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A Mixed Methods Approach to Identifying Barriers and Supports to Physical Activity in Adults Following Residential Relocation

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A Mixed Methods Approach to Identifying Barriers and Supports to Physical Activity in Adults Following Residential Relocation

by

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A THESIS

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Abstract

Using a systematized review of qualitative studies and a quasi-longitudinal mixed-methods analysis of primary data, this thesis explored the built environment's influence on physical activity among adults. The systematized review provided insight into functional, aesthetic, destination, and safety characteristics' that are associated with physical activity. Sociodemographic characteristics were also found to affect the built environment-physical activity relationship. In the mixed-methods analysis, quantitative data suggested positive associations between self-reported changes in transportation walking and cycling and improvements in objectively measured neighbourhood walkability (Walk Score®) following residential relocation. Findings from the qualitative semi-structure interviews reinforced the quantitative findings and specifically highlighted the importance of having access to safe walking and cycling paths and nearby destinations that support active transportation. The interview data also suggested neighbourhood opportunities that allow adults to connect with community, family and the environment while being active supported enjoyable physical activity. Notably, some participants also reported using time spent on active transportation to compensate for changes in time spent in leisure physical activity. The thesis findings have the potential to inform urban planning and policy for improving physical activity and in turn health in adult populations.

Preface

Grazia Salvo(GS) worked collaboratively with supervisor and committee members, Dr. Gavin McCormack (GM), Dr. Patricia Doyle-Baker (PDB) and Dr. Bonnie Lashewicz (BM) to design the study. GS conducted the review, data collection, analysis and interpretation of results and led the writing of the manuscripts. Committee members provided additional expertise and final approval for the project.

Chapter 2 (Manuscript)

Salvo G, Lashewicz BM, Doyle-Baker PK, McCormack GR. *Neighborhood built environment influences on physical activity among adults: A systematized review of qualitative evidence*. Has been formatted for submission to peer reviewed journal PLOS One (January 2018). All co-authors have provided permission to include the manuscript in this thesis (Appendix A).

GS refined the key search terms, undertook the database search and collaborated with co-authors to decide which papers met inclusion criteria. GS conducted data extraction, tabulated the data and constructed the initial draft of the manuscript. GS worked collaboratively with co-authors for data interpretation and incorporated editorial feedback from all co-authors.

Chapter 3 (Manuscript)

Salvo G, Lashewicz BM, Doyle-Baker PK, McCormack GR. *A mixed methods study on the barriers and facilitators of physical activity associated with residential relocation*. Has been formatted for submission to peer reviewed journal Health and Place (January 2018). All co-authors have provided permission to include the manuscript in this thesis (Appendix A).

The quantitative data analyzed in this study were collected previously in 2014 as part of the Pathways to Health study. GS conceived the study, created the interview script, recruited participants, conducted the interviews in 2016, analyzed the quantitative and qualitative data, interpreted findings and lead the drafting of the manuscript. GS worked collaboratively with co-authors for data interpretation and incorporated editorial feedback from all co-authors.

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Finally, I wish to thank the study participants who generously shared their stories, without whom this work would not have been possible.

Table of Contents

List of Tables

Glossary

Active Transportation:

Any form of physical activity that is used to commute from one destination to another. This includes but is not limited to cycling, walking, roller-blading, skateboarding, uni-cycling, paddling, cross country skiing, skating etc. In the quantitative analysis, active transportation refers to walking and cycling for transportation.

Analysis of Narratives

A type of qualitative analysis that uses collected stories as data and analyzes them with descriptions of themes that hold across the stories or in common elements (taxonomies of types of stories, characters, or settings) (Polkinghorne, 1995).

Built Environment

The part of the physical environment that is constructed by human activity and consists of the following elements: land use patterns, the transportation system, the physical infrastructure of roads, sidewalks, bike paths, and urban design (Saelens and Handy, 2008).

Land Use Mix

The heterogeneity of land uses in geographically defined areas. Land use mix is typically measured using residential, commercial, institutional, industrial, recreational, and agricultural uses (Croucher et al., 2012).

Neighbourhood/Residential Self Selection

Adults may choose to live in neighbourhoods that reflect their physical activity preferences which may explain the relationship between physical activity and the built environment rather than neighbourhood design changing their behaviours (Giles-Corti et al., 2013).

Physical Activity

Any movement of the body produced by skeletal muscles that requires energy expenditure (World Health Organization, 2010).

Sedentary Behaviour

Any behaviour conducted in the sitting or reclining posture (eg, watching television, playing computer games, driving a car, sitting, or reading) that have low energy expenditure 1.5 METs or less (Warburton and Bredin, 2016).

Street Connectivity

Street connectivity creates more and shorter routes to destinations. Connectivity includes features such as shorter blocks, increased intersections, and few dead-ends (Berrigan et al., 2010).

Environmental Sustainability

Practices that contribute to long term quality of the environment and are capable of being maintained at the same rate without compromising future generation's access to pristine natural resources.

Urban Design

The arrangement and appearance of the physical elements in a neighbourhood (Saelens and Handy, 2008).

Walk Score®

An objectively derived measure of walkability that captures the proximity to 12 important amenities associated with walking (Walk Score®, 2014).

Walkability or "Walkable"

The "walkable" neighbourhood contains built environment features that encourage safe and efficient walking and cycling for transportation over car use.

List of Abbreviations

PA: physical activity

MVPA: moderate to vigorous physical activity

PAHDQ: physical activity, health and demographic questionnaire

CHAPTER 1

Thesis Introduction

1.1 Introduction

Physical inactivity is a risk factor for numerous chronic health conditions including overweight and obesity, type II diabetes, heart disease, stroke, high blood pressure, osteoporosis and depression (Warburton et al., 2006). Eighty-five percent of Canadian adults do not accumulate the 150 minutes of moderate to vigorous physical activity per week recommended by the Canadian Physical Activity Guidelines to accrue optimal health benefits (Bounajm et al., 2014). Increasing the level of physical activity to recommended levels in just 10% of the population could lead to significant reductions in the incidence of chronic health conditions (Bounajm et al., 2014; Katzmarzyk and Janssen, 2004).

Quantitative evidence suggests that neighbourhood characteristics such as street connectivity, destinations of interest, residential density, park space, safety and aesthetics are associated with physical activity and in particular walking (Foster and Giles-Corti, 2008; McCormack and Shiell, 2011; Renalds et al., 2010; Saelens and Handy, 2008; Wendel-Vos et al., 2007). However, while creating physical activity supportive or "walkable" neighbourhood environments has the potential to increase physical activity levels, not everyone who resides in a "walkable" neighbourhood achieves recommended levels of physical activity. Although quantitative studies test "how much" and "which" built environment characteristic are associated with physical activity, qualitative studies are better suited to answer "why" and "how" adults change their physical activity habits in response to their environment (Green and Thorogood,

2014). Qualitative studies have explored how individuals perceive the influence of the built environment on their physical activity (Belon et al., 2014; McCormack et al., 2010; Montemurro et al., 2011). This qualitative evidence provides useful insight about the relations between the built environment and physical activity, though few studies focus on adults who recently moved to a different neighbourhood. Studying residential relocation illuminates the potential of changes in the built environment, following relocation, to influence physical activity changes. Further insight derived from mixed qualitative and quantitative approaches that explore behavior changes is needed to advance knowledge regarding the impact of the neighbourhood built environment on physical activity in adults.

1.2 Background

1.2.1 Population Health and Public Health lens

Based on Canadian statistics for population attributable fractions, it is estimated that if all individuals were to achieve the recommended levels of physical activity, there would be a 24.3% reduction in stroke incidence, a 24.0% reduction in osteoporosis, a 21.1% reduction in diabetes, a 19.4% reduction in coronary artery disease, an 18% reduction in colon cancer and a 14.2% reduction in breast cancer (Warburton et al., 2010). Given that the majority Canadian adults are not meeting the recommended levels of physical activity (Bounajm et al., 2014), population level interventions for increasing physical activity are needed. Non-population-level interventions are those that target people at an individual-level. Such individual-level interventions include behavioural interventions (i.e. goal setting, self-monitoring, cues, rewards, feedback) and cognitive interventions (designed to change knowledge, attitudes, beliefs) (Conn et al., 2011). A

review of evidence shows that individual-level interventions can lead to moderate physical activity improvements, though such interventions typically do not result in sustained improvements of physical activity over time after the intervention (Conn et al., 2011). Population-level interventions include those that improve the risk factors or health outcomes of entire populations as opposed to targeting high-risk or vulnerable individuals (Rose, 1985). In other words, these interventions shift the distribution in a risk factor or health outcome in a positive direction without exacerbating inequalities. Increasing physical activity to recommended levels in just 10% of the population could lead to significant reductions in the incidence of chronic health conditions (Bounajm et al., 2014; Katzmarzyk and Janssen, 2004). Even modest increases in physical activity regardless of whether an individual achieves the Canadian Physical Activity Guidelines of 150 minutes per week can have significant health benefits for inactive individuals (Warburton and Bredin, 2016). For example, if individuals were classified into five quintiles according to their physical activity levels with the first quintile being the lowest physical activity level, relative risk of premature mortality would decrease the most when moving from the first to the second quintile whereas decrease in premature mortality from the second quintile to the fifth would be minimal (Warburton and Bredin, 2016). Thus the greatest health gains are associated with moving inactive adults to some activity (Warburton and Bredin, 2016). Major individual barriers to neighbourhood physical activity include: health issues, childcare responsibilities, lack of motivation and time. Whereas environmental barriers include poor weather, poor lighting, unsafe interactions with traffic and lack of nearby interesting places (Lee et al., 2013). Modifying the built environment by implementing urban planning and policy to support physical activity is a population level intervention that has the potential to partially

address the population's insufficient physical activity level and prevent chronic disease (Giles-Corti et al., 2015).

1.2.2 Correlates of physical activity in adults

The correlates of physical activity in adults are multi-dimensional, incorporating demographic, biological, cognitive, behavioural, social and physical environment factors (Trost et al., 2002). Demographic factors such as low income and education correlate with lower levels of physical activity (Trost et al., 2002). Physical activity levels are also lower in women and decrease with advancing age and poor health status (Trost et al., 2002). Cognitive factors such as attitude towards physical activity, self-efficacy, intentions, motivations and commitment may also influence physical activity decision-making and levels (Spence and Dinh, 2015). Social environmental factors including marital status, dog ownership and having children are all factors found to have an impact on physical activity (Christian et al., 2013; Frank et al., 2005; Giles-Corti and Donovan, 2002; Trost et al., 2002). Finally, physical environment factors such as distance from fitness facilities, aesthetics and outdoor park space influence physical activity (Spence and Dinh, 2015). Physical activity is more likely to be adopted and continued if there is a sense of purpose (Morgan, 2001). Although this thesis examines the impact of the built environment on physical activity, several of these correlates of physical activity are present and play a role in influencing the effect that the built environment likely has on physical activity. Lastly, residence in an urban or rural area, gender and age have all been found to act as effect modifiers in the relationship between the built environment and physical activity (Van Cauwenberg et al., 2011).

1.2.3 Built environments and physical activity

The built environment consists of the distribution of buildings and spaces that house activities, services and infrastructure of the transportation system (including roads, sidewalk, bike paths), and urban design (Saelens and Handy, 2008). Neighbourhood built characteristics including street or pedestrian connectivity, the mix of destinations and land uses, population and residential density are consistently associated with physical activity and in particular walking in quantitative studies (McCormack and Shiell, 2011; Renalds et al., 2010; Wendel-Vos et al., 2007). Neighbourhood park space, safety and aesthetics may also support physical activity (Foster and Giles-Corti, 2008; McCormack and Shiell, 2011; Saelens and Handy, 2008). As previously mentioned, these socio-demographic, social environmental and psychological attributes can act as effect modifiers in the relationship between the built environment and physical activity (Ding and Gebel, 2012). For example, aesthetic built characteristics are more likely to be associated with an increase physical activity in men whereas safety characteristics increase physical activity in women (Van Cauwenberg et al., 2011). Qualitative evidence illuminates how different built characteristics influence physical activity behaviours in different sociodemographic groups (Moran et al., 2014). A review of the qualitative research focusing on older adults shows how accessible facilities, rest areas, shade and accessible toilets encourage walking in aging adults who have health conditions, which require more breaks. A review of qualitative evidence on physical activity in parks suggest that more walkable neighbourhoods are supportive of physical activity regardless of sociodemographic characteristics (McCormack et al., 2010). However, specific built characteristics may be more important for different subpopulations. For example, individuals living in low-income neighbourhoods perceive safety of parks as a barrier to physical activity; dog owners find that dog litter bins are useful; and

caregivers care about quality playgrounds (McCormack et al., 2010). Previous reviews of qualitative evidence have focused on the elderly (Moran et al., 2014) or physical activity undertaken in parks (McCormack et al., 2010). There is, however a lack of research synthesizing qualitative evidence that studies physical activity undertaken anywhere in the neighbourhood in adults of all ages.

The relationship between the built environment and physical activity has been previously studied in the Calgary context using quantitative methods (Jack and McCormack, 2014; McCormack et al., 2014). Cross-sectional data from Calgary suggests that highly walkable neighbourhoods are associated with increases in transportation walking but not with increases in recreational walking (Jack and McCormack, 2014). In addition, a study that stratified by subpopulation (motor vehicle access, age, child caregiver, sex, education, income, health status, weight status and dog ownership) found that with few exceptions, subpopulations residing in high-walkable neighbourhoods undertook more physical activity than those residing in low-walkable neighbourhoods (McCormack et al., 2014). The same study found that owning a dog led to similar physical activity levels independent of neighbourhood type and protected against seasonal fluctuations in physical activity.

