’s immediate environment.

In relation to the first theme of confusion with new infrastructure, the residents highlighted the importance of having clear messaging surrounding new developments. For example, the one-way streets of the Greenway caused some despair among drivers and visitors to the West End neighbourhood. New infrastructure that supports active transportation and activity in a community is presented positively in the literature, and population-level interventions to increase activity have been shown to have longer and larger spread impacts when compared with smaller, individual-level interventions (Kohl et al., 2012). However, it is important for the creators of new infrastructure to receive feedback from people living in the area, so as to make the new design as clear and as relevant as possible. When design plans are shown ahead of time, and before the implementation of developments, this provides an opportunity to find any potential areas to clarify or improve on. Cleland and colleagues also discuss the importance of having communities engaged when planning new strategies for increased physical activity (2014). The World Health Organization talks highly of community involvement, and states that "societies that enable all citizens to play a full and useful role in the social, economic and cultural life of their society will be healthier" (2003, p. 11). The City of Vancouver engaged members of the West End neighbourhood in discussions of the Greenway development, but it is still not known exactly how much community involvement is the perfect amount. In our interviews, we found that some older adults were involved in discussions about the new Greenway, but others felt that they were not given any opportunities. With regards to the new bike lanes and bike regulations along the Greenway, the majority of participants in our study used walking as their main form of transportation through their neighbourhoods. Talking to walkers about biking provides a different perspective than when we talked with the bikers in our study about the new bike lanes. The consensus among all participants was that there are parts along the Greenway that could be clearer for bikers and walkers alike. With more intensive community engagement and feedback, and with more clarity with messaging, the development of the Greenway could have a wider impact among older adults.

Our second theme found that destinations are of great importance when older adults are choosing which routes to take to actively travel (i.e., when walking or biking from place to place) in their neighbourhoods. It has been shown in recent literature that older adults that predominantly walk or bike to get around strategically choose routes that have interesting or practical places to visit (Chudyk et al., 2015; Hirsch, Winters, Ashe, Clarke, & McKay, 2015). Whether the destination is a grocery store, bank, or friend's home, the routes that have more places to visit are the routes that are the most used. For older adults with mobility limitations, choosing the route that covers off the most errands in the most direct way possible is an important factor when it comes to choosing where to walk. In our study, we found that participants used the Greenway to travel to the local hospital, or the weekend farmers market. If the Greenway did not have these destinations, then the walking routes may have changed for some older adults. Even though many of our participants chose the streets with many shops when walking for transportation and leisure (such as Denman or Davie), beautiful environments were also important for our participants, and many commented on the trees and flowers along the Greenway. These findings align with Rugel's recent report on the positive associations between greenspace (parks, trees, and natural areas) and mental wellbeing (2015). Our participants found that the trees and greenery were important for their positive feelings about their travel routes. In short, along with the importance of destinations, greenery and clean aesthetics are some of the factors driving the route choices among older adults.

When talking with our participants about their perspectives on the Greenway development, the slope of the Greenway was a topic that a majority of them described as a barrier. Micro-scale features such as benches were added in an attempt to alleviate the physical barrier of the steep street segments, but this was not enough to make older adults choose the Greenway as their primary walking or cycling route. As mentioned previously, the West End neighbourhood of Vancouver has a high Walk Score® (94/100), and is a "Walker's Paradise" (Walk Score®, 2017). Something important to note is that this scoring system does not take into account some aspects of the physical geography of the environment, such as the slope and steepness of some block segments of the neighbourhood. This high Walk Score® doesn't necessarily make a place walkable for older adults if there are other non-modifiable physical barriers such as a steep slope present. The consideration of the physical geography of a route is highly important when choosing an area for a Greenway, if the aim of the intervention is to draw older adults to use it.

3.4.1. Strengths and limitations

This qualitative analysis provides a unique perspective that complements our quantitative natural experiment study. In particular, it provides insight into perspectives of a new Greenway development, from a group of older adults that may not have otherwise had their opinions heard. In our quantitative study, we found no significant change in weekly transportation-related physical activity among older adults. Through this study, we were able to capture perspectives as to why the Greenway did not increase levels of walking and cycling. Further, we have gathered information from older adults in their own words, which can provide insights to city planners to aid with future built environment interventions. Quantitative methods do not provide specific details about the Greenway implementation, for example, that some older adults were confused with the new infrastructure, or that having more destinations is highly important for their route choice. By sharing the voices of older adults in response to this Greenway development, we are bridging the communication gap between planners and community members. This qualitative analysis adds value to other quantitative studies on Greenways, as it is important to gain an understanding as to why a Greenway did not have a large impact on the increase of physical activity among the aging population.

We acknowledge that our study has limitations. The interviews were semi-structured, leaning more on the structured side. Deeper perspectives may have been uncovered with fully open-ended interviews. We also did not find major differences in the 2012 and 2014 interviews before and after the Greenway was developed. Older adults' opinions of the Greenway did not change substantially one-year after the development. Other research shows that the time between our 2012 and 2014 interviews may not have been long enough to see major changes (Ward Thompson, Curl, Aspinall, Alves, & Zuin, 2014).

Additionally, if we had another opportunity for follow-up, we would ask participants how the development of the Greenway influenced their decision to walk or cycle on other streets. We discussed how the development of the Greenway impacted their decision to walk along that particular route, but in hindsight we would have liked to see if the Greenway increased the number of cyclists along the route, but drove the walkers to other streets. The West End neighbourhood of Vancouver was a "Walker's Paradise" before the Greenway was developed, and our older adult participants had regular weekly routines that remained mostly unchanged at our 2014 follow-up discussions. Residents have different route choices in this highly walkable neighbourhood, and this limited the degree of impact that the Greenway had on the active transportation patterns of our participants. Additionally, our participants were active to begin with, prior to the Greenway development. The degree of impact of the new Greenway might have differed if our population was more sedentary prior to the development of the new infrastructure. Also, our study looked exclusively at the perspectives of the Greenway among older adults and we cannot expand our results to include the impact among younger populations such as children or adults. Individuals of different age groups (children, teenagers, adults) may have different thoughts about how the Greenway impacted their daily routines. Finally, our follow-up interviews happened only one year after the development of the Greenway. It is still unknown what the perfect length of time to measure behaviour change is after a built environment intervention. Perhaps our results would have been different if we had follow-up sessions two, three, or four years after the Greenway was built.

3.4.2. Conclusion and policy implications

While we try to create healthy neighbourhoods that support our aging population, it is important to consider the clarity of messaging, presence of enticing destinations, and geography of the location of potential built environment interventions. In short, our study gained an insight into the older adult perspectives of a new Greenway. Based on our three themes (confusion with new infrastructure, destinations and the neighbourhood environment, and physical geography), we found that building new infrastructure in an already highly walkable area has limited impacts among the aging population. So what does this mean for city planners? If a city wishes to increase active transportation for older adults, an important aspect to consider when building new infrastructure is to take into account the physical geography of the environment. In our study, the new Greenway was built along a street that had a steep slope, and the addition of benches was not enough to entice older adult walkers and cyclists to choose the Greenway as their preferred route. New infrastructure, such as a greenway, will have a greater impact in areas that have a poor Walk Score® and lack pre-existing walking routes. Future studies might wish to compare the impact of new greenways in different types of neighbourhoods, such as rural or suburban areas.