1.2.4 Causation in the built environment and physical activity relationship

Given that the built environment typically changes slowly over time and research on the relationship between built environment and physical activity is still exploratory, most of the related literature is based on cross-sectional studies (Wendel-Vos et al., 2007). Although cross-sectional studies are useful to determine plausibility, correlation and provide insights into dose-

response relationships, they are not designed to provide evidence for temporality as they capture correlates and outcomes at one point in time. Temporality is an important criterion for establishing causality in epidemiological research (Bradford-Hill, 1965). This is especially the case in the built environment and physical activity relationship where there is debate as to whether active individuals choose to reside in neighbourhoods that support their physical activity preferences (i.e., residential self-selection) (McCormack and Shiell, 2011). More rigorous study designs that can assess whether exposure to characteristics of the built environment do indeed cause changes in physical activity are necessary to infer temporality. Natural experiments and longitudinal research in this field attempt to study changes in physical activity following changes in the built environment. Such studies provide evidence on temporality needed to establish causation in the relationship between the built environment and physical activity (McCormack and Shiell, 2011). Natural experiments can include two types of designs: 1) pre-post designs where a sample is studied before and after an environmental intervention and 2) residential relocation where a sample of individuals changes neighbourhood. Quasi-longitudinal residential relocation studies estimate retrospective changes in physical activity following residential relocation. Although these studies are less precise, they still offer important measures of relative magnitude and direction (Aditjandra et al., 2015; Handy et al., 2008; Milakis et al., 2015). Studying the impact of the built environment on physical activity using quasi-longitudinal studies and natural experiments could provide insight into changes in physical activity over time as environments change, and thus establish temporality (Giles-Corti et al., 2013).

1.2.5 Built environment and physical activity: natural experiments and longitudinal studies

A recent longitudinal study following participants that have recently relocated to new housing developments in Perth, Australia (RESIDE) provides evidence that walking for both recreation and transportation change in response to the availability of neighbourhood destinations related to transportation and recreation (Beenackers et al., 2012; Giles-Corti et al., 2013; Knuiman et al., 2014). Findings from RESIDE also suggest that transportation walking following residential relocation was significantly related to neighbourhood connectivity, land use mix, number of public transit stops and diversity of destination types that were accessible from home by walking (Knuiman et al., 2014). An increase in cycling, after residential relocation, was positively associated with residential density, increased access to parks and more recreation-related destinations (Beenackers et al., 2012). The RESIDE study also suggests that changes in both perceived and objective neighbourhood characteristics are independently associated with changes in physical activity (Giles-Corti et al., 2013; Knuiman et al., 2014). For the relationship between access to interesting destinations and transportation walking, the perceived access to destinations was much stronger than objective access to destinations (Knuiman et al., 2014). Perceptions reflect destinations that individuals perceive as important and thus these destinations may have greater impact on decisions to walk.

A longitudinal study from the United States that used Walk Score® as an objective measure of walkability found that moving to a neighbourhood with higher Walk Score® was associated with an increase in transportation walking but not with a change in leisure walking (Hirsch et al., 2014). Hirsch et al. (2014) hypothesized that Walk Score® focuses on access to destinations that could be associated with transportation walking but may not capture elements of the built environment that could be associated with leisure walking such as aesthetics and

attractiveness. The correlation between active transportation and overall physical activity was studied in a longitudinal study in the United Kingdom where the impact of cycling and walking infrastructure was studied (Sahlqvist et al., 2013). The study findings suggest that increases in active travel are strongly associated with increases in overall physical activity. The same study found that increases in active transportation were associated with commensurate increases in overall physical activity suggesting that those who use active transportation do not compensate for it by doing less recreational physical activity.

A cross-sectional and quasi-longitudinal study from North California, United States, that surveyed individuals who moved to a new neighbourhood within the previous year, asked questions about changes in physical activity. Perceptions of safety, physical activity options (i.e. access to bicycle paths, sidewalks and parks), socializing and attractiveness were positively correlated with neighbourhood physical activity; neighbourhood attractiveness being the most correlated with changes in neighbourhood physical activity (Saelens and Handy, 2008). Quasi-longitudinal evidence confirms that increased neighbourhood safety, travel access, outdoor space and attractiveness are associated with increased walking for transportation among British adults (Aditjandra et al., 2015). By contrast, decreases in safety have been associated with decreases in cycling and decreased transportation options with decreased walking while studying relocation from USA to Greek neighbourhoods (Milakis et al., 2015).

1.2.6 Residential Self-selection

In the context of built environment and physical activity research, residential self-selection is the choice to reside in a neighbourhood that reflects an individual's physical activity

preferences. This phenomenon complicates our ability to understand the relationship between the built environment and physical activity because it is independently associated with both exposure (living in a physical activity supportive environment) and the outcome (physical activity), without being on the causal pathway (Giles-Corti et al., 2013; McCormack and Shiell, 2011; Wendel-Vos et al., 2007). Studies of residential relocation have led to contradicting evidence on the importance of residential self-selection. Cross-sectional studies have found that residential self-selection explains some of the association between the built environment and physical activity (Berry et al., 2010; Van Dyck et al., 2011). However longitudinal results from the RESIDE study found no evidence that self-selection influenced the relationship between the built environment and physical activity. This same study also found affordability to be the main reason for choosing a neighbourhood (Giles-Corti et al., 2013). In general, the estimated associations between the built environment and physical activity typically remain, although attenuated, after statistical adjustment for residential self-selection (McCormack and Shiell, 2011).

1.3 Conceptual framework for explaining physical activity behaviours

This thesis uses a social ecological framework to guide the assessment of environmental influences on physical activity behaviour (Giles-Corti and Donovan, 2003). The social ecological framework has been developed as a tool for health promotion to describe the multiple levels that influence health behaviours (McLeroy et al., 1988). The social ecological framework posits that although individual attitudes, knowledge and skills can influence health behaviour choices, these choices are constrained by the interpersonal factors (social support systems such as family, work colleagues, friendship networks), institutional environment (work and school environments),

community factors (relations among organizations, institutions and informal networks), physical environment (sidewalks, pathways and natural spaces) and public policy factors (local and national laws and policies) (Jackson, 1985; McLeroy et al., 1988). Several authors have described different versions of the social ecological framework that specify different levels of influence on health behaviours (Golden and Earp, 2012; Jackson, 1985; McLeroy et al., 1988; Rütten et al., 2013; Sallis et al., 2006). A common assumption however is that each level interacts with the others to influence health behaviours (Jackson, 1985). Sallis et al. (2006) developed a social ecological framework specific for creating active communities (Sallis et al., 2006). Their framework identifies social, physical and policy interdependencies that influence the four domains of active living: recreation, transport, occupation and household (Sallis et al., 2006). This thesis is informed by the framework developed by Sallis et al. (2006) and focuses on the recreation and transport domains of active living as those are the most influenced by neighbourhood built environments. In general, social ecological frameworks help us understand the multifaceted and interdependent determinants of physical activity leading to a need for health promotion interventions to be multifaceted as well (Golden and Earp, 2012). Multiple levels of possible interventions such as community-based, mass media campaigns, health care setting, policy interventions and built environment interventions are suggested (Rütten et al., 2013). Although individual health behavioural interventions have been shown to create marginal improvements in health, such interventions are arguably not sustainable once the intervention is over. Focusing on individual lifestyle choices can also lead to "victim blaming" (McLeroy et al., 1988). In contrast, the social ecological framework acknowledges that multiple interacting layers influence lifestyle choices. The framework aims to act upon those layers (Golden and Earp, 2012; Jackson, 1985; McLeroy et al., 1988; Sallis et al., 2006). Despite this knowledge, a

majority of health promotion interventions continue to target individual characteristics (Golden and Earp, 2012).

Although the purpose of this research is to assess environmental determinants of physical activity, both social and individual determinants help us understand how different built environment interventions that take those determinants into consideration could make a more profound impact. For example, if social interactions with family encourage physical activity, built environment interventions that allow for these interactions to take place will support physical activity. Individual motivations to walk such as desire to connect with nature could also inform built environment interventions. In order to assess physical environment influences in greater detail, this research uses a framework specifically developed by Pikora et al. to assess the environmental determinants of walking and cycling. This framework was developed using published evidence and policy literature, interviews with experts and a Delphi study (Pikora et al., 2003). The framework categorizes determinants of cycling and walking for both leisure and transportation into four overarching categories. It has been used to inform questions related to the built environment and categorize them into factors related to aesthetics, functionality, destinations and safety (Appendix B). In this research, aesthetic features include elements in the streetscape (trees, flowers, etc.) and views. Functional features include walking surface (maintenance) and streets (width). Safety features include personal safety (surveillance) and traffic safety (cross-walks). Destinations include local facilities such as parks and shops. This framework has been widely used in literature related to physical activity and the built environment (Bentley et al., 2010; McCormack et al., 2004). The interview guide for this qualitative research was developed using this framework to inquire about built environment

determinants as well as larger questions regarding the social and individual determinants of physical activity.

1.4 Thesis Outline

1.4.1 Study Aim

The aim of this study was to understand the environmental correlates of changes in physical activity in adults following relocation.

1.4.2 Research objectives

This thesis project addressed three primary research objectives:

1) To explore how the built environment influenced physical activity in adults, through the synthesis of findings from qualitative studies.

2) To estimate the associations between perceived changes in physical activity (transportation walking, transportation cycling and overall physical activity) and changes in objectively-assessed neighbourhood walkability (Walk Score®) following residential relocation through the quantitative phase of the mixed methods study.

3) To describe perceived built environment barriers and facilitators to physical activity following neighbourhood relocation through the qualitative phase of the mixed-methods study.

1.4.3 Significance

Our study provides novel and informative evidence about the individual, social and environmental factors that potentially influence changes in physical activity following residential

relocation. Based on recommendations from other researchers (Montemurro et al., 2011), our study examined these factors while considering the importance of both the perceived and objectively measured built environment. The conclusions drawn from this study could be used to inform transportation planning, urban design, landscape architecture, road engineering, parks and recreation, bylaw enforcement, and public health to improve the physical activity supportiveness of neighborhood environments.

1.4.4 Thesis structure

This thesis contains four chapters. Chapter 1 provides background information on the built environment and physical activity relationship, and also identifies the current knowledge gaps in physical activity and the built environment. This lead into the thesis aim and research questions. Chapter 2 contains a systematized review of qualitative literature on physical activity and the built environment. Chapter 3 contains a mixed methods analysis that examines perceived physical activity changes in adults following residential relocation. The sample of adults used for Chapter 3 had recently relocated and this data was taken from the larger "Pathways to Health" study, originally undertaken to understand how contextual (neighbourhood built characteristics) and compositional (neighbourhood-level socioeconomic status) neighbourhood characteristics influence physical activity, diet and weight status in the Canadian context (McCormack et al., 2017; McInerney et al., 2016). This occurred in 2014 from March to June, and was a stratified random sample of adults (n=1023; ≥20 years of age) residing in established Calgary neighbourhoods (not new builds). They completed an online or postal survey as part of the "Pathways to Health" study. We recruited participants from 12 neighbourhoods, stratified by street pattern (grid, warped-grid, and curvilinear) and socioeconomic status (quartiles). One

participant per selected household was eligible to participate. Recruited participants completed the Canadian Diet History Questionnaire (II) and a physical activity, health and demographic questionnaire (PAHDQ). During the PAHDQ, participants reported whether they had relocated neighbourhoods in the past 12 months, the household address information for their previous and current neighbourhood, and whether their walking, cycling, and total physical activity had changed since the relocation. The amount of time since the move (approximately 1 year for the quantitative phase and 2 years for the qualitative phase in this study) allowed participants time to be exposed to and be familiar with their residential environment (Giles-Corti et al., 2013). Previous residential relocation studies have used similar time-frames (Handy et al., 2008).

The quantitative phase uses survey data to measure associations between walking and cycling for transportation and overall physical activity, and objective walkability change. The qualitative phase contains an analysis of narratives from interview data that explores how changes in the built environment following residential relocation impact physical activity. Chapter 4 incorporates the results from the systematized review and mixed-methods study and provides a summary of evidence. The thesis concludes with recommendations for interventions and future research directions.

1.4.5 Systematized literature review rationale

Although previous quantitative research has answered questions related to "how much" different built environment characteristics influence physical activity, qualitative research can answer "what", "how or "why" built environment characteristics lead to changes in physical activity (Green and Thorogood, 2014). Qualitative evidence contributes to better understanding of the

causal relationship between the built environment and physical activity, by shedding light on the plausibility and coherence of the relationship (Bradford-Hill, 1965). Furthermore, aspects that have been associated with physical activity such as interesting destinations, aesthetics and socialization vary according to people's perceptions. Qualitative methods could be used to generate insight about how individuals perceive and interact with their neighbourhood environments in their attempts to be physically active. Although previous qualitative research on the built environment and physical activity exists, there are a lack of studies that synthesize this literature for the adult population. The purpose of the systematized review was to address the first thesis research question by gathering and summarizing qualitative evidence on the relationship between the built environment and physical activity among adults. The chapter describing the systematized literature review has been formatted for submission to peer-reviewed Journal PLOS One.