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Chapter 4.

Conclusion

This thesis sought to understand the impacts that a new Greenway had on older adult mobility. This natural experiment study used both quantitative and qualitative methodologies: we analyzed objective physical activity change using GPS monitors and accelerometers over a two-year period, and also probed potential reasons why this change occurred with qualitative interviews.

Recent natural experiment studies on greenways have shown mixed results, and few studies have focused solely on understanding the impacts of new infrastructure among the older adult population. Similar to our findings, four recent natural experiment studies also found no significant changes in activity levels after the construction of a greenway (Dorwart, 2015; Price et al., 2012; West & Shores, 2011, 2015). Amongst these, only one study focused on older adults populations (Dorwart, 2015). None of these studies used GPS to capture location-based physical activity, which is crucial to capture activity specific to the built environment change, rather than overall physical activity

In Chapter 2, we captured location-specific travel and physical activity measurements using accelerometers and GPS monitors. We did this to obtain objective measures of transportation-related activity (total trips and total physical activity). We quantified transportation-related activity (anywhere), as well as specific activity along the Greenway and along a parallel comparison corridor. We hypothesized that participants' activity would be maintained over time rather than the expected age-related declines. We also hypothesized that their weekly travel would include more activity along the Greenway instead of alternate routes. We found no significant change in weekly transportation-related physical activity levels, and contrary to our hypothesis we found a significant decrease in the number of trips older adults took along the Greenway.

Though our sample size may be small from the perspective of an epidemiological study, the number of participants was determined by the main ASAP study (n=193), and was based on an extensive recruitment plan from a population-based list of older adults in the area (see Appendix E for the recruitment flowchart). In our location-based study in Chapter 2, we could only include those with GPS data from both time periods (2012 and 2014) in order to measure changes in the number of trips and transportation-related physical activity. These 121 participants did not differ from the full ASAP analysis. In Chapter 2, our analysis dataset was each second of data captured during the trips of these participants over the course of a week (~20 per participants): this was over 3 million seconds of trip data in 2012 alone.

In Chapter 3, we analyzed the semi-structured, in-depth interviews that were conducted among a sub-sample of the older adult participants (n=13). We found three themes that suggest reasons for a decrease in trips and non-significant physical activity change along the Greenway. The participants discussed the confusion of messaging, a lack of destinations along the Greenway, and the steep slope (physical geography) of the route.

We found a large benefit by using a mixed-methods approach to explore the impacts of a new Greenway on older adult mobility. While our results in Chapter 2 showed no significant decline, we were able to understand potential reasons why their transportation-related activity or trips along the new Greenway did not increase over time in the in-depth interviews. By presenting to city planners both quantitative and qualitative results of our analysis of the Greenway, we can share not only the data on older adult physical activity, but also stories from older adults about what they think about the change to their neighbourhood. We can engage both academics and important stakeholder groups (for example, other research teams that focus on older adult mobility, the City of Vancouver, and The West End Seniors' Network) by sharing our quantitative results along with our interview data. In 2015, the ASAP study research team held an event for our participants that showcased our findings from the street audit tool

(SWEAT - R), the qualitative interviews, and the GPS location data. In 2017, we plan to share these results with the City of Vancouver and the West End Seniors' Network.

4.1. Future Directions

While this study focused on one Greenway development, these types of investments are being made in cities around the world. We will be sharing these findings at two international conferences this coming summer to promote knowledge translation (June 2017: The International Society of Behavioral Nutrition and Physical Activity annual meeting, and July 2017: The International Association of Geriatrics and Gerontology Conference). We hope our findings can inform city planners around the world about the impacts that greenways have on older adult activity, and potential factors to be aware of when creating this type of infrastructure (i.e., the importance of the slope along a new walking and cycling route, and the importance of clear messaging and presence of destinations along the route).

As we look forward to future greenway developments in the City of Vancouver and beyond, it is imperative that we learn from the findings and limitations of this study. Our research team is conducting a new natural experiment study that looks at the impacts of the Arbutus Greenway in Vancouver, BC. For this study, we are also using both quantitative methods and qualitative methods to measure the impact of this new development on older adult mobility. We are learning from the ASAP study, in particular, planning more than one follow-up period, conducting intercept surveys along the route itself, providing chargers for the GPS units, and including questions in the semi-structured interviews about specific travel patterns along the new greenway before and after its development.

We contribute relevant evidence on the impacts of this type of investment for older adults, which may be insightful for planners and decision-makers in other cities, and aid future city planners in creating healthy communities for all ages. As we found in our natural experiment study, built environment interventions have potential to support active transportation, but must be developed carefully and with close communication with the community members that will be affected by the new infrastructure. If we can create neighbourhoods that support active transportation and healthy aging, our population as a whole will thrive.

4.2. References

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Appendix A.

Abstract for Manuscript Chapter 2

Purpose: Supportive built environments can promote walking, active forms of transportation, and increased physical activity, yet little work leverages construction of new infrastructure to study this relationship. We address the gap in longitudinal data by using a natural experiment study to assess change in physical activity among older adults after the 2013 development of the Comox-Helmcken Greenway, a 2 km corridor in the West End of Vancouver.

Methods: We acquired GPS and accelerometry data from older adult residents (≥ 60 years) in the Active Streets, Active People study (n=121, mean age 69.9 ± 6.6 years at baseline). We used date and time stamps to combine GPS and accelerometry data before importing it into Geographic Information System software for analysis. We used fixed-effects linear regression models to measure within-person changes in transportation-related physical activity from 2012 to 2014. Our analysis on older adult physical activity change focused on two outcomes: 1) change in the number of outdoor trips per week (trips) and 2) change in total minutes of trip-based physical activity per week (transportation-related physical activity). We modeled our two outcomes among three geographic areas: all travel, travel along the Greenway, and travel along a parallel comparison corridor.

Results: This group of older adults was highly active, accruing a mean of 237 (±207) minutes per week of transportation-related physical activity in 2012 and a mean of 218 (±181) minutes per week in 2014. Our regression models found no significant change in total transportation-related physical activity in the three geographic areas. In particular, we did not see any significant decline in physical activity, which may be expected given age-related changes.

Conclusion: Our analysis found that the development of a Greenway in a highly walkable neighbourhood did not demonstrate a significant change in physical activity in a group of community-dwelling older adult participants. There may be a lag between infrastructure and adaptive behavioural changes. Alternatively, the setting may already be very supportive for walking, there may be other impacts aside from physical activity (e.g., travel behaviour, social connections), and it is possible that other population groups are impacted.

Appendix B.

Abstract for Manuscript Chapter 3

Background: There is increasing evidence surrounding the importance of neighbourhood design for older adult mobility, but there is a gap in qualitative studies that examine older adult perceptions of new built environment interventions. In Vancouver, BC, a new Greenway was built in 2013 with the aim to increase active transportation for individuals of all ages.

Methods: To examine the impact of this development among older adults, we interviewed 13 older adults one year before and one year after the Greenway was developed to discuss their perceptions of the new Greenway. We conducted semi-structured in-depth interviews among community-dwelling older adults that lived within 400 m of the new Greenway development. We used framework analysis to code the interviews, followed by inductive analysis to examine detailed perceptions of the Greenway. The focus of this analysis was to examine perceptions of the Greenway before it was developed, and to then examine their perceptions one year after the development.

Results: Three themes arose from the semi-structured interviews. First, residents found the new infrastructure to be confusing with regards to vehicle traffic and new biking regulations. Second, the importance of destinations was of high importance among older adults when choosing which routes to travel to get from point A to point B in their daily routines. And last, it was speculated that the physical geography (i.e. slope of the streets) comes into play when deciding how to travel through one's immediate environment.

Conclusion: In short, our study gained an insight into the older adult perspectives of a new Greenway. While we try to create healthy neighbourhoods that support our aging population, it is important to consider the clarity of messaging, presence of enticing destinations, and geography of potential built environment interventions.

Appendix C.

SWEAT - R Street Audit Tool

		Segment number					
Observer ID							
Date (mm/dd/yy)							
Segment ID							
Mini-park street segment		yes = 1; no = 2					
Start time							
Temperature (°F or °C)							
Is it raining?		yes = 1; no = 2					
Answer questions 1-5 at the NW corner of the segment							
NW Corner of Segment							
1a Is there an **intended** NW crossing area for pedestrians?	1	yes = 1; no = 2					
1b Is the crossing area marked? (ie, painted lines, zebra striping, and different road surfaces/paving)	2	yes = 1; no = 2; N/A (no intended crossing) = 99					
2 Determine whether any of these **traffic/pedestrian signals and systems** are provided. Mark all that apply.							
Traffic signal	3	yes = 1; no = 2; N/A (no intended crossing) = 99					
Stop sign	4	yes = 1; no = 2; N/A (no intended crossing) = 99					
Yield sign	5	yes = 1; no = 2; N/A (no intended crossing) = 99					
Pedestrian crossing sign	6	yes = 1; no = 2; N/A (no intended crossing) = 99					
Pedestrian activated signal	7	yes = 1; no = 2; N/A (no intended crossing) = 99					
Pedestrian signal (not activated by pedestrian)	8	yes = 1; no = 2; N/A (no intended crossing) = 99					
Pedestrian overpass/underpass/bridge	9	yes = 1; no = 2; N/A (no intended crossing) = 99					
3 Time **traffic signal** (Green) or **pedestrian signal** (Walk).	10	seconds; NA (no signal) = 9898; N/A (no intended crossing) = 9999					
4a Does this end of the segment have **ramps or curb cuts**?	11	One side = 1; Both sides = 2; None = 3; NA (no sidewalk/curb) = 98					
4b Determine whether the following **curb cut features** are present.							
Grooves or bumps	12	yes = 1; no = 2; NA (no curb cuts) = 98					
Color contrast with ground surface	13	yes = 1; no = 2; NA (no curb cuts) = 98					

Material contrast with ground surface	14	yes = 1; no = 2; NA (no curb cuts) = 98					
Broad apron curb cuts	15	yes = 1; no = 2; NA (no curb cuts) = 98					
5 Measured maximum **curb height** at this segment end.	16	inches; NA (curb cuts/no sidewalk) = 98					
		Segment number à					
Answer questions 6-10 at mid-segment crossing area.							
Mid-Block Crossing Area							
6a Is there a mid-block alleyway street divide?	17	yes = 1; no = 2					
6b Is there an intended mid-block crossing area for pedestrians?	18	yes = 1; no = 2					
6c Is the crossing area marked? (ie, painted lines, zebra striping, and different road surfaces/paving)	19	yes = 1; no = 2; N/A (no intended crossing) = 99					
7 What type of traffic/pedestrian signal(s)/system(s) is/are provided? Mark all that apply.							
Traffic signal	20	yes = 1; no = 2; N/A (no intended crossing) = 99					
Stop sign	21	yes = 1; no = 2; N/A (no intended crossing) = 99					
Yield sign	22	yes = 1; no = 2; N/A (no intended crossing) = 99					
Pedestrian crossing sign	23	yes = 1; no = 2; N/A (no intended crossing) = 99					
Pedestrian activated signal	24	yes = 1; no = 2; N/A (no intended crossing) = 99					
Pedestrian signal (not activated by pedestrian)	25	yes = 1; no = 2; N/A (no intended crossing) = 99					
Pedestrian overpass/underpass/bridge	26	yes = 1; no = 2; N/A (no intended crossing) = 99					
8 Time traffic signal (Green) or pedestrian signal (Walk).	27	seconds; NA (no signal) = 9898; N/A (no intended crossing) = 9999					
9a Does the crossing area have ramps or curb cuts?	28	One side = 1; Both sides = 2; None = 3; NA (no sidewalk/curb) = 98 N/A (no intended crossing) = 99					
9b Determine whether the following curb cut features are present.							
Grooves or bumps	29	yes = 1; no = 2; NA (no curb cuts) = 98 N/A (no intended crossing) = 99					
Color contrast with ground surface	30	yes = 1; no = 2; NA (no curb cuts) = 98 N/A (no intended crossing) = 99					
Material contrast with ground surface	31	yes = 1; no = 2; NA (no curb cuts) = 98					

		N/A (no intended crossing) = 99					
Broad apron curb cuts	32	yes = 1; no = 2; NA (no curb cuts) = 98 N/A (no intended crossing) = 99					
10 Measured maximum curb height.	33	inches; NA (curb cuts/no sidewalk) = 98 N/A (no intended crossing) = 99					
Answer questions 11-48 while walking along segment							
Buffer Area							
11a Is there a buffer zone between sidewalk and street ? (e.g., landscaped strip, trees, benches, etc.)	34	1 side = 1; 2 sides = 2; No sides = 3 NA (no sidewalk) = 98					
11b Measured maximum buffer zone width on segment.	35	inches; NA (no buffer zone) = 9898					
12a Count mature trees in the buffer zone and/or on median (if present).	36	count					
12b Are all mature trees on one side of the segment?	37	yes = 1; no = 2; NA (no trees) = 98					
Land Uses/Buildings							
13 Mark the types of **land uses** present on this segment.							
Residential							
Single family home -detached	38	yes = 1; no = 2					
Single family home/duplex -attached (2 or more units)	39	yes = 1; no = 2					
Low-rise multi-family housing (less than 5 stories)	40	yes = 1; no = 2					
High-rise multi-family housing (5 or more stories)	41	yes = 1; no = 2					
Mobile homes	42	yes = 1; no = 2					
Residential, other	43	yes = 1; no = 2					
Recreational/Leisure/Fitness							
Gym/fitness center (also includes yoga/pilates studios, etc.)	44	yes = 1; no = 2					
Movie theater/rental	45	yes = 1; no = 2					
Recreational, other	46	yes = 1; no = 2					
Public/Civic Building							
School, college, or university	47	yes = 1; no = 2					
Community center or library	48	yes = 1; no = 2					
Museum, auditorium, concert hall, theater	49	yes = 1; no = 2					
Post office	50	yes = 1; no = 2					
Police station, courthouse, Department of Motor Vehicles	51	yes = 1; no = 2					
Public building, other	52	yes = 1; no = 2					
Institutional							
Religious institution (church, temple, mosque, etc.)	53	yes = 1; no = 2					
Hospital	54	yes = 1; no = 2					
Institutional, other	55	yes = 1; no = 2					
Commercial							
Restaurants	56	yes = 1; no = 2					