1.4.6 Mixed methods study rationale

The purpose of this chapter was to address the second and third research objectives. This chapter contributes to the existing quasi-longitudinal literature on the built environment and physical activity through both qualitative and quantitative study of Calgary adults who recently relocated neighbourhoods. This chapter responds to the findings of the systematized review, and aims to explore how individuals perceive the changes in their neighbourhood built environment following relocation influence their physical activity. The qualitative phase examines the lived experiences behind the changes in physical activity observed in the quantitative phase. The chapter describing the mixed methods study has been formatted for submission to peer reviewed Journal Health and Place.

1.5 Ethical Considerations

The Conjoint Health Research Ethics Board at the University of Calgary's Faculty of Medicine approved this project in June 2015 (ID REB130301_MOD6). An amendment to the original ethics application was also approved, which allowed the candidate to perform qualitative interviews with the participants (April 2016).

All participant data were kept confidential in a secure place, on a password-protected computer, in an encrypted passcode protected file. Only the candidate, the study's principal investigator and a professional transcriber had access to this information (Appendix C). The information provided by each individual was combined with that of all participants. The collective data was used to write this thesis paper.

There were minimal risks involved in participating in this study. The interview questions were designed to be simple to answer and did not cover any subjects of a sensitive nature. Participants were informed that they did not have to answer every question and that they were free to stop the interview at any time if they wished to. Participants could withdraw from the study at any point in time before the data were analyzed. All participation was voluntary. Anonymity of participants was protected via pseudonyms, the elimination of any identifying information, and some paraphrases of content.

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CHAPTER 2

Neighbourhood built environment influences on physical activity among adults: A systematized review of qualitative evidence

2.1 Abstract

Qualitative studies can provide important information about how and why the built environment impacts physical activity decision-making – information that is important for informing local urban policies. We undertook a systematized literature review to synthesize findings from qualitative studies exploring how the built environment influences physical activity in adults. Our review included 36 peer-reviewed qualitative studies published from 1998 onwards. Our findings complemented existing quantitative evidence and provided additional insight into how functional, aesthetic, destination, and safety built characteristics influence physical activity decision-making. Sociodemographic characteristics (age, sex, ethnicity, and socioeconomic status) also impacted the built environment's influence on physical activity.

2.2 Background

Physical activity is an important determinant of health, wellbeing, and disease prevention. Regular moderate-to-vigorous intensity physical activity (MVPA) can improve metabolic, cardiovascular, oncological, musculoskeletal, and psychological function and can reduce the risk of chronic conditions including cardiovascular disease, some cancers, type II diabetes, hypertension, stroke, depression, and overweight and obesity as stated previously (Warburton et al., 2006). However, despite the numerous health benefits of physical activity, many adults in high-income countries such as Canada, US, and Australia do not participate in levels of physical

activity sufficient to accrue optimal health benefits. As part of their Global Strategy on Diet, Physical Activity, and Health, the World Health Organization recommends that adults participate in at least 150 minutes of MVPA per week through accumulated physical activity undertaken for leisure, transportation, work, play, sports, and exercise (World Health Organization, 2010).

The determinants of physical activity are multi-faceted and complex. Over the past few decades there has been increasing research and political interest in the role of the built environment in supporting physical activity (Giles-Corti et al., 2015). The built environment is human-made and consists of the distribution of buildings and designed spaces that support activities, the services and infrastructure of the transportation system (including roads, sidewalk, bike paths), and urban design (Saelens and Handy, 2008). Findings from quantitative studies suggest that neighbourhood built characteristics including street or pedestrian connectivity, the mix of destinations and land uses, population and residential density are consistently associated with physical activity and in particular walking (McCormack and Shiell, 2011; Renalds et al., 2010; Wendel-Vos et al., 2007) since dense neighbourhoods that are connected and offer nearby destinations may increase transportation walking. While less consistent, there is also quantitative evidence suggesting that neighbourhood park space, safety and aesthetics, features associated predominantly with leisure walking, may support physical activity (Foster and Giles-Corti, 2008; McCormack and Shiell, 2011; Saelens and Handy, 2008).

There have been recent calls for more evidence on the built environment and physical activity that is policy relevant and that can be easily implemented in urban planning and design (Giles-Corti et al., 2015). Quantitative evidence shows that there are relationships between the

built environment and physical activity. This evidence is important to inform urban planning policy and practice however, quantitative studies provide limited insight and understanding about the day-to-day lived experiences and the interactions adults encounter with potential built environment constraints and enablers when they attempt to be physically active in their local neighbourhood. Exploration of people's experiences with the built environment in relation to their physical activity can provide new and different knowledge, which might be of importance for local urban planning decision-making. For example, a review of qualitative studies of park environments and physical activity (McCormack et al., 2010) supported findings from the quantitative evidence (Kaczynski and Henderson, 2008, 2007). These findings also contributed novel insights suggesting that the influence of park availability and proximity on physical activity while important, is often constrained by perceived and actual personal safety concerns and that the delineation between built versus social environment determinants of physical activity is not always clear.

Qualitative research can therefore provide important contextual insights about the determinants of physical activity (Cleland et al., 2015; Montemurro et al., 2011), including supportive and constraining neighbourhood built characteristics that could inform local urban planning and policy. Given that much of the quantitative evidence on built environments and physical activity is cross-sectional, thus limiting causal inferences, qualitative evidence has the potential to illuminate the plausibility of this relationship including under what individual-level and social conditions the built environment enables or inhibits physical activity (Montemurro et al., 2011). Further, built characteristics found to be associated with physical activity, such as interesting destinations and aesthetics, can vary according to people's perceptions, personal

experiences, and attitudes (Yen et al., 2007), and may not be fully discernable when these perceptions are statistically summarized as is the case in quantitative studies. Qualitative studies explore and describe experiences and lead to insight about how adults perceive and interact with their neighbourhood environments in their attempts to be physically active. Therefore, the purpose of our study was to undertake a systematized literature review to synthesize qualitative research findings on how the neighbourhood built environment influences physical activity in adult populations.

2.3. Methods

2.3.1 Overview

This study included a systematized literature review, synthesizing qualitative evidence. Similar to systematic reviews, the article search and selection, data extraction, and results synthesis for systematized reviews are determined *a priori*, fully documented, and systematic. However, a systematized review is distinguished from a systematic review in that the former may not include some procedures for preserving internal validity, such as having two reviewers at each stage of the review, assessing study scientific quality using a validated tool or comparable qualitative quality appraisal measures, weighting findings, or excluding studies based on methodological quality, or pooling results to undertake meta-analysis (Grant and Booth, 2009). Systematized literature reviews are often undertaken when sufficient resources (e.g., time or personnel) are not available to undertake a comprehensive systematic review but scientific rigor and objectivity are still necessary. Systematized literature reviews have been undertaken

previously to explore the relations between built and social environments and health outcomes (Canelas et al., 2016) including physical activity (Sawka et al., 2013).

2.3.2 Search strategy

In April 2016, we searched for English-language peer-reviewed qualitative studies, with no publication date restrictions, that had reported associations between the built environment and physical activity. Given the interdisciplinary nature of this research topic, we searched for relevant articles within health (PubMed, MedLine, PsycInfo, and SPORTDiscus), leisure (Leisure Tourism Abstracts), urban planning (Urban Studies: Environmental Complete) and transportation (Transport Research Information Services (TRIS)) databases. Within article title and abstracts, we searched for a combination of key terms (and their variant spellings) related to the built environment (i.e., built environment, spatial, neighbourhood, physical environment, streetscape, urban form, urban planning, walkability, pedestrian-friendly, geographic information systems, parks, and greenspace), physical activity (physical activity, exercise, inactivity, walk, bicycling, cycle, stroll, run, jog, leisure-time, sport, recreation, active transportation, and pedestrian), and qualitative research (qualitative, focus group, interview, ethnographic, ethnography, case study, and anthropology).

2.3.3 Study selection

Following the database search, n=8237 articles remained after the removal of duplicates. We screened all article titles and abstracts for relevance, and removed non-primary studies (e.g., literature reviews, methodological studies) and article types irrelevant to our purpose (i.e., commentaries, editorials, conference proceedings). Relevance of titles and abstracts led to the

selection of 71 articles that underwent full-text review. Following full-text review, articles were included if they reported qualitative findings for an association between the neighbourhood built environment and physical activity (i.e., included either participant descriptions or interviewer interpretation of participant descriptions of the association). Eligible articles must have specifically reported on a primary study that: 1) included at least one qualitative data collection method (i.e., unstructured or semi-structured interviews, focus groups, photovoice methods, qualitative survey); 2) discussed or reported on participants' experiences of neighbourhood built environment barriers and facilitators to physical activity, and; 3) included an adult sample. Studies that did not include adults or included quantitative findings only were excluded from the review. A total of 36 articles met the inclusion criteria.

2.3.4 Data extraction

For each included article, we extracted and reported information regarding data collection method (e.g. interview, focus group), sample characteristics (e.g. sex, age, rural vs. urban, ethnicity, socioeconomic status), analytic approach (e.g. thematic analysis, grounded theory) and findings about the built environment's supporting or restricting role in relation to physical activity (Appendix D). We used an existing conceptual framework (Pikora et al., 2003) to guide our extraction and reporting of the built environment and physical activity findings. This framework posits the relations between specific neighbourhood built characteristics and walking in terms of four key features: functionality, safety, aesthetics, and destinations (Pikora et al., 2003). Functional features included direct routes, intersection design, path design and maintenance, traffic control and vehicle parking. Safety features included surveillance, crossing aids and lighting. Aesthetics features included cleanliness, interesting sights, maintenance,

greenery, architecture and pollution. Destination features included proximity, accesses, and availability of local facilities, parks, shops, parking facilities, public transit and other destinations. This framework has been used in previously published studies investigating the associations between the built environment and physical activity (Bentley et al., 2010; Cleland et al., 2015; McCormack et al., 2004).

2.4. Results

2.4.1 Summary of study methods

Study characteristics and sample designs

The 36 studies included in this review were published between 1998 and 2015. Twelve were undertaken in the USA, six in Canada, two in the UK, eight in Australia, two in New-Zealand, and one each in Ireland, Brazil, Sweden, Belgium and Iceland, with one study having recruited from both Canada and the USA (Table 2.1). Sample sizes varied from eight to 396 participants with four studies not specifying a sample size. Thirty-four studies used purposive sampling frameworks to recruit participants based on: gender (n=16), ethnicity (n=7), socio-economic status (n=9) and/or age with 13 studies focusing on adults older than at least 50 years. Studies that sampled based on ethnicity did so from African American, Hispanic/Latino, Chinese, and American Indians populations. Three studies specifically sampled adults from rural areas.

Data collection and analytic approaches

Focus groups and individual face-to-face interviews were the most common qualitative data collection approach (Table 2.1). Five studies included photovoice methods in addition to focus groups or interviews. The photovoice method elicits rich data through allowing participants to take photos of their surroundings, then using the photos to tell the stories behind them to the researcher (Belon et al., 2014; Gallagher et al., 2010; Lockett et al., 2005; Mahmood et al., 2012; Mitra et al., 2015). Two of these studies included walk-along interviews (Van Cauwenberg et al., 2012; Walton, 2014). One study used a qualitative questionnaire, which included open-ended questions capturing participants reasons for enjoying physical activity (Bellows-Riecken et al., 2013). One mixed methods study presented qualitative data from semi-structured interviews only (Stathi et al., 2012) (Table 2.1).

Of the analytical approaches, thematic analysis and content analysis were used most frequently. Content and thematic analysis were used somewhat interchangeably, although qualitative methodologists tend to distinguish content analysis as focused on what language is used by participants and with what frequency, while thematic analysis tends to emphasis interpreting participant language in context (Vaismoradi et al., 2013). Six studies identified grounded theory as their analytical approach and used techniques such as constant comparison however, they did not necessarily specify the ways in which their approach led to the theory building expected when employing grounded theory approaches (Green and Thorogood, 2014). A phenomenological approach was used in one study as guiding researchers to focus on the essence and structure of participants' subjective experiences of physical activity and the built environment (Green and Thorogood, 2014) (Table 2.1).

2.4.2 Relationships between the built environment and physical activity

Results from this section are summarized in Table 2.2.

2.4.2.1 Functional features

Paths and access to amenities supporting physical activity and mobility

In several studies participants reported access to sidewalks, paths and walkways as key characteristics that support their walking (Belon et al., 2014; Gallagher et al., 2010; Mahmood et al., 2012; Stathi et al., 2012). In high traffic areas, the presence of pedestrian bridges over large roads helped make walking feasible (Walton, 2014). In contrast, sidewalks that suddenly ended and had poorly maintained surfaces that were uneven or slippery due to cracks, puddles or ice were barriers to walking (Gallagher et al., 2010; Mahmood et al., 2012; Stathi et al., 2012; Van Cauwenberg et al., 2012). In particular, for older adults where the fear of falling was a barrier to physical activity, sidewalk cracks, stairs and hills posed challenges (Bjornsdottir et al., 2012; Lockett et al., 2005; Marquez et al., 2014; Stathi et al., 2012; Van Cauwenberg et al., 2012). For older adults, access to less steep sidewalk ramps were found to be helpful for enabling walking (Bjornsdottir et al., 2012; Lockett et al., 2005; Stathi et al., 2012). As one older woman noted in relation to access to less steep ramps: "At least here you can walk without falling or spraining your ankle, this is all flat" (Van Cauwenberg et al., 2012, p. 5).

Further, older adults had a special appreciation for amenities such as benches, drinking fountains, public washrooms, railings for stairs, shaded areas and ramp access (Gallagher et al., 2010; Lockett et al., 2005; Mahmood et al., 2012; Mitra et al., 2015; Stathi et al., 2012; Walker and Hiller, 2007). Without these amenities, some pathways and public open spaces may simply

not be supportive of physical activity, as one elderly woman expressed: "Of course you want shade in the park. A couple of senior citizens out for a stroll, they want to be able to sit when they get pooped, there is nowhere for them to sit."(Mitra et al., 2015, p. 15). Weather conditions such as extreme heat and slippery or snowy winter conditions also posed a falling risk for older adults (Bjornsdottir et al., 2012; Gallagher et al., 2010; Lord and Bush, 2012; Marquez et al., 2014; Stathi et al., 2012; Strath et al., 2007; Van Cauwenberg et al., 2012). Whereas removal of ice and snow on pathways helped older adults to remain active in the winter months (Gallagher et al., 2010).

Path design and connectivity supporting active transportation modes

Several functional features were reported as supporting cycling. For instance, having different types of pathways connect (i.e., connectivity) was considered important for bicycle commuting in an Edmonton (Canada) study where some participants reported driving by car to the bike path because of lack of bike path connectivity: ''I mean the river valley is beautiful but there's no way to get there on a bike, I mean there is but you have to drive there with your bike''(Montemurro et al., 2011, p. 897). Participants also mentioned how separated bike lanes, walking paths and motorized vehicle lanes improve ease of getting around (Belon et al., 2014; Strath et al., 2007). For example: "Now we have wonderful biking facilities and path[s] [separated from motorized traffic] I walk with a friend in the morning . . . it's a 2-mile stretch." (Strath et al., 2007, p. 417).

2.4.2.2 Safety features

Crime and sense of trust in the community

Participants raised two main safety concerns in relation to the built environment: 1) safety from crime, and 2) safety from traffic. If residents perceived the crime rate in neighbourhoods as being high, they were not inclined to walk or participate in physical activities in local public areas such as parks (Ball et al., 2006; Burgoyne et al., 2008; Caperchione et al., 2009; Casey et al., 2011; Dunn, 2008; Eyler et al., 2002, 1998; Gallagher et al., 2010; Mama et al., 2015; Marquez et al., 2014; Stathi et al., 2012; Van Cauwenberg et al., 2012). In some cases, participants were afraid to leave their homes because of the presence of gangs and drug dealing and this deterred neighbourhood physical activity (Ball et al., 2006; Burgoyne et al., 2008; Caperchione et al., 2009; Durand et al., 2011; Eyler et al., 2002; Zieff et al., 2012). For example "You're insane to be outside. You could get shot, robbed, beat up" (Zieff et al., 2012, p. 1058). Notably, safety from crime was of greater concern among women compared with men (Eriksson and Emmelin, 2013). Environments that provide safe spaces from crime were mentioned as supportive places to undertake physical activity especially among women (Ball et al., 2006; Caperchione et al., 2009; Eriksson and Emmelin, 2013; Eyler et al., 2002, 1998; Mama et al., 2015).

Perceived or real lack of safety discouraged participants from being physically active outdoors especially in low-socioeconomic status neighbourhoods (Ball et al., 2006; Cassou et al., 2011; Eyler et al., 2002; Yen et al., 2007; Zieff et al., 2012). Even in these low-socioeconomic status neighbourhoods where facilities and destinations were close or within walking distance to home, the fear of crime was a barrier to physical activity – as a woman from a low-socioeconomic status neighbourhood noted: “It's like you're scared to live here. At a certain time

at night ... uh, well everything's close by there, but the truth is, you don't feel comfortable living. […] And well that's what worries us...because sometimes we can't go out or you don't feel comfortable going out." (Yen et al., 2007, p. 102). Non-violent crime and evidence of incivilities including loitering (Yen et al., 2007), explicit sexual behaviours (Yen et al., 2007), vandalism (Mahmood et al., 2012), lack of cleanliness/littering (Burgoyne et al., 2008; Stathi et al., 2012; Zieff et al., 2012), cars illegally parked on sidewalks (Stathi et al., 2012), and drug paraphernalia (Mahmood et al., 2012; Zieff et al., 2012) also negatively influenced participants perception of safety and subsequently, their neighbourhood physical activity patterns: "Some problems in the area include poverty, drug and criminal activities and poor housing, etc. Some people do not feel safe or willing to walk through area to get to river." (Mahmood et al., 2012, p. 1184).

Increased police presence helped some to feel safer in high crime areas (Gallagher et al., 2010; Stathi et al., 2012; Yen et al., 2007; Zieff et al., 2012): for example "More police presence might enhance use as the parks would be safer" (Yen et al., 2007, p. 102). In contrast, minority groups living in low-income neighbourhoods in the US experienced racial profiling by law enforcement authorities dissuading them from visiting and being physically active in neighbourhood spaces such as parks and recreation centers (Marquez et al., 2014; Zieff et al., 2012). One resident living in a minority neighbourhood described the racial profiling: "The police intervene unnecessarily when a group of teens hang out at the Rec[reation] Center and profiling makes them think they are a gang" (Zieff et al., 2012, p. 1061). This contrast may suggest that some neighbourhood built characteristics impact the physical activity levels of different populations in different ways via potentially different means (e.g., informed or modified by cultural and social norms and stereotypes).

Sense of community, facilitated by the built environment, and knowing one's neighbors contributed to feelings of safety. Residents in low-socioeconomic status areas used social spaces and amenities such as courtyards, picnic tables and BBQs to develop social ties with others in the community (Burton et al., 2003; Walker and Hiller, 2007; Walton, 2014). As Walker and Hiller (2007) describe: "For one woman, being 'known' at her local shops contributed to her sense of safety within the area" (Walker and Hiller, 2007, p. 1160). An African American woman described her experience in a courtyard as: "If you're out in a courtyard area, then you see people coming and going, being outside. So, you get to know them. You may not speak the same language, but you know, you do say 'hi' to each other. They'll ask me how I'm doing. I'll ask them how they're doing. So, it's more like a family" (Walton, 2014, p. 8). Creating neighbourhood spaces that facilitate social interaction and sense of community may counter the fear of crime, resulting in more passive and active surveillance, and encourage adults to engage in neighbourhood physical activity.

Lighting and fear of darkness

Participants preferred being physically active during the day or in well-lit environments and avoided darkness and isolated areas with poor visibility (Azar et al., 2010; Burgoyne et al., 2008; Caperchione et al., 2009; Eyler et al., 1998; Mahmood et al., 2012; Stathi et al., 2012). In particular, women felt uncomfortable undertaking physical activity outdoors at night and preferred well-lit areas (Caperchione et al., 2009; Eyler et al., 2002, 1998; Kilgour and Parker, 2013), for example: "So, I sort of think, it's a Friday evening, do I really want to go for a jog around the park, when there's going to be groups of lads drinking? And I end up not going"

(Kilgour and Parker, 2013, p. 47). The perceived need for more lighting seemed to be more important in some low-socioeconomic status neighbourhoods where violent crime and gangs were present (Ball et al., 2006; Eyler et al., 1998). Notably, safety concerns for women dissipate as women become more familiar with the neighbourhood and where well-lit and or well populated areas exist (Kilgour and Parker, 2013).

Traffic hazards related to different user type conflict

Traffic hazards deterred transportation walking and cycling (Annear et al., 2009; Burgoyne et al., 2008; Caperchione et al., 2009; Eyler et al., 2002; Lockett et al., 2005; Montemurro et al., 2011; Strath et al., 2007). Traffic was a barrier to transportation cycling as expressed by one woman "Too much traffic to bike to town […] it is just scary." (Belon et al., 2014, p. 13). Notably, cyclists themselves were identified as being a hazard for pedestrians: "Most cyclists ride like they're on a highway. Older persons are frightened or have to step aside" (Van Cauwenberg et al., 2012, p. 7). Separating pedestrians and cyclists from motorized traffic was reported as a means of countering traffic-related safety concerns (Strath et al., 2007). Ambiguity regarding right of way between different modes of transportation including motor vehicles, bicycles and pedestrians influenced older adults walking behaviours (Grant et al., 2010).

Among traffic issues, speeding cars and careless drivers were identified as hazards for walking and cycling (Annear et al., 2009; Mahmood et al., 2012; Van Cauwenberg et al., 2012). Older adults felt especially unsafe around traffic and speeding cars (Annear et al., 2009; Lockett et al., 2005; Mahmood et al., 2012; Marquez et al., 2014; Stathi et al., 2012; Strath et al., 2007; Van Cauwenberg et al., 2012). Lack of pedestrian crossings was a barrier to physical activity

(Mahmood et al., 2012) and time allowances of crosswalks was considered not long enough (Lockett et al., 2005; Marquez et al., 2014; Mitra et al., 2015). As one elderly woman in Canada noted: "The major roads, they don't give sufficient time for you to cross […] doesn't give you enough time for a person who is elderly, who is immobile to cross, there isn't a sufficient island for the person to safely stand there" (Mitra et al., 2015, p. 14). Signage indicating that elderly people are in the vicinity might help older adults feel safer while crossing roads (Marquez et al., 2014).

By comparison, in rural areas, traffic density was less of a problem when compared to concerns related to the presence of large vehicles and winding roads: "But the road . . . I walked it once and I was terrified. Because it's sort of a windy road. It's narrow and you get log trucks" (Cleland et al., 2015, p. 5). Thus, built environment design strategies for improving the physical activity supportiveness of urban areas likely differ to the strategies that might improve physical activity in rural areas.

2.4.2.3 Aesthetic features

Desire to be active in beautiful environments

People were motivated to be active within public environments that were aesthetically pleasing and beautiful (Gallagher et al., 2010; Ivory et al., 2015; Stathi et al., 2012). Contact with greenery whether in the bush, park, garden or courtyard, as opposed to streets, was valued and for many participants, seemed to confer feelings of peace, well-being and restoration (Annear et al., 2009; Belon et al., 2014; Eriksson and Emmelin, 2013; Gallagher et al., 2010; Ivory et al.,

2015; Lockett et al., 2005; Van Cauwenberg et al., 2012). One man described the green spaces in his neighbourhood as important: "That is one of the most important values with this living environment. There are green spaces. […]; These spaces give opportunity to experience the closeness of vegetation and greenness" (Eriksson and Emmelin, 2013, p. 118). Moreover, water elements such as beaches (Ivory et al., 2015), rivers (Montemurro et al., 2011) and waterfalls (Lockett et al., 2005) were noted as motivators for physical activity in public areas. Furthermore, participants expressed preferring to take scenic routes in some cases even if these take more time (Eyler et al., 1998; Gallagher et al., 2010; Strath et al., 2007). Human-made elements such as architecture and historical monuments were also mentioned for their power to give places meaning and beauty (Belon et al., 2014; Gallagher et al., 2010). Feelings propelled by aesthetic elements encouraged participants to engage in physical activities such as running or walking in their surroundings as described by a man living in a New Zealand suburb: "No, I love running in the bush and things, I think it's great, as opposed to running around the streets. I mean I like the character houses, I can do that, but I would much prefer to be in the bush and round the mountain bike parks and places" (Ivory et al., 2015, p. 317). On the flipside, unaesthetic areas containing trash and vacant un-kept lots were considered unsupportive to outdoor physical activities as were areas exposed to noise (Annear et al., 2009; Stathi et al., 2012; Van Cauwenberg et al., 2012) and air pollution (Annear et al., 2009; Belon et al., 2014).

2.4.2.4 Destination features

Availability of, and access to, local destinations and active transportation

Participants reported increased willingness to visit recreation physical activity destinations such as parks and facilities when these destinations were conveniently located near home (Mathews et al., 2010) and when visiting these destinations did not entail using a car, as Belon et al. highlighted: "several participants who had automobiles reported that they preferred not to drive to distant recreation areas or facilities. Thus, shorter walking distances between home and these areas could encourage physical activity." (Belon et al., 2014, p. 15). Grocery stores (Bjornsdottir et al., 2012; Mahmood et al., 2012; Marquez et al., 2014; Stathi et al., 2012; Walton, 2014) and post-offices (Stathi et al., 2012) were considered important facilitators of active transportation. Notably, participants living in a car-friendly city that encouraged car use to run errands, still appreciated having recreational infrastructure such as dog parks and soccer fields within walking distance (Montemurro et al., 2011).