Grocery store / Convenience store	57	yes = 1; no = 2					
Retail stores	58	yes = 1; no = 2					
Bank/financial service	59	yes = 1; no = 2					
Pharmacy/Drug Store	60	yes = 1; no = 2					
Hotel/hospitality	61	yes = 1; no = 2					
Car dealership	62	yes = 1; no = 2					
Gas/service station	63	yes = 1; no = 2					
Commercial, other	64	yes = 1; no = 2					
Office/Service							
Offices	65	yes = 1; no = 2					
Health clinics, Medical facilities, Medical offices (not hospitals)	66	yes = 1; no = 2					
Beauty/Barber Shop, Nail Salon	67	yes = 1; no = 2					
Service facilities (ie, insurance offices, funeral homes, dry cleaners, laundromats)	68	yes = 1; no = 2					
Office/service, other	69	yes = 1; no = 2					
Other	70	yes = 1; no = 2					
Industrial/Manufacturing							
Harbor/marina/boat launch	71	yes = 1; no = 2					
Undeveloped land	72	yes = 1; no = 2					
Agricultural land, ranch, farming	73	yes = 1; no = 2					
Nature feature (ie, beach, river, lake, forest)	74	yes = 1; no = 2					
Parking lot	75	yes = 1; no = 2					
Other	76	yes = 1; no = 2					
14 What is the predominant **building height**?	77	no predominant height = 1; 1-2 stories = 2; 3-4 stories = 3; 5 or more = 4; NA (no buildings) = 98					
15 Do the buildings in this segment contain **vertical-mixed use**?	78	yes = 1; no = 2; NA (no buildings>1 story) = 98					
16 Are there signs signifying that buildings on this segment are **senior oriented**?							
Senior housing (e.g. independent living, assisted living, retirement home)	79	yes = 1; no = 2; NA (no buildings) = 98					
Senior activities (e.g. senior centers, adult day care)	80	yes = 1; no = 2; NA (no buildings) = 98					
17 Determine whether any of the following **gathering places** are on this segment							
Restaurants	81	yes = 1; no = 2					
Coffee shops	82	yes = 1; no = 2					
Bar/brewery	83	yes = 1; no = 2					
Libraries/bookstores	84	yes = 1; no = 2					
“Corner” store	85	yes = 1; no = 2					
Art galleries, museums, theatres	86	yes = 1; no = 2					
Farmers market	87	yes = 1; no = 2					
18 Determine whether any of these **distinctive retail types** are present (focusing on the form of the building).							
Big box shops (includes super stores or warehouse stores)	88	yes = 1; no = 2					
Shopping mall	89	yes = 1; no = 2					

Outdoor mall	90	yes = 1; no = 2						
Strip mall/row of shops	91	yes = 1; no = 2						
Drive-thru	92	yes = 1; no = 2						
Public Space								
19 Mark the types of **public space** present on this segment.								
Plaza /square /courtyard	93	yes = 1; no = 2						
Public garden	94	yes = 1; no = 2						
Community garden	95	yes = 1; no = 2						
Park/playground	96	yes = 1; no = 2						
Outdoor fitness/recreation area (ie, playing field, walking trails)	97	yes = 1; no = 2						
Public Space, other (not benches)	98	yes = 1; no = 2						
20a How many **benches** (ie., public and/or transit benches) are present for the public to rest on?	99	count						
20b Do any of the benches on this segment have the following **features**?								
Back support	100	yes = 1; no = 2; NA (no benches) = 98						
Armrest	101	yes = 1; no = 2; NA (no benches) = 98						
Covered seating	102	yes = 1; no = 2; NA (no benches) = 98						
Color contrast with ground surface	103	yes = 1; no = 2; NA (no benches) = 98						
Clean	104	yes = 1; no = 2; NA (no benches) = 98						
Undamaged	105	yes = 1; no = 2; NA (no benches) = 98						
21 Determine the quality of **public spaces** on this segment	106	low quality = 1; neutral = 2; high quality = 3; N/A (no public space) = 98						
Sidewalks								
22 Are sidewalks **presen**t?	107	1 side = 1; 2 sides = 2; No sides = 3						
23 Are sidewalks **continuous**?	108	1 side = 1; 2 sides = 2; No sides = 3; NA (no sidewalks) = 98						
Sidewalks								
24 Sidewalk **material** (check all that are present)								
Concrete/Asphalt	109	yes = 1; no = 2; NA (no sidewalks) = 98						
Brick/Tile	110	yes = 1; no = 2; NA (no sidewalks) = 98						
Dirt/Gravel/Grass/Lawn	111	yes = 1; no = 2; NA (no sidewalks) = 98						
Other	112	yes = 1; no = 2; NA (no sidewalks) = 98						
25a What is the **condition** of the sidewalk?	113	poor = 1; moderate = 2; good = 3; NA (no sidewalks) = 98						
25b Is any portion of the sidewalk **under repair**?	114	yes = 1; no = 2; NA (no sidewalks) = 98						
26 Are there sidewalk **obstructions** blocking pedestrian pathways?	115	yes = 1; no = 2; NA (no sidewalks) = 98						

27 Determine how much of the sidewalk is covered by these features that provide protection from sun, rain, and/or snow.							
Arcades	116	some/most covered = 1; no/little covered = 2; NA (no sidewalk) = 98					
Awnings	117	some/most covered = 1; no/little covered = 2; NA (no sidewalk) = 98					
Other	118	some/most covered = 1; no/little covered = 2; NA (no sidewalk) = 98					
28 Measured minimum **sidewalk width** on segment.	119	< 4 feet = 1; 4 -6 feet = 2; > 6 feet = 3; NA (no sidewalks) = 98					
29 What is the **slope** of this segment?	120	flat/gentle = 1; moderate = 2; steep = 3					
Street Characteristics							
30 How many **lanes** of traffic are on this segment?	121	1 lane = 1; 2 lanes = 2; 3 lanes = 3; 4 or more lanes = 4					
31 Is this a **one-way** or two-way street?	122	one-way = 1; two-way = 2					
32 Street **material** (check all that are present)							
Concrete/Asphalt	123	yes = 1; no = 2					
Brick/Tile	124	yes = 1; no = 2					
Dirt/Gravel/Grass/Lawn	125	yes = 1; no = 2					
Other	126	yes = 1; no = 2					
33a What is the **condition** of the street?	127	poor = 1; moderate = 2; good = 3					
33b Is any portion of the street **under repair**?	128	yes = 1; no = 2					
34 Is there a designated **bike lane** in the street?	129	yes = 1; no = 2					
35 Are any of these **traffic-calming devices** on the segment?							
Traffic circle	130	yes = 1; no = 2					
Median	131	yes = 1; no = 2					
Speed bumps/humps	132	yes = 1; no = 2					
Marked crosswalk	133	yes = 1; no = 2					
Sidewalk extensions	134	yes = 1; no = 2					
Signs for pedestrians/children/etc (e.g., Pedestrian crossing sign, playground sign)	135	yes = 1; no = 2					
Signs for school speed zone (e.g., School Speed 20 When Children Present)	136	yes = 1; no = 2					
Signs for traffic activity (e.g., Stop Ahead, bikes on roadway)	137	yes = 1; no = 2					
Other	138	yes = 1; no = 2					
36 Does this segment end in a **cul-de-sac** or **dead end**?	139	No = 1; Yes, without pedestrian thruway = 2; Yes, with pedestrian thruway = 3					
Street Life							
37a. Count **vehicle scale streetlights** on the segment.	140	count					