Proximity to destinations within walking distance became especially important for older adults in cases where they chose, or were forced, to relinquish their motor vehicle operator's license. Considering the possibility of not being able to drive in the future, one elderly woman describes the importance of proximity to destinations as follows: "[The neighbourhood is] very close to all facilities this is what attracted me. The closeness of shops. Everything else. The bus is only at the corner and the doctor and a dentist and a chemist and a post office and everything, supermarket, everything within a five minute walk" (Walker and Hiller, 2007, p. 1161). Older adults valued proximity to shops/markets, post office, food stores, restaurants, libraries, churches, historic monuments, community gardens and parks/green spaces (Bjornsdottir et al., 2012; Gallagher et al., 2010; Mahmood et al., 2012; Mitra et al., 2015; Stathi et al., 2012; Strath et al., 2007). Proximity to recreational facilities within the neighbourhood was also considered

important and facilities identified include sports fields (Belon et al., 2014; Montemurro et al., 2011), playgrounds (Ivory et al., 2015), green space/parks (Mahmood et al., 2012; Stathi et al., 2012; Walton, 2014; Zieff et al., 2012), courtyards with picnic tables (Walton, 2014), festivals (Mahmood et al., 2012), community gardens (Zieff et al., 2012), and historical destinations (Gallagher et al., 2010). Access to public transit was mentioned as a factor in supporting walking for transportation and accessing specific physical activity facilities (Belon et al., 2014; Mahmood et al., 2012; Stathi et al., 2012; Van Cauwenberg et al., 2012), for example: "I find just even having that [train] makes me get out and be more physical than if I had a car […] I like that I have a little bit of a walk to get to the train." (Belon et al., 2014, p. 13).

The lack of nearby physical activity facilities (i.e., gyms, sports facilities, pools) was mentioned as a barrier to neighbourhood physical activity (Shuval et al., 2013; Stathi et al., 2012; Zieff et al., 2012). Further, poor quality of, and lack of participant knowledge about exercise machines in such facilities (Casey et al., 2011), as well as lack of participant knowledge about availability of recreational facilities in the neighbourhood (Zieff et al., 2012), along with limited operating hours of recreational facilities such as pools, were potential barriers to physical activity (Belon et al., 2014). Not only is the structure and proximity of recreational destinations important, but the operations of recreational facilities (available support for using equipment or facilities, hours of operation, user fees of costs) have the potential to enable or discourage physical activity.

Social interactions at destinations supporting physical activity behaviour

Destinations that are close to home and offer socializing opportunities appeared to motivate participants to be physically active in their neighbourhoods. Some destinations, such as parks and community gardens, were valued as a safe space for physical activity and creating social ties (Mahmood et al., 2012; Walton, 2014). Inclusive environments where neighbours were friendly and inclined to greet one another were preferred destinations for walking (Eriksson and Emmelin, 2013; Gallagher et al., 2010): "I walk around the track.... It is really nice, and you see people are running or jogging" (Gallagher et al., 2010, p. 107). Older adults also considered local destinations to be important for physical activity and socializing (Bjornsdottir et al., 2012; Marquez et al., 2014). In addition environments affording opportunities to see familiar faces (Gallagher et al., 2010; Strath et al., 2007; Van Cauwenberg et al., 2012; Walker and Hiller, 2007), those affording contact with nature and wildlife were important, as noted by a 93-year old: "I prefer to sit outside, its not so lonely being outside in the open. You can hear the birds, not so lonely as always being by yourself inside" (Walker and Hiller, 2007, p. 1161). Retirement offered older adults more time to spend engaging in the neighbourhood as a means to connect with others while staying active (Grant et al., 2010). Older adults were found willing to actively travel up to 45 minutes to get to their destinations if the proper infrastructure was in place to engage in pleasurable and purposeful activities: "Now I have enough time, so I can get on my bike and go to the library, and bike to church, or bike wherever I want to." (Strath et al., 2007, p. 419). Even if they have the time, however, if barriers are present, older adults are less likely to engage in an outdoor physical activity: "[Even with time] the absence of sidewalks, high traffic . . . I won't walk, why would I?" (Strath et al., 2007, p. 419).

Destinations were also important for some ethnic minority groups where, for example, cultural forms of physical activity such as traditional dances, were a preferred means of physical activity and socialization (Eyler et al., 2002, 1998). As noted by an American Indian woman: "I go to a pow-wow with my grandchildren and dance!" (Eyler et al., 1998, p. 644).

Table 2.1: Sample design, data collection approach, and analytical approach methods for studies included in the review (n=36).

Author and year of publication	Study location	Sample Design (n)	Sample n for qualitative data collection	Qualitative data collection approach	Analytical approach
Cleland et al. (2015)	Australia	Rural dwelling adults 18-55 yrs	49	Semi-structured interviews	Thematic analysis
Mitra et al. (2015)	Canada	Elderly adults >65 yrs	14	Photovoice and interviews	Thematic analysis
Mama et al. (2015)	USA	African American/Hispanic middle-aged women (age M= 43.9 ± 7.3 yrs)	8	In-depth interviews	Thematic analysis
Ivory et al. (2015)	New Zealand	Adults 18-65 yrs from varying neighborhood walkability and deprivation	Not stated	Focus groups	Thematic analysis
Marquez et al. (2014)	USA	Older Latino adults > 50 yrs	20	Exploratory focus groups	Thematic analysis
Belon et al. (2014)	Canada	Adults >16yrs from four communities both rural and urban	35	Photovoice and semi-structured interviews	Thematic analysis
Walton E. (2014)	USA	Adults 20-79 yrs of low income neighborhoods	27	Walk-along interviews and focus groups	Thematic analysis
Shuval (2013)	USA	Low income ethnic minority urban adults 30-54 yrs	25	Qualitative interviews	Thematic analysis
Bellows-Riecken (2013)	Canada	Undergraduate students, mean age 22.26 yrs	126	Qualitative written questionnaire	Thematic analysis
Eriksson et al. (2013)	Sweden	Adults 18-84 yrs	28	Focus Groups	Grounded Theory
Kilgour et al. (2013)	UK	Women 18-62 yrs	10	Group and individual interviews	Not stated
Bjornsdottir et al. (2012)	Iceland	Women >70 yrs living in retirement community	10	Interviews in home or retirement centre	Phenomenology
Lord et al. (2012)	Australia	Men >45 yrs	65	Focus group and semi-structured interviews	Thematic analysis
Mahmood et al. (2012)	Canada/USA	Older adults >65 yrs in Vancouver and Greater Portland	66	Photovoice and group discussion.	Thematic analysis
Stathi et al. (2012)	UK	Adults >70 yrs	25	Semi-structured interviews	Cpntent analysis
VanCauwenberg et al. (2012)	Belgium	Adults >65 yrs in urban or semi-urban areas	57	Walk-along interviews and structured interview	Content analysis
Zieff et al. (2012)	USA	Residents >18 yrs and city staff from low- and high-crime neighborhoods	101	Focus groups	Grounded theory
Casey et al. (2011)	Australia	Men 25-65 yrs from low-SES neighborhoods	25	Semi-structured interview	Content analysis
Cassou et al. (2011)	Brasil	Women >60 yrs from low and high SES neighborhoods	25	Focus Group	Content analysis
Montemurro et al. (2011)	Canada	Adults from urban city	63	Focus Group	Content analysis
Azar et al. (2010)	Australia	Women 18-30 yrs, with and without depressive symptoms	40	Semi- structured interviews	Thematic analysis
Gallagher et al. (2010)	USA	African American seniors >65 yrs in Detroit	21	Photovoice and Focus Groups	Content analysis
Grant et al. (2010)	Canada	Adults >65yrs who resided in same neighborhood >2 years	75	Focus Groups	Not stated
Mathews et al. (2010)	USA	Older adults >50 yrs from different ethnic minority groups	396	Focus Groups	Thematic analysis
Annear et al. (2009)	New Zealand	Older adults 65-91 yrs of high and low deprivation neighborhoods	63	Surveys and semi-structured interviews	Not stated
Caperchoine et al. (2009)	Australia	Women belonging to women walking groups	78	Focus Groups	Thematic analysis
Burgoyne et al. (2008)	Ireland	Adults from low-income neighborhoods	Not stated	Focus groups and unstructured interviews	Grounded theory
Dunn (2008)	USA	African American women 45-65 yrs	14	Focus Groups	Content analysis
Strath et al. (2007)	USA	Adults >55 yrs from low and high walkable neighborhoods	37	Survey with semi-structured interviews.	Content analysis
Walker et al. (2007)	Australia	Women 75-93 yrs living alone in the community	20	In-depth interviews	Grounded theory
Yen et al. (2007)	USA	Women with at least one child <18 aged 21-66 yrs in 3 neighborhoods	52	Focus groups	Thematic analysis
Ball et al. (2006)	Australia	Women 18-65 yrs from high and low-SES neighborhoods	37	Semi-structured interviews	Thematic analysis
Lockett et al. (2005)	Canada	Elderly 60-90 yrs from rural and urban neighborhoods	27	Photovoice and focus groups	Grounded theory
Burton et al. (2003)	Australia	Adults 18-60 yrs from low, middle and high individual-level SES groups	60	Semi-structured interviews	Not stated
Eyler et al. (2002)	USA	White, African-American, American-Indian and Latina women 20-50 yrs	Not stated	Focus Groups	Not stated
Eyler et al. (1998)	USA	Women > 40 yrs	Not stated	Focus Groups	Not stated

Table 2.2: Summary of findings related specifically to the built environment features and physical activity (PA) extracted from the reviewed studies (n=36)

Author	Functional	Safety	Aesthetics	Destination	Other Outcomes
Cleland et al. (2015)	(+) Footpaths	(-)Road safety related to large trucks and winding roads in rural (-) Traffic density in urban areas	(+) Nature changing with seasons in rural areas	(-) Facility hours not meeting needs (-) Not being able to walk/cycle places	
Mitra et al. (2015)	(-) Lack of benches, poor sidewalk quality	(-) Absence of street lights	(+) Nature and trees	(+) Proximity to parks, access to shops	
Mama et al. (2015)		(-) Criminal activity		(-) Lack of nearby PA facility	(-) Time, caretaking (+) Social support
Ivory et al. (2015)			(+) Greenery was restorative (+) Pleasantness/Beauty: running/walking in bush, beach as opposed to streets even if accessed by car	(+) Open spaces (fields, playgrounds, cemeteries...) *Nearness of destinations appeared to be more influenced by easy accessibility by car or frequency of use	(+) PA for social connection and mental restoration over and above specifically "health" reasons.)
Marquez et al. (2014).		(-) Lack of safety: crime (gangs and drugs) especially after dark. (-) Racial tensions, lack of jobs, lack of social cohesion (-) Non-crime safety (sidewalk cracks, traffic, weather, ice, snow, cold, extreme heat (fear of falling) (+) Longer time for elderly crossings, "elderly people present"		(+) Elders walk to stores for PA and socialization	(+) Family structure and passing on of PA values
Belon et al. (2014)	(+) Direct public transit access to PA facilities (+) Paths, sidewalks, shaded areas	(-) Sidewalk cracks for seniors (-) Surfacing materials under playgrounds (+) Street lighting (-) Traffic cyclist concerns. (-) Weather	(+) Green spaces: peace (+) Architecture. (-) Trash and vandalism, pollution (+) Promotion of group activities to counter crime.	(+) Recreation infrastructure (soccer fields, tennis courts) in walking distance for seniors and children, car owners reported unwilling to drive for recreation (-) Parks that are not conveniently located (-) Hours of operation of pools. (-) Expensive PA facilities	(+) Access to information on local activities. (+) Social aspects: motivation (peer support) for PA (-) Car culture and screen time (+) Free PA programs
Walton E. (2014)	(+) Improved access in traffic areas through pedestrian bridges.	(+) Safety of parks may increase their use at all hours of the day.	(+) Parks and courtyards	(+) Proximity to ethnic grocery store, proximity to parks increases their use (+) Park as an area that creates social ties	
Shuval (2013)		(-) Neighborhood crime		(-) Lack of exercise facilities and parks	(+) Social pressure to walk
Bellows-Riecken (2013)	(-) Weather		(-) Unaesthetic environments		(+) Social involvement (-) Conflicting with activities such as studies
Eriksson et al. (2013)		(-) Safety concerns more evident among females	(+) Neighborhood greenness = well-being	(+) greenspaces, work, school, family, friends, leisure.	(+) "Hi factor": inclusivity and joy from being greeted

Table 2.2: Summary of findings related specifically to the built environment features and physical activity (PA) extracted from the reviewed studies (n=36) (continued)