37b. Count **pedestrian/sidewalk scale streetlights** on this segment	141	count					
38 Is there a **transit stop** present on the segment?	142	yes = 1; no = 2					
39 Does the **transit stop** have a **light**?	143	yes = 1; no = 2; NA (no transit stop) = 98					
40 How many residential buildings on this segment have **front porches**? (porches you can sit on)	144	few/none = 1; some =2; all/most = 3; NA (no residential buildings) = 98					
41 Are there **outdoor dining areas** (e.g. cafes, outdoor tables at coffee shops or plazas, etc.) located on or open to the segment	145	yes = 1; no = 2					
42 Are there publicly accessible **restrooms/washrooms** on the segment?	146	yes = 1; no = 2					
43 Is there parking for the general public anywhere on the segment?	147	yes = 1; no = 2					
Maintenance							
44 How many **buildings** on this segment are in **good condition**?	148	few/none = 1; some = 2; all/most = 3; NA (no buildings) = 98					
45 How many buildings on this segment have **windows with bars**?	149	few/none = 1; some = 2; all/most = 3; NA (no buildings) = 98					
46 How many **yards** on this segment are **well-maintained**?	150	few/none = 1; some = 2; all/most = 3; NA (no yards) = 98					
47 Is there **litter, graffiti, broken glass**, etc. on the segment?	151	Yes, dominant feature = 1; Yes, but not dominant feature = 2; None or almost none = 3					
48 Are there **abandoned buildings or lots** on this segment?	152	none = 1; few = 2; some/a lot = 3					
End time							
Difficulty		very easy = 1; easy = 2; average = 3; difficult = 4; very difficult = 5					
NOTES							

Appendix D.

ASAP Qualitative Interview Guide

ASAP- Qualitative Component
Interview Guide- October 26, 2012
Version 1

Purpose: This first section of this document outlines the questions that we will ask each participant in the qualitative interview.
The subsequent 'field notes section' will be completed by the interviewer within 24 hours of the interview. This is a standard field notes template used for in-depth interviewing and ethnographic studies to track the interviewing process (e.g. it tracks the length of the interview, interruptions, technical problems, etc.). Tracking things such as the weather, who was present at the interview, and body language are necessary for crafting the "complete picture" of the interview (e.g. the weather may factor into whether or not a participant decided to participate in the walking portion of the interview and the presence of another individual at the interview, such as a family member in another room, may impact how the participant answered some questions). This comprehensive tracking is an essential component of ethnographic research, and enhances to overall rigour of the study. These field notes are a product of the chosen methodology, not necessarily the research question.

Section A: Personal Information & Activity

Opening Question:

Starting with when you get up, can you please talk me through a typical day for you – think about it like a story: tell me - **what** you do, **where** you go, and **who** you see?

Probes:

What you do:

What are your regular activities?

    How long have you been doing these activities?

Where you go:

    Where do these activities take place?
    How do you get there? (Probe on route choice, mode of transportation and type of travel)
    Does anyone help you get around? (does anyone drive you places? walk with you? etc.)

Do you have any hobbies, favourite activities, or belong to any groups?

    How long have you been doing your favourite activities?
    How regularly do you do these favourite activities?
    Where do these activities take place?

What do you enjoy about your favourite activities?
Do you work or volunteer outside of the home?

Are there any activities that you can't do (e.g. bathing and other self-care activities)?
Why can't you do it (probe: health issues)?

Who you see:
Who do you see or talk to on a typical day?
Do you have family living nearby? (how often do you see them or talk to them? When you do get together, what do you do?)
Do you have friends living nearby? (how often do you see them or talk to them? When you do get together, what do you do?)

Current Health & Barriers to Physical Activity:
Do any health issues, or caregiving responsibilities limit your ability to do what you want to do in daily life? (Probe: Current Health & Barriers to Physical Activity, do these prevent you from getting around the home or neighbourhood)?
Is this a new issue since you participated in the previous ASAP data collection session?

Can you sum-up/ explain – what gets you out the door?

Section B: Physical & Built Environment

Neighbourhood Questions:
Now I would like to ask you some questions about the neighbourhood that you live in. I am also going to invite you to draw on this blank piece of paper with these pens [take out paper and pens and place on table] if you feel it helps to illustrate what you are saying. This activity will become clearer as we talk about certain things during this conversation.

What made you decide to live in this neighbourhood?

Are there places in your current neighbourhood that you like to go? (Probe for parks, green spaces, walking trails, shops, businesses, services) How do you typically get there? What do you do when you get there?
Would you like to draw any routes or landmarks on this paper [in black]?

- *If they say yes – suggest that they first draw an image/ symbol to represent the location of their house*
- *If after that they still seem hesitant, suggest they draw a basic grid of where they go*
- *Use judgement of degree of map 'co-production.'*
- *As standard procedure, give them the black pen, and make additions with the green and red pens*
- *While they are talking ask, for example* ***'can we label that park as "1"*** *(you may have to write a small number on their map),* ***so we can remember what this map tells us***
- **The conversation may naturally progress to services without a pause in focus on the drawing*

The Service Community:

I would like to ask a few questions specifically about the availability and accessibility of services in your neighbourhood. Services can include things like banks, shops and medical services.

Are all of the services that you need nearby? (Probe for which services are present and which are missing)

Which services are easiest to get to? (Probe for how they get there, how often they go there, etc.)

Which services are most difficult to get to? (Probe for what makes it difficult: physical obstacles, hills, safety issues, etc.)

> *[Proceed with drawing only if they seemed comfortable with the activity during the previous questions]*
>
> ***Are you able to illustrate where these services on the piece of paper? Location does not have to be exact. If these are very important services please make them bigger on your map.***

Are there places in your neighbourhood that you avoid? Why or why not? (Probe for physical obstacles, hills, safety issues etc.)

> ***Would you like to illustrate any places that you avoid or don't like on your map? Let's label them with numbers as we talk***

Is there anything missing from your neighbourhood that you would like it to have (Probe for parks, green spaces, walking trails, shops, businesses, services)?

Safety:

I would like to ask a few questions specifically about your perceptions of your neighbourhood safety….

Do you have any fears or concerns about leaving the house?

Overall do you feel safe in your neighbourhood?

> What helps you to feel safe? (Probe for lighting, traffic, other people, atmosphere, time of day)
>
> What makes you feel unsafe? (Probe for lighting, traffic, other people, atmosphere, time of day)
>
> - *If keen, continue adding to map*

What, in anything, would make you feel safer in your neighbourhood?

Overall Walkability:

Do you think that your neighbourhood is walkable? What makes you say that?

What, if anything, about your neighbourhood encourages or motivates you to walk?

Is this neighbourhood is more or less walkable than the last neighbourhood you lived in? Why?

Neighbourhood improvements:

If you were told that there was going to be some money to upgrade any area in your neighbourhood….and,

> If city planners could do ONE thing to make your neighbourhood easier for you to get around, what would it be?
>
> If city planners could do ONE thing to make your city easier for you to get around, what would it be?

Before I ask this next question I would like to re-emphasize that I do not work for the City and that your answer is confidential.

From your perspective, do you currently see Comox and Helmcken Sts. as either preferred walking routes or destinations (i.e to sit on benches)?
Knowing that the City of Vancouver is going to be investing in improvements along the Comox St. and Helmcken:
What is the most important thing that they could improve along that route? Or if you think there should not be improvements, why is that?
Do you have any concerns about the improvements?

Neighbourhood Social Connections:
I'd like to know a bit about you and your neighbours ….
Do you feel comfortable and included in your neighbourhood community? [probe: based on age – cultural background]
Do you feel your community is inclusive of people of different ages and cultural backgrounds? Why?
Do you know your neighbours? [Probe: why do you think that is?]
If you were walking down the street and saw one of your neighbours, what would happen? What would you do? (Probe: If yes, how does this make you feel? If no, why do you think this is?
If you had an emergency, would you feel comfortable asking any of your neighbours for help? (Probe: Who would you go to? Under what circumstances? If no, why not?)

Demographics:
Now, just to finish-up, I have a few quick "tick-box" questions to go over with you:
Do you live alone?

- Yes
- No

If no, who do you live with?

- Spouse/Partner
- Daughter/Son
- Niece/nephew
- Other relative
- Friend
- Other

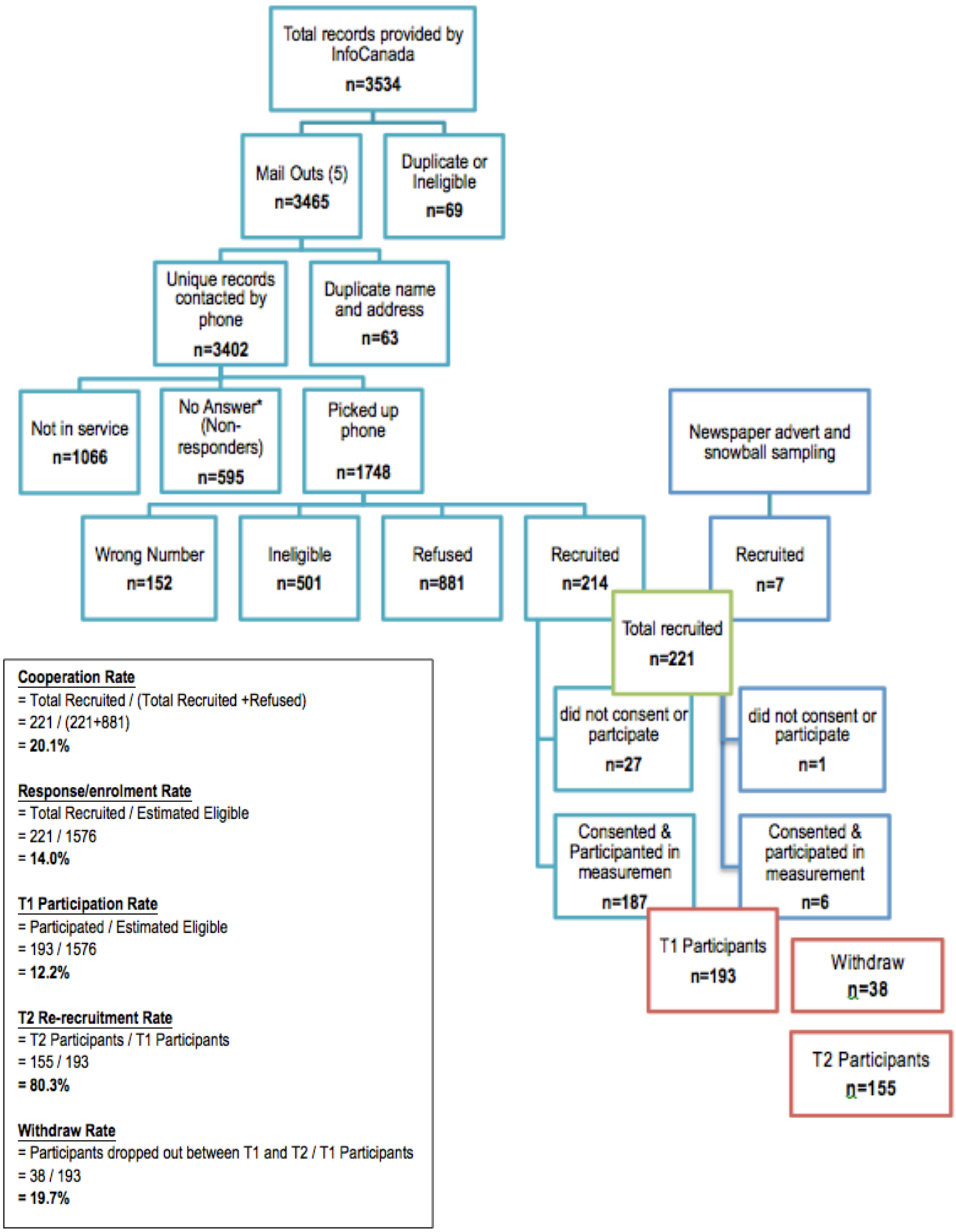
Map checklist

- Landmarks on map are clearly marked with numbers or words
- Map is labelled with symbol for orienting north
- Paper clip with participant ID attached
- Explain degree of co-participation and pen colours used by each person here: __________

Conclusion:
Thank you so much for your time and insights. Is there anything else that you would like to add to our discussion today?

Appendix E.

Flowchart of Participants Included in the ASAP Study



Appendix F.