Kilgour et al. (2013)		(-) Fear of dark (+) Familiarity of geography and people, previous experiences			
Bjornsdottir et al. (2012)	(+) Non-slippery sidewalks.	(-) Wind, ice, hills/stairs (+) Familiar surroundings	(+)Importance of "fresh air"	(+) Good outdoor areas, proximity to shops	(-) Low encouragement from family, staff and culture.
Lord et al. (2012)		(-) Winter sleet, summer temperatures		(+) Facility access	(+) Positive community environment
Mahmood et al. (2012)	(+) Getting there: convenient public transit: both scheduling and infrastructure (+) Comfort in movement: easily accessible sidewalks and walkways, safer parking lots, benches, drinking fountains (facilitator), clean public bathrooms. Shade, railings to stairs	(-) Sidewalks ending, having to walk in the street, improper lighting. (-)Traffic hazards (cars speeding, heavy traffic, unsafe drivers), lack of crossings (-) Signs of poverty, drugs, criminal activity, vandalism, poor housing	(+)	(+) Diversity of Destinations: parks, greenspace, markets, festivals	(+) community based programs (+) peer support: family, community gardening and activities, intergenerational programs
Stathi et al. (2012)	(+) Seating along walking routes, wide pavements, good bus service (-) Hills	(-) Weather and darkness (-) Fear of crime, lack of police presence	(+) Attractive local environments (-) Poor maintenance gardens. Lack of cleanliness, traffic noise, cars parked on sidewalks	(+) Local amenities in walking distance (high impact) such as post office, newsagent, food stores, shops, PA facilities (+) Accessible green space	(+) Friendly neighbors (+) Encouragement to be active, exercise companion (+) Past active habits.
VanCauwenberg et al. (2012).	(+) Walking facilities: sidewalks quality, crossings, benches (+) Connectivity (-) Increased risk of falling,	(-) Traffic safety (bus, behavior of road users including cyclists on sidewalk and careless car drivers) (-) Safety from crime (-) Weather	(+) Buildings, natural elements (-) Noise, smell	(+) Access to facilities (+) Non-residential uses of land (+) Public transit	(+) Familiarity, social contact
Zieff et al. (2012)		(-) Violent Crime and non-violent crime (litter, garbage, dog waste, drug paraphernalia) (-) Low SES neighborhoods: vacuums where lack of function led to low police involvement/ crime		(+) Parks, community gardening, YMCA (+) Increased access to information on places to go to get PA was important.	(-) Racial profiling in some low income neighborhoods
Casey et al. (2011)		(-) Fear of violent neighborhoods preventing men from leaving house: stems from lack of community trust.		(-) PA facilities lacking quality (no people to explain machines)	(+) Affordability (few inactive men recognized potential for free PA)
Cassou et al. (2011)		(-) Safety was more of a concern ore among low SES (-) Fear of injury			(-) Lack of social support among high SES women (-) Environmental barriers amongst low SES women

Table 2.2: Summary of findings related specifically to the built environment features and physical activity (PA) extracted from the reviewed studies (n=36) (continued)

Montemurro et al. (2011)	(-) Lack of path connectivity and quality	(-) Winter walking and traffic	(+)Natural walking area such as river in walking distance promoted walking for leisure	(-) Adults preferred car use to travel and report walking mainly for leisure (+) Dog park important. (+) Recreational infrastructure for children (-) Matching infrastructure to community needs (unused baseball diamonds)	(-) Cost barrier for PA. (+) Information on local recreational activities desired. (+) Social capital and community
Azar et al. (2010)	(+) Footpaths	(+) Proper lighting		(+) Facilities (tennis, courts), dog park (+) Community center activities that are publicized	(-) Women with depressive disorder more likely to report past negative PA experiences,
Gallagher et al. (2010)	(+) Shade, shoveled sidewalks (-) Sidewalks that end, ice (+) Walking trails (+) Amenities: places to eat, use washroom and rest	(-) Criminal activity (-) Isolated trails with poor visibility (-) Fear of dogs (+) Senior patrol, police, early morning walking	(+) Peaceful, beautiful scenery (+) Gardens and parks (-) Vacant houses, overgrown lots, trash (+) Presence of animals: brids and squirrels (+) Enjoyment of fresh air	(+) Historical destinations with meaning	(+) Presence of people and familiar faces (+) Seeing others being physically active.
Grant et al. (2010)	(+) Getting around: fitting walking within an integrated transportation system that includes the elderly (-) Experiencing ambiguity (right of way)	(-) Navigating hostile walking environments such as ending sidewalks	(+) Personal meanings given to green space,		(+) Meaningful relationships
Mathews et al. (2010)		(-) Fear of falling,		(-) Distance to recreation facilities as a barrier. (+/-): Church as barrier or support	(-) Assimilation for indigenous people (+) Having non-PA related transportation be less convenient to encourage walking
Annear et al. (2009)		(-) Traffic/speed/noise/air pollution.	(+) Attractive and walkable surroundings (parks, gardens, attractive paths) (+) Pride in ownership	(+) Well-served leisure environment	(+) Social support
Caperchoine et al. (2009)		(-) Traffic/lighting/animals (-) Gangs/unfamiliar people			(-) Childcare (-) Lack of support
Burgoyne et al. (2008)		(-) Lack of cleanliness, garbage (cans, glass, old fridges and cars…), (-) lack of lighting, gangs.		(+) Need for gym/ pools in walking distance for families with only 1 car who rely on public transit.	(+) Community contentment: personally, socially and environmentally content
Dunn (2008)		(-) Unsafe neighborhood			(-) Lack of family support, family obligations, (+) Most compelling reason to walk in was to help others

Table 2.2: Summary of findings related specifically to the built environment features and physical activity (PA) extracted from the reviewed studies (n=36) (continued)

Strath et al. (2007)	(+) Presence and maintenance of sidewalks, (+) traffic control for streets, bicycle lanes and trails.	(+) Separating walkers and cyclists from motorized traffic. (+) Sense of personal safety for women especially	(+) Living things like trees (+) Scenic route chosen even if it is longer	(+) Retail and entertainment (restaurants), parks, recreation, natural areas, libraries, churches. (+)Older adults willing to walk for transportation 20 to 45 min to engage in pleasurable and purposeful activities.	(+) Social environments and social support.
Walker et al. (2007)	(-) Elderly felt that lack of ramp access excluded them from certain areas.	(-) Elderly women took inordinate steps to ensure that door and windows were locked and secure.	(+) Outdoors areas with birds counteracted feelings of loneliness	(+) Access to destinations within walking distance was comforting for elderly who were going to stop driving soon.	(+) Social capital (-) Difficulty to make new neighbor friends in elderly
Yen et al. (2007)		(-) Unsafe parks in low SES areas (+) Improved maintenance and police presence in parks (-) Gangs, drug dealing, loitering, explicit sexual behavior		(-) Fast food destinations viewed as hazard resulting car traffic and unsightly garbage (-) Low-SES women perceived neighborhood area is 1/4th that of high-SES women (+) Parks/facilities used in high SES areas	(-) Neighborhood characteristics vary by income and inform adults' opinions of hazards and resources as well as their behaviors.
Ball et al. (2006)		(-) Crime issue in low SES groups		(+) Low SES more likely to participate in transport related PA (walking cycling) as opposed to high SES (gym, sports...)	(+) Family PA in low-SES. (+) Dog walking common to all SES groups.
Lockett et al. (2005)	(+) Amenities such as benches and washrooms	(-) Traffic hazards (crosswalks, light timing, cars) (-) Fall hazards: slopes, ending sidewalks, cracks, lack of railings, stairs, snow, ice	(+) Waterfalls and trees mentioned		
Burton et al. (2003)		(+) Environmental safety		(+) Aesthetics	(+) Social support
Eyler et al. (2002)	(-) Lack of sidewalks and uneven pavement for walking	Weather and daylight (-) Traffic (-) Presence of homeless, drug dealers or drive-by shootings (-) Dust, traffic, insects, dogs		(-) Distance to facilities makes walking difficult	(-) Multiple women's cultural duties/roles: wife, daughter, mother, worker (+) Social support (+) Traditional/cultural PA as motivational.
Eyler et al. (1998)		(-) Fear of darkness outdoors and crime	(+) Scenic places to exercise		(+) Women enjoyed dancing (powow, jazzarcise...) (-) lack of social network

2.5 Discussion

Our review of qualitative studies, similar to previous reviews of quantitative (Sugiyama et al., 2012; Van Cauwenberg et al., 2011) and qualitative evidence (McCormack et al., 2010; Moran et al., 2014), confirmed the importance of the built environment for influencing different types of physical activity (transportation walking, recreational walking, bicycling, running, sports, and other outdoor activities) among adults. For example, street connectivity and nearby destinations were consistently acknowledged in the qualitative studies reviewed as important for supporting transportation-related physical activity. Functional features that increase street or pedestrian connectivity, that create physical activity opportunities for all physical abilities and ages, and that support different transportation modes were important for supporting physical activity. Safety features such as lighting, the creation of safe public areas for socializing, and infrastructure that separate pedestrians, cyclists and motorized traffic were found to positively impact physical activity. Aesthetic features including natural elements (e.g., vegetation, waterfalls, beaches), greenery, and the presence of interesting destinations were important for motivating people to be physically active, increasing the time people spend outside, and for providing restorative benefits to people while they walk for leisure, bicycle, and participate in other outdoor activity.

Our review findings illuminated the lived experience shaping associations between the built environment and physical activity. Specifically, age and other sociodemographic characteristics contributed to perceived built environment enablers and barriers of physical activity, and in some cases the built environment (e.g., the presence of police in local public area) even had a differential effect on physical activity of individuals depending on their

sociodemographic characteristics. Older adult perspectives on built environment enablers and barriers on physical activity were consistent with findings from a previous review of qualitative evidence, which found pedestrian infrastructure, safety, aesthetics, and access to nearby destinations, rest areas with benches, and washrooms to influence physical activity (Moran et al., 2014). We found that safety and functionality features and destinations were important for supporting recreational and transportation physical activity among older adults.

Fear of falling was a major concern among older adults. Environments, including slippery floors, poor lighting and uneven surfaces, are a major risk factor for falls in older adults (Todd and Skelton, 2004). Some older adults restrict their physical activity, as well as activities of daily living, because of their fear of falling (Fucahori et al., 2014), which in turn can increase the risk of falls because of the decline in muscle strength and proprioception that results from decreased physical activity and the aging process (Delbaere et al., 2004). Because of conditions such as chronic diseases and limited mobility, older adults sometimes reported pathways and sidewalks with uneven slippery surfaces, and no amenities such as benches, washrooms and railings, heightened their fear of falling and restricted their physical activity. Our review findings also highlighted the importance of creating neighbourhood built environments that allow aging in place. For example, destinations within walking distance to home that support physical activity were used more often by older adults. As the world's population is rapidly ageing, the World Health Organization is emphasizing the importance of engaging cities to promote active ageing in place (World Health Organization, 2007). Shorter walking distances to destinations and amenities in supporting active transportation became more important with advancing age. Notably, active transportation is associated with improved overall fitness and health benefits

(reduced BMI, hypertension, waist circumference, triglycerides, stress) (Avila-Palencia et al., 2017; Berger et al., 2017; Boone-Heinonen et al., 2009; Ming Wen and Rissel, 2008).

Findings from our qualitative review highlighted consistent evidence regarding the importance of the social environment, and notably built characteristics that encourage or enable social interactions, in supporting physical activity. The importance of the social environment for supporting physical activity has also been found in quantitative studies (Wendel-Vos et al., 2007). The presence of social spaces where neighbors could meet one another provided individuals with a sense of safety in neighbourhoods that were perceived to be unsafe. Building trust in the community through social events and social spaces could improve physical activity by making residents feel safer, other elements that relate to perceived sense of safety include built environment elements (lighting and maintenance), individual factors (gender and age), passive surveillance (likelihood that neighbors are watching), and the time of day (Foster and Giles-Corti, 2008). The multifaceted evidence from our review reveal that social spaces also act as incentives for individuals to be active when they offer opportunities to see friendly faces. In addition to providing a sense of community, knowing that others (even if not known by name) in the community may be watching could provide sense of safety. Previous quantitative literature has not consistently found sense of community to be associated with physical activity, however these studies were limited as "sense of community" is difficult to measure objectively (Foster and Giles-Corti, 2008). Environmental characteristics that have been associated with heightened sense of community include low residential density, low mixed land and high walkability (French et al., 2014). However, objective measures of low density and low residential density are correlated with low walkability in most quantitative studies, our study illuminates how the

non-objective dimensions such as "sense of community" could complicate these associations (McCormack and Shiell, 2011; Renalds et al., 2010; Wendel-Vos et al., 2007). Our findings show for example that neighbourhood cultural activities such as pow-wows could also help develop a sense of community. Thus in neighbourhoods with a predominant ethnic group, customizing the physical activity opportunities to cultural needs and creating culturally appropriate opportunities for socializing such as traditional dances could contribute to the sense of community, perceived safety and increase physical activity.

Our review findings reinforce the need for synergy between transportation planning, urban design, landscape architecture, road engineering, parks and recreation, bylaw enforcement, and public health to be involved in creating neighbourhood environments that support physical activity (Giles-Corti et al., 2015). Our findings, also suggest that there is a need for local neighbourhood citizens and associations with representation from individuals and groups with different sociodemographic backgrounds to have input into neighbourhood environment planning process. The process of engagement and actual engagement of local residents can often impact if and what built environment modifications occur in neighbourhoods (Rock et al., 2016a). Similar to previous reviews (McCormack et al., 2010; Moran et al., 2014), our findings suggest that neighbourhood physical infrastructure that supports physical activity is important, but not a sufficient enabler for physical activity and that the sociodemographic profile of the neighbourhood as well as other social environmental, cultural, and historical factors need to be considered when promoting physical activity. Physical activity interventions informed by the socioecological framework (Giles-Corti and Donovan, 2003) which incorporate components that target individual, social environmental, physical environment, and policy and regulatory

determinants are more likely to encourage behaviour change. Previous research shows that combining built environment changes with other health promotion and behaviour change strategies have been successful in increasing physical activity in adults (Brown et al., 2006). For example, a community strategy to promote walking that involved health marketing, health promotion strategies from health care providers and environmental strategies, such as signage and pathways repairs, lead to modest increases in physical activity in adult women (Brown et al., 2006).