ASAP Consent Form

THE UNIVERSITY OF BRITISH COLUMBIA AND SIMON FRASER UNIVERSITY
Active Streets, Active People (ASAP):
An Integrated Community Partnership to Enhance the Health and Mobility of Older Adults

Information Letter and Consent Form

Principal Investigator: Dr. Heather McKay, PhD
Professor
Department of Orthopaedics, Faculty of Medicine, UBC

Contacts:	
Mrs. Suzanne Therrien, MPH Project Coordinator Department of Orthopaedics, Faculty of Medicine Centre for Hip Health and Mobility University of British Columbia	**Dr. Joanie Sims-Gould, RSW, PhD** Research Associate Knowledge Translation Centre for Hip Health and Mobility Vancouver Coastal Health Research Institute

Co-investigators:

Dr. Meghan Winters, PhD
Assistant Professor
Faculty of Health Sciences, Simon Fraser University
Researcher, Center for Hip Health and Mobility,
Vancouver Coastal Health Research Institute

Dr. Maureen Ashe, PT, PhD
Assistant Professor
Department of Family Medicine, Faculty of Medicine
Centre for Hip Health and Mobility
University of British Columbia

Dr. Atiya Mahmood, Ph.D.
Assistant Professor
Environmental Gerontology, Gerontology Department
Simon Fraser University

Dr Antonio Paez
Associate Professor
School of Geography and Earth, McMaster University

Dr Philippa Clarke
Research Assistant Professor,
Institute for Social Research, University of Michigan

The primary purpose of this study is to understand supporting and limiting factors that influence older adults' ability to move about their neighbourhood and participate in their community.

Should you choose to participate in the study you will be asked to participate in an initial measurement session. This measurement session will take approximately 60 minutes and a detailed description is included on page 4.

You will also be asked to wear an accelerometer, a small device worn on your waist that monitors physical activity, and record your journeys taken in a travel diary for seven days. You will also be invited to carry a small Global Positioning System (GPS) device.

If after reading the study description, you would like to learn more about the study, please call our research co-coordinator Suzanne Therrien. She will be pleased to answer any questions and provide you with more details about the study. Should you have any immediate questions about this study please contact co-investigator Dr. Joanie Sims-Gould at the University of British Columbia. The Primary Investigator for this study is Dr. Heather McKay at the University of British Columbia. Thank you for your interest in the study.

THE UNIVERSITY OF BRITISH COLUMBIA AND SIMON FRASER UNIVERSITY
Active Streets, Active People (ASAP):
An Integrated Community Partnership to Enhance the Health and Mobility of Older Adults

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Consent form

Introduction
You are being invited to take part in this research study because you meet participation requirements.

Your participation in this study is entirely voluntary, so it is up to you to decide whether or not to take part in this study. Before you decide, it is important for you to understand what the research involves. This consent form will tell you about the study, why the research is being done, what will happen to you during the study and the possible benefits, risk and discomforts.

If you wish to participate, you will be asked to sign this form. If you do decide to take part in this study, you are still free to withdraw at any time and without giving any reasons for your decision. If you do not wish to participate, you do not have to provide any reasons for your decision not to participate nor will you lose the benefit of any medical care to which you are entitled or are presently receiving.

Please take time to read the following information carefully before you decide.

Who is conducting this study?
This study is being conducted by Dr. Heather McKay, Dr. Joanie Sims Gould at the University of British Columbia and Dr. Meghan Winters at Simon Fraser University and the Centre for Hip Health and Mobility.

Background
Older adults' travel is constrained geographically and as they age, they become more reliant on their local neighbourhood. Developing 'age-friendly' physical environments that increase mobility and liveability can enhance the health of older adults.

What is the purpose of the study?
The main objective of this study is to evaluate mobility and social interactions of older adults before and after changes to neighbourhood streets and environments.

Who can participate in this study?
You can participate in this study if you are an English-speaking man or woman aged 60 years and older, and live along the Comox-Helmcken Corridor in the West End of downtown Vancouver.

Who should not participate in this study?
You should not participate in this study if you are unable to leave your residence; plan to move out of your residence in the next two years; and/or cannot consent to be involved in research.

What does the study involve?
This study is taking place in neighbourhoods surrounding the Comox-Helmcken Greenway and at community organizations in Downtown Vancouver. We plan to enroll 200 participants. It will take approximately 2 years to complete the study from the time you agree to participate.

Assessments
You will be asked to attend a 1 hour measurement session. During this time you will be asked questions about your medical history, current physical activity level, your neighbourhood and your daily journeys.
We will also ask you to wear an accelerometer for 7 days. Accelerometers are small devices worn at the waist. The accelerometer tells us how active you are (i.e. sitting, walking) as well as the number of steps you take per day. For these same 7 days we will also ask you to record your journeys in a travel diary.
You will also be asked to carry a small Global Positioning System (GPS) device with you for up to 7 days. A GPS device helps us understand where you participate in physical activity and how you travel around your neighbourhood. The GPS device is a small device that can be worn on a keychain. The GPS device will continually monitor and record where you are and your movements at all times that you are wearing the device.

You will be asked to participate in an additional appointment in 2 years. This is aimed at understanding how changes to your community space impact your health.

You do not have to answer any questions at the initial or future appointments if you are not comfortable with them.

How much of my time is required?
If you agree to participate in this study, the following amount of your time is required:

- 2 hours total for the initial measurement session and the additional appointment over the course of 2 years.
- Approximately 15 minutes each day for fourteen days to complete the travel diary and physical activity information over the course of 2 years.

Therefore, the total amount of time required is approximately 5.5 hours for the interviews and travel behaviour measurements over the course of two years.

What are the possible harms and side effects of participating?
During the study period you will be asked to carry the GPS device and accelerometer with you wherever you travel. Information recorded by the GPS device can include personal locations (i.e. home), however confidentiality is of upmost concern and no information that discloses your identity will be released. There are no physical harms or side effects associated with either device.

What are the benefits of participating in this study?
No one knows whether or not you will benefit from this study. There may or may not be direct benefits to you from taking part in this study. We hope that the new knowledge we obtain from this study can be used in the future to help promote and enable the mobility of older adults.

What happens if I decide to withdraw my consent to participate?
Your participation in this research is entirely voluntary. You may withdraw from this study at any time and no reason for withdrawal needs to be provided. If you decide to enter the study and to withdraw at any time in the future, there will be no penalty or loss of benefits to which you are otherwise entitled, and your future medical care will not be affected. If you choose to enter the study and then decide to withdraw at a later time, all data collected about you during your enrolment in the study will be retained for analysis. You do not waive any of your legal rights by signing this consent form. If you wish to withdraw please contact Mrs. Suzanne Therrien

What happens after the study is finished?
Once your participation in the study is concluded, you will be provided with a one page summary of the general study findings. No personal feedback will be provided.

What will the study cost me?
You will not incur any personal expenses as a result of participating in the study. You will receive a $20 gift card as compensation for your time.

Will my taking part in this study be kept confidential?
Your confidentiality will be respected. No information that discloses your identity will be released or published without your specific consent to this disclosure. However, research records may be inspected in the presence of the investigator by representatives of the SFU or UBC Research Ethics Board for the purpose of monitoring the research. The study coordinator will have access to your name and phone number for the purposes of contacting you to set up an appointment. However, no records, which identify you by name or initials, will be allowed to leave the investigators' offices. For the purpose of research analysis, de-identified GPS and accelerometer records may be temporarily stored or accessed outside Canada. By consenting to participate in

the group-based measurement session, you confirm that any information you encounter will be kept confidential and not revealed to parties outside the group. Although the objective is to maintain confidentiality, it cannot be guaranteed.

Who do I contact if I have questions about the study during my participation?
The primary investigator for this study is Dr. Heather McKay however if you have any questions or desire further information about this study before or during participation, you can contact our primary contact **Mrs. Suzanne Therrien** or Dr. Joanie Sims-Gould.