Our findings are impacted by the methodological rigor and limitations of which there are several, of the individual qualitative studies included in our review. Although no studies were excluded for methodological reasons, transparency of sources, analysis, reflexivity and rich data (Bansal and Corley, 2011) were not always described in the studies included in our review. Moreover, we included both citations and authors' interpretations in our analysis. Thus, both the points of view of the authors of the original studies and the qualitative findings presented in these studies influenced our synthesis and interpretations of findings. Despite incorporating qualitative evidence only, our review is not impervious to publication bias – studies with uninteresting, or conventional findings in relation to the built environment and physical activity may be underrepresented in our review because they have not been published in the peer-reviewed literature. It is possible that by including only published peer review qualitative studies in our review; the association between the built environment and physical activity has been overemphasized. Nevertheless, our general findings do reflect those reported in other quantitative and qualitative reviews, that is, the neighbourhood built environment is associated with physical activity. In addition, the studies included originated from several areas in the world

indicating that barriers and supports to physical activity in the built environment are similar in different countries.

Our review accounts for lived experiences in adults' current neighbourhood environment when deciding to be physically active or when undertaking physical activity. No studies included in our review captured the lived experience in relation to changes in neighbourhood environment and physical activity change over time (e.g., as part of residential relocation studies or natural experiments). There have been calls for more natural experiment research investigating the relations between the built environment and physical activity to better evaluate temporal causal pathways (McCormack and Shiell, 2011; Montemurro et al., 2011). While these calls seem to emphasize quantitative study designs, there similarly needs to be more natural experiments that incorporate qualitative data collection. Natural experiments are recommended to understand the impact of large-scale interventions on health; however, such experiments may be vulnerable to bias. Combining methods is one recommended way of addressing this bias and contributing to the plausibility of any causal inferences (Craig et al., 2012). Mixed method study designs within natural experiments, such as those that have been used in recent park-related studies (Goodman et al., 2012; McCormack et al., 2016; Prins et al., 2016; Rock et al., 2016b) will provide a fuller understanding regarding the plausibility of the causal relations between the built environment and physical activity.

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CHAPTER 3

A mixed methods study on the barriers and facilitators of physical activity associated with residential relocation

3.1 Abstract

Quantitative evidence suggests that neighbourhood characteristics are associated with physical activity. Despite this evidence, very few mixed methods studies (combined quantitative and qualitative approaches) have investigated how relocating neighbourhood, and subsequent changes in the built environment, might influence physical activity. This sequential mixed methods study has two objectives: 1) to estimate associations between self-reported changes in overall physical activity and transportation walking and cycling and changes in objectively-assessed neighbourhood walkability (Walk Score®), and; 2) to describe perceived individual, social and environmental barriers and facilitators to physical activity following residential relocation. In 2014, a random sample of Calgary adults completed an online survey capturing physical activity and sociodemographic characteristics, residential relocation within the past 12 months, and perceived changes in physical activity since the relocation. Among participants who reported relocating neighbourhood (n=97), 14 completed semi-structured qualitative interviews about barriers and facilitators to physical activity. On average, walkability improvers reported a slight increase in transportation walking, while walkability decliners on average reported little or no perceived change in their transportation walking after relocation (difference approached statistical significance, p=0.053). Walkability decliners reported on average a slight decrease in transportation cycling, while walkability improvers on average reported little or no perceived change in their transportation cycling after relocation (statistically

significant difference, $p<0.05$). Change in walkability was not associated with perceived change in overall physical activity. Our qualitative findings suggest that moving to a more walkable neighbourhood supported increases in transportation walking and cycling. In particular safe paths connecting to nearby destinations were found to facilitate transportation walking and cycling. Notably, some participants describe adjusting their leisure physical activity levels to compensate for changes in transportation walking and cycling resulting from residential relocation to maintain overall physical activity levels and this was supported by the quantitative findings. Strong contributors to neighbourhood leisure physical activity included the presence of appealing or aesthetic features (greenery, scenery) and availability of recreational opportunities that allow for the creation of social connections with community, family and nature. Future interventions that leverage caregiver-family relationships, increase local opportunities for interaction with natural settings and improve built characteristics associated with walkability can promote leisure and transportation physical activity.

3.2 Background

In recent decades, increasing research and political interest have focused on interventions that modify neighbourhood built environments to facilitate physical activity (Giles-Corti et al., 2015). However, evidence informing these interventions is mainly derived from cross-sectional studies (Durand et al., 2011; Wendel-Vos et al., 2007). Cross-sectional studies cannot provide temporal evidence and are vulnerable to biases that may result in spurious associations, making it difficult to infer causality between the built environment and physical activity (Bradford-Hill, 1965; McCormack and Shiell,

2011). Quasi-experimental and longitudinal studies are vital to illuminating causal relationships between the built environment and physical activity (McCormack and Shiell, 2011). Despite these more rigorous study designs providing estimates of temporal relations between the built environment and physical activity (Knuiman et al., 2014; Prins et al., 2016) they provide limited evidence about why, how, and under what conditions, these relationships exist. Qualitative, and indeed a mix of qualitative and quantitative research approaches, are needed to understand the pathways by which the built environment is associated with physical activity.

Quantitative research findings suggest that neighbourhood connectivity, residential density, land use mix, diversity of destinations and indices of overall walkability, including Walk Score® (a publicly available, objectively-derived walkability indicator) are associated with physical activity in longitudinal residential relocation studies (Beenackers et al., 2012; Giles-Corti et al., 2013; Hirsch et al., 2014). Hirsch et al. (2014) found that participants moving to a neighbourhood with a higher Walk Score® reported an increase in transportation walking but reported no change in their leisure walking. Further, changes in neighbourhood safety, availability of outdoor spaces, aesthetics, access to public transportation, and physical activity opportunities have been associated with perceived physical activity change in quasi-longitudinal residential relocation studies (Aditjandra et al., 2015; Handy et al., 2008; Milakis et al., 2015). Others have found perceptions of the neighbourhood built environment to be associated with changes in walking and cycling (Sugiyama et al., 2014; Van Dyck et al., 2012). Compared with objectively-determined access to destinations, perceived access to

destinations may have greater impact on adult's decisions to walk for transportation (Gebel et al., 2011; Knuiman et al., 2014).

Few qualitative studies on the built environment and physical activity exist (McCormack et al., 2010; Moran et al., 2014). Qualitative research has explored how built characteristics such as safety, functionality, destinations and aesthetics influence physical activity preferences (Belon et al., 2014; Montemurro et al., 2011; Moran et al., 2014). Nevertheless, such studies call attention to barriers and facilitators to physical activity specific to sociodemographic groups (Belon et al., 2014). For example, functional features such as railings, benches, washrooms and shade along pathways encourage walking among older adults (Gallagher et al., 2010; Lockett et al., 2005; Mahmood et al., 2012; Mitra et al., 2015; Stathi et al., 2012; Walker and Hiller, 2007) while fear of crime may be a barrier to outdoor physical activity especially among socioeconomically disadvantaged populations (Ball et al., 2006; Cassou et al., 2011; Eyler et al., 2002; Yen et al., 2007; Zieff et al., 2012). Specific aesthetic features, including greenery, parks and gardens, may motivate walking in adults as these features confer feelings of peace and restoration (Annear et al., 2009; Belon et al., 2014; Eriksson and Emmelin, 2013; Gallagher et al., 2010; Ivory et al., 2015; Lockett et al., 2005; Van Cauwenberg et al., 2012). Although one qualitative study found that changes in commuting habits following relocation was motivated by convenience, speed, cost and reliability of transportation mode (Jones and Ogilvie, 2012), few qualitative studies explore how changes in the built environment following relocation impact physical activity. Qualitative study of adults who have relocated neighbourhood will generate participant descriptions and

comparisons of how and why their experiences being physically active change in different lived environments.

This sequential mixed methods study has two objectives: 1) estimate the associations between perceived changes in walking and cycling for transportation and overall physical activity and changes in objectively-assessed neighbourhood walkability (Walk Score®), and 2) describe perceived built environment barriers and facilitators to physical activity following neighbourhood relocation. Informed by previous evidence (Beenackers et al., 2012; Giles-Corti et al., 2013; Hirsch et al., 2014), we hypothesized that improvements in objectively-assessed walkability would be associated with a perceived mean improvement in transportation walking and transportation cycling when compared with decrease in objectively-assessed walkability. Through these objectives, we provide novel evidence about individual, social and environmental factors that potentially influence changes in physical activity following a residential relocation.

3.3. Methods

3.3.1 Study Design

Our mixed methods sequential study design included two phases and we placed greater emphasis on qualitative findings that help interpret our quantitative results (Leech and Onwuegbuzie, 2009). Phase I is a quantitative descriptive analysis of existing survey data on changes in physical activity behaviours and changes in the built environment following residential relocation. Phase II is a narrative study, specifically, a qualitative

analysis of narratives, through which we explore participant reasons for the behaviour change following residential relocation. At its foundation, narrative research is about collecting and describing participants' stories – or "consequential linkings" of experiences (Riessman, 2005) then interpreting the meanings of those experiences. Stories provide access to the richness of experience because people use stories to reflect who they are, what they have experienced, and what and how they wish to share their "internalized world" with others (Smith and Sparkes, 2009). Thus through stories, researchers may obtain in-depth insight into participants' experiences. In our mixed methods study, analysis of narratives is used to add meaning and understandings of lived experiences to help explain the changes in behaviour evident in the quantitative results.

3.3.2 Sample design and participant recruitment

In 2014, a large stratified random sample of Calgary households (n= 10,500) were sent survey packages, of which n=1023 adults completed online and postal surveys. A full description of the sampling and data collection are detailed elsewhere (McCormack et al., 2017; McInerney et al., 2016). For this study, we drew upon n=113 participants who reported relocating neighbourhood in the past 12 months. Of these, 16 moved to a neighbourhood of same walkability (based on Walk Score®), 49 moved to a less walkable neighbourhood, and 48 moved to a more walkable neighbourhood. For our quantitative analysis (Phase I), we included data from all 97 survey respondents who experienced a change in neighbourhood walkability after the relocation. For the qualitative analysis (Phase II), we reached out to 42 survey respondents who had relocated neighbourhood and agreed to be contacted for future research, of which 14

agreed to participate in a semi-structured interview. This sampling strategy allowed us to capture, compare and contrast adult's perceived barriers and facilitators to physical activity in relation to their experience residing in two physically different neighbourhood environments. The University of Calgary's Conjoint Health Research Ethics Board approved this study. Verbal informed consent from participants was obtained prior to commencing interviews. Anonymity of participants was protected by assigning pseudonyms, eliminating identifying information, and paraphrasing content.

3.3.3 Data collection

Phase I: Data collection via online and postal surveys, was completed in 2014 (McCormack et al., 2017; McInerney et al., 2016). Sociodemographic variables relevant to the current study captured from the survey included sex, age, education level, dog ownership and presence of injury that impacted walking. Physical activity variables included respondents' perceived change in their transportation walking, transportation cycling, and overall physical activity since their relocation. Response options for these three physical activity items were captured on a 5-point scale: (1) a lot less now, (2) a little less now, (3) about the same, (4) a little more now and (5) a lot more now (Appendix E). Perceived quasi-longitudinal changes in physical activity have been captured with similar response options elsewhere (Aditjandra et al., 2015; Milakis et al., 2015) and have acceptable test–retest reliability (Handy et al., 2008). Participants reported their previous and current neighbourhood name and/or postal code (Appendix F). Walk Score®, available for 6-digit Canadian postal codes, was aggregated to the neighbourhood administrative-level and used to estimate the walkability of the

participants' previous and current neighbourhoods. Aggregation of Walk Score® was undertaken because not all movers could accurately recall the postal code of their previous households, but all could recall the name of their previous neighbourhood. Due to the date the quantitative data were collected we used the previous version of Walk Score® (estimated based on distance to 12 destinations posited to be important for walking). Notably the previous version of Walk Score® did not capture built characteristics such as personal safety, aesthetics and attractiveness, and streetscape pedestrian infrastructure, all of which may be associated with leisure walking and other physical activity (Brookfield and Tilley, 2016; Owen et al., 2004; Pikora et al., 2006).

Phase II: Qualitative data were collected through individual semi-structured telephone interviews each lasting approximately one hour. Our interview guide included questions to elicit information about individual, social and environmental barriers and facilitators to physical activity, although given the focus of this study, our emphasis was on understanding the neighbourhood built environment determinants (Appendix G). We used an existing conceptual framework to develop interview questions related to the built environment. This framework organizes the potential environmental influences on walking and cycling into four constructs: aesthetics (i.e. cleanliness, greenery, pleasant sights), functionality (i.e. direct routes, path maintenance, street design), destinations (i.e., local facilities, services, public transportation) and safety (i.e. traffic and crime safety) based on previous literature and expert consultation (Pikora et al., 2003). This conceptual framework has been used to guide extraction and reporting of the built environment and physical activity findings in both qualitative (Cleland et al., 2015) and quantitative

studies (Bentley et al., 2010; Cleland et al., 2015; McCormack et al., 2004). The interview guide was pilot tested internally to ensure that questions were understandable and likely to elicit rich descriptive responses. A trained graduate student conducted interviews, which were audio-recorded and transcribed verbatim.

3.3.4 Data Analysis

Phase I: Walk Score® change between participants' previous and current neighbourhoods, regardless of the magnitude, was used to dichotomize participants as being a "walkability improver" or "walkability decliner". Due to the small sample, we were unable to undertake a sensitivity analysis to test the influence of other Walk Score® cut-points for identifying walkability improvers or decliners. We analyzed perceived change in each physical activity as numerical outcomes using the original 5-point scale (i.e., values equal to 3 indicated no perceived change; values below 3 indicated a perceived decrease, and; values above 3 indicated a perceived increase in physical activity).