Who do I contact if I have any questions or concerns about my rights as a subject during the study?
If you have any concerns about your rights as a research subject and/or your experiences while participating in this study, contact the Research Subject Information Line at the University of British Columbia, Office of Research Services at (604) 822-8598 and/or Simon Fraser University Office of Research Ethics.

SUBJECT CONSENT TO PARTICIPATE

I have read and understood the subject information and consent form.
I have had sufficient time to consider the information provided and to ask for advice if necessary.
I have had the opportunity to ask questions and have had satisfactory responses to my questions.
I understand that all of the information collected will be kept confidential and that the result will only be used for the scientific objectives.
I understand that de-identified information collected may be temporarily stored and accessed outside of Canada for the purpose of analysis and the results will only be used for scientific objectives.
I understand that my participation in this study is voluntary and that I am completely free to refuse to participate or to withdraw from this study at any time without changing in any way the quality of care that I receive.
I understand that I am not waiving any of my legal rights as a result of signing this consent form.
I understand that there is no guarantee that this study will provide any benefits to me.
I have read this form and I freely consent to participate in this study.
I have been told that I will receive a dated and signed copy of this form.

I would like to be contacted for future studies. ☐ **Yes** ☐ **No**

We may use the data collected in this study for further analysis in future studies interested in enhancing the health and mobility of older adults. For example, we may examine this data in conjunction with an individual follow-up interview.

I understand that my data may be used in this manner. ☐ **Yes** ☐ **No**

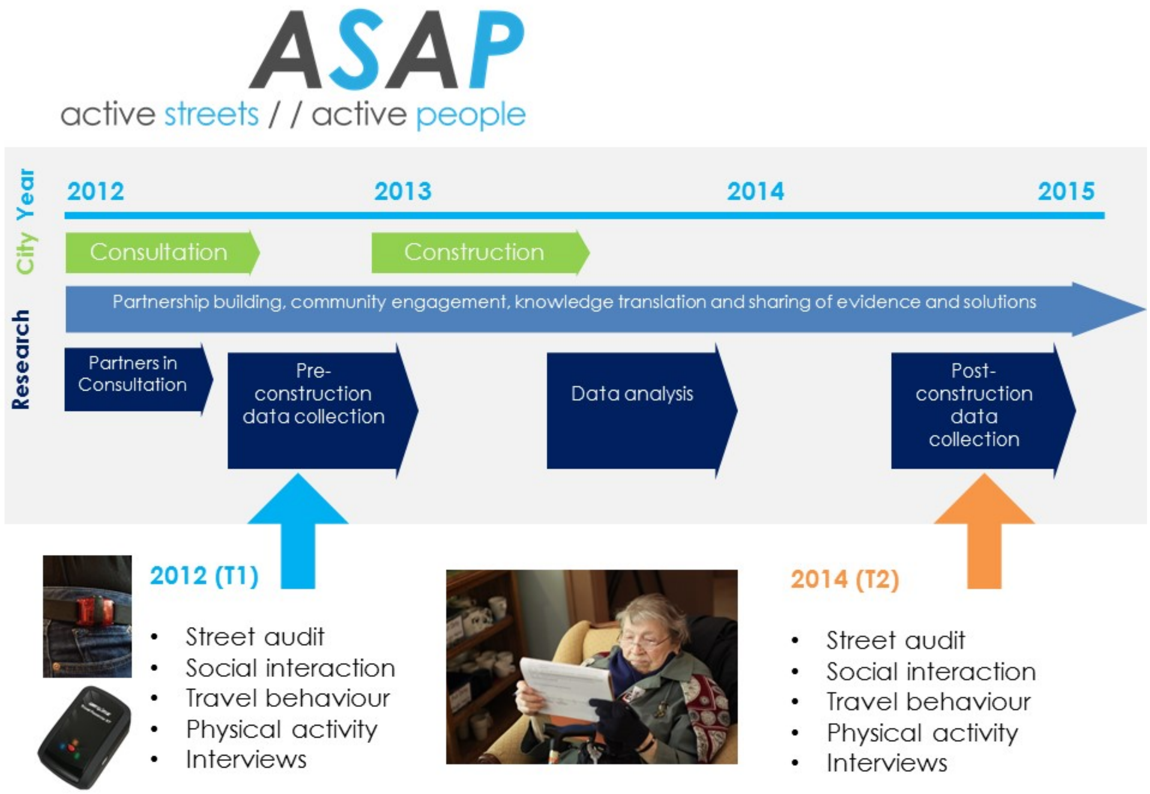
Signatures

Printed name of subject **Signature** **Date**

Printed name of principal investigator/ Designated representative **Signature** **Date**

Appendix G.

ASAP Study Timeline



Appendix H.

Participant Components Completed

Recruited T1
n=221

T1 Recruited but not consented:
n=28
n=4, left town
n=10, major life/health event
n=3, no show and no response to calls
n=8, no longer interested
n=2, rescheduled and did not show
n=1, displeased w/ proposed

T1 Consented & Participated
n=193

T2 Participated
n=155

T2 Attrition Reason,
N=38
n=8 refused
n=7 too busy
n=6 number not in service
n=5 no response
n=4 moved
n=3 health/illness
n=2 caretaking responsibilities
n=1 reported death
n=1 did not call to rebook
n=1 repeated no show & no response to calls

MB, TD, ACC, GPS
n=171

MB & TD
n=184

TD & ACC
n=174

ACC & GPS
n=171

Measurement Booklets (MB)
n=193

Travel Diaries (TD)
n=184
n=2, wheelchair, not given
n=7, failed to complete at least 1 day of diary
n=3, only 1 day filled out
n=5, recording issues

n= 5837, valid trips for analysis & reporting

Accelerometry (ACC), Based on 60s epoch
n=174, Valid Acc Files (>=3d)

n=9, Failed Acc Files (<3d)
n=10, no data *(2 in wheelchair and not given, 6 refused, 2 hardware error)*

Global Positioning System (GPS)
n=178
n= 6, refused monitor:
n=2, not given monitor (wheelchair):
n=7 hardware error (no data on device)

Measurement Booklets (MB)
n=155

Travel Diaries (TD)
n=138
n= 1, wheelchair (given)
n=38 dropouts
n=15 refused
n=1 returned empty
n=1 not returned

n=4408 valid tripe for analysis and reporting

Accelerometry (ACC), Based on 60s epoch
***n=135* Valid Acc Files (>=3d)**

n=3 Failed Acc Files (<3d)
n=17, no data *(1 wheelchair and not given, 15 refused, 1 monitor not returned)*

Global Positioning System (GPS)
n=136
n= 38 withdrew from T1
n= 15 refused monitor
n=1 hardware error (no data on device)
n=1 monitor not returned
n=2 invalid data

MB & TD
n=137

TD & ACC
n=134

ACC & GPS
n=135

MB, TD, ACC, GPS
n=133

Qualitative Interviews
n=28 transcripts *(26 sessions, 2 with 2 participants)*

Qualitative Interviews
n=23 transcripts *(20 sessions, 3 with 2 participants)*