We estimated descriptive statistics and frequencies for the sample sociodemographic characteristics (i.e., gender, dog ownership, car use, marital status, education level, presence of dependents, and presence of injury) stratified by residential status (i.e. walkability improver vs walkability decliner). We used independent t-tests to assess the relations between perceived change in transportation walking, transportation cycling, and overall physical activity and changes in walkability ("improvers" vs. "decliners"). Informed by previous quantitative evidence (Hirsch et al., 2014), we used

one-tailed p-values to test our directional hypothesis that increasing walkability leads to increased physical activity after relocation, and decreased walkability leads to decreased physical activity after relocation. We use a significance level of alpha = 0.05 and SPSS version 22 (SPSS Inc., Chicago, IL, USA) was used to analyze our quantitative data.

Phase II: Our narrative informed data analysis (Creswell, 2013; Green and Thorogood, 2014; Polkinghorne, 1995) is consistent with Polkinghorne (1995), as we relied on stories that have a linear timeline including beginning, plot and denouement that allow us to understand present choices by linking them to prior events, specifically how residential relocation influenced physical activity behaviour change. We applied a three-dimensional space approach (Connelly and Clandinin, 1990) to analyze data from three dimensions: interactions (social, individual), continuity (time, before and after the move) and situation (physical environment). The interview transcription, handwritten interviewer notes and coding were managed electronically using NVivo 10.2.2 software. Analysis was iterative and occurred alongside data collection in multiple stages (Fraser, 2004). First, long interview segments were separated into individual stories by identifying scenes in which a plot unfolds and by scanning for story characters and chronology. Each story was then scanned for themes. We then re-scanned all stories and recordings for other dimensions that may have been missed upon first reading such as emotional, interpersonal and cultural dimensions. Next, the stories were examined for commonalities and differences to allow us to identify themes, patterns and differences between stories. Differences between stories were then examined in relation to the different environmental settings and socio-cultural contexts in which the participants are living. Themes were

discussed and refined among the co-authors. For the analysis of built characteristics, interviews were coded according to expected themes (functional characteristics, safety, destinations, and aesthetics). Characteristics that did not fit into the expected themes were coded separately.

3.3.5 Trustworthiness

Efforts to enhance the trustworthiness of our study began with "member checking" with participants during interviews and were followed with "peer debriefing" by developing and refining themes among co-authors (Green and Thorogood, 2014). To enhance transferability, the particularities of each story were described to illuminate context and relevance to other settings while dependability was enhanced by maintenance of an audit trail detailing the logic of data analysis decisions (Creswell, 2013).

3.4 Results

3.4.1 Quantitative Findings

We found no significant differences in the sociodemographic characteristics of walkability improvers and walkability decliners (Table 3.1). On average, walkability improvers reported a slight increase in transportation walking, while walkability decliners on average reported little or no perceived change in their transportation walking after relocation. This difference approached statistical significance (walkability decliner 2.96 ±1.12 vs 3.29 ±0.87, p=0.053) (Table 3.2). We also found that on average, walkability decliners reported a slight decrease in transportation cycling, while walkability improvers

on average reported little or no perceived change in their transportation cycling after relocation. This difference was statistically significant (walkability decliner 2.69 ±0.96 vs 3.02 ±0.84, p=0.039). Change in walkability was not associated with perceived change in overall physical activity, although both walkability improvers and decliners reported increases in overall physical activity after the move.

Table 3.1: Sociodemographic characteristics by residential relocation group

		Residential relocation group		
		Moved to less walkable neighbourhood (n=49) "decliners"	Moved to more walkable neighbourhood (n=48) "improvers"	P Value*
Sociodemographic characteristics		**Estimate[a]**	**Estimate[a]**	
Age, years (SD)		41.64±16.67	42.83±15.59	0.72
Have children <18 years, %		20.4	35.4	0.10
Sex, %	Women	73.5	49.3	0.95
Highest education achieved, %	High school	14.3	10.4	
	College	16.3	18.8	0.83
	University	69.4	70.8	
Marital status, %	Married/common-law	67.3	75.0	0.41
Dog ownership in past year, %	Owner	36.7	54.2	0.09
Motor vehicle access, %	Never/don't drive	12.2	6.3	0.31
Injury in past year, %	No injury	65.3	79.2	0.13

[a] Percent estimated for categorical variables and mean estimated (SD) for continuous variables. *Pearson's chi-square estimated differences for categorical variables and T-test estimated differences for continuous variables.

Table 3.2: Differences in mean activity change by residential relocation group

	Residential relocation group		
	Moved to less walkable neighbourhood "decliners" (n=49)	Moved to more walkable neighbourhood "improvers" (n=48)	P Value [a]
Activity	**Mean±sd**	**Mean±sd**	
Walking for transportation	2.96±1.12	3.29±0.87	0.053
Cycling for transportation	2.69±0.96	3.02±0.84	0.039 [b]
Overall physical activity	3.29±1.06	3.29±0.97	0.489

[a]T-test estimated differences for activity change means.

[b]Estimate is significantly different between groups at p<.05.

3.4.2 Qualitative findings

Our 14 interview participants were 12 women and two men. Nine participants increased walkability ("improvers") while five decreased walkability ("decliners") after relocating neighbourhood (Table 3.3). We generated three broad themes of influences on changes in physical activity after relocating: 1) the built environment and getting "around"; 2) neighbourhood opportunities that offer "a chance to connect", and; 3) adjusting or adapting physical activity behaviours in response to a new environment. The built environment and getting "around" theme, was comprised of four sub-themes: a) functional attributes (i.e. street pattern preferences), b) safety features (i.e. exposure to traffic and feelings of security) c) aesthetic features that support versus not aesthetic features that act as barriers to physical activity, and d) nearby destinations that encourage active transportation choices. The second theme, neighbourhood opportunities that offer "a chance to connect" was divided into two subthemes; a) characteristics that enable physical activity while connecting with family and community, b) characteristics that allow for connections with nature and feelings of sustainability. The third theme of adjusting or adapting physical activity behaviours in response to a new environment describes how different built characteristics allowed for changes in transportation and leisure physical activity.

Table 3.3: Qualitative sample characteristics (n=14)					
Pseudonym	**Age**	**Gender**	**Change in transportation walking since relocation**	**Change in transportation cycling since relocation**	**Change in overall physical activity since relocation**
Walkability Improvers					
Becky	23	Female	increase	same	increase
Eva	30	Female	increase	increase	increase
Alexia	45	Female	increase*	same	same
Caroline	32	Female	increase*	same	same
Chrissy	32	Female	increase	increase	increase
Melina	33	Female	increase*	increase*	increase*
Marie	48	Female	increase	increase	increase
Denise	41	Female	same	same*	increase*
Victor	43	Male	increase	increase	increase
Walkability Decliners					
Rosa	30	Female	increase	same	increase
Eric	33	Male	decrease	decrease	increase
Laura	56	Female	decrease	decrease	same
Emilia	66	Female	increase	N/A*	same
Bernadette	-	Female	decrease	decrease	decrease

* Indicates that participant changed their initial answer from the quantitative survey during the qualitative interview

3.4.2.1 The built environment and "getting around"

Functional features

Street pattern preferences according to physical activity context

Some participants report grid pattern streets allow ease of access from point A to B (i.e., improving way finding). Marie describes her new more walkable neighbourhood by noting: "I live in kind of old fashioned streets where they go straight north and south, east and west so you don't have to go out of your way to get somewhere". Although some participants appreciate having relocated to grid-like neighbourhoods for ease of getting around via active transportation, others prefer curvilinear street patterns as these streets allow exploration of different areas during leisure time walking, as Alexia explains: "The roads are not as uniform, so I find I can explore a little bit more when I walk through this neighbourhood rather than the other neighbourhood. […] it's a bit more enticing I guess.

[…] there's more parks with cul-de-sacs, there's unusual walking roads, there's different options rather than the other house I was just living on a street and I [could go] to the left or right." These participants suggest that grid pattern neighbourhoods may support transportation walking while curvilinear street patterns could support leisure walking and cycling.

Safety

"Not very pedestrian friendly": high traffic areas that encourage car use

In some neighbourhoods, the presence of large boulevards encouraged participants to use their cars instead of walk. They feel that car drivers are not looking out for pedestrians or cyclists at intersections. In areas of high traffic, having crossings separated from roads, such as pedestrian bridges made participants feel somewhat safer. Melina, who enjoys transportation walking in her current more walkable neighbourhood, describes having rarely walked to amenities in her old neighbourhood as she had to cross a large, busy boulevard: "[In previous neighbourhood], I was definitely less active just because I lived beside a main thoroughfare so it's definitely not safe for cycling and I just found it much easier to get around there by car than by cycling […] it's not very pedestrian friendly to cross [the thoroughfare]. It's dangerous, it's loud, you have to run across the boulevard to make sure that you get across in time […] it would be better if there was a pathway or a bridge going over." Participants explain that pathways that are separate from motorized traffic and connected to destinations of interest allow them to feel safer and increase their walking and cycling for leisure. Denise (walkability

improver) notes that in her previous neighbourhood: “there weren’t as many walking paths or quiet areas, [it] was a lot busier with a lot more traffic so I tended not to go out as much. Whereas in [my current neighbourhood], it’s a lot quieter being closer to [a large provincial park], walking distance to stores and so I find I’m a lot more physical in this neighbourhood than I was.”

Cyclists find that separating bike paths from traffic is both safer and less exhausting as noted in Eva’s description of traffic lights in her current more walkable neighbourhood: “to stop on a bike and then to keep going takes a lot of energy (…) It’s more encouraging if you don’t have to ride with the traffic. I used to ride on [the street] but it was really miserable[…] Now, I’ve rerouted to the pathways along the river so it’s more enjoyable, it definitely encourage[s] more physical activity.” Relocating to a more walkable neighbourhood, and gaining access to pathways separate from motorized traffic, encourages participants to use active modes of transportation on the grounds of safety afforded by pathways, bike lanes and cycle tracks.

Participants who relocated to neighbourhoods with a limited number of motor vehicle entry points appreciate how this feature offers protection from high traffic volumes and supports physical activity in a peaceful environment. Denise (walkability improver) says: “[My new neighbourhood] is safer because there are only two entry points so that helps to cut down on traffic […]. Whereas in [my previous neighbourhood], there was definitely a lot more traffic […] I don’t like being around traffic, […] so I […] didn’t get out as much in that (previous) neighbourhood. Whereas here, I’m more inclined to go out because I know there won’t be as much traffic”. Exposure to built

characteristics that reduce interactions with traffic by diminishing neighbourhood traffic encourages increases in both leisure and transportation walking and cycling while supporting a more pleasant experience.

"Confidence in the community"

Feelings of security are important in participant descriptions of expanding their outdoor exercise hours after dark in neighbourhoods with which they are familiar. Bernadette describes feeling safer in her new, less walkable neighbourhood given the confidence she has in her neighbours: "I can easily walk during the day and the evening or even at night, I don't really have anything that I'm concerned about […] because of that confidence I have with the community, I feel it is a safe place". Participants do not report changes in the actual level of criminal activity in their new neighbourhoods as making them change their physical activity, but rather speak in terms of confidence in their new neighbours as determining their physical activity habits.

Aesthetics

"It just feels better": physical activity near greenery and nice surroundings

The presence of nature or natural features is a motivator for neighbourhood physical activity. Participants who relocated from neighbourhoods that contained smaller parks to neighbourhoods with larger parks report that the larger parks increased their walking for leisure. Participants indicate being drawn to greenery and nature and prefer to be physically active amidst nature during their leisure time for the calmness, peace and

quiet nature provides. Chrissy (walkability improver) reports: "It just feels better to have nice lush trees and a nice surrounding. It's more encouraging to want to go out." Large parks are described by Denise (walkability improver) as offering nature's restorative properties: "It's a lot quieter, there's a lot more wildlife [in new neighbourhood] […] to me that makes it a lot more peaceful (than previous neighbourhood)". Mature trees lining streets, community and private gardens, yards and parks are mentioned as spaces for connecting with nature. Participants also claim that compared to newer neighbourhoods/areas with many rental properties, in older neighbourhoods, homeowners tend to have more pride in ownership and are likely to have invested in features such as varied architecture and gardens which can motivate participants to walk for leisure and enjoy surroundings. Alexia (walkability improver) describes her increased walking behaviour in an architecturally mixed neighbourhood: "unique houses in this area. There's small ones and big ones. Whereas the other [neighbourhood] was more smallish houses. [This neighbourhood is] more interesting […] I enjoy walking around and looking at the different things that people have done to their homes so I would say it does [motivate me to walk more]." For many participants, having relocated to neighbourhoods with large parks and attractive or interesting views or scenery increased leisure walking.

"Too many cars": un-aesthetic barriers to physical activity

Participants report the presence of cars as unattractive and discouraging to spending time outside. Specifically, cars parked on lawns and the presence of large parking areas make neighbourhoods less attractive and discourage walking. Eva explains that in her current more walkable neighbourhood: "The city came by this year to prune all

the trees. It looked really nice […] The streets are wider, they're not cluttered with parked cars [as in previous neighbourhood]." Proximity to cars is also unpleasant because of air and noise pollution. Bernadette (walkability decliner) notes: "At the same time I find [my new neighbourhood] a little bit [more] quiet, because I'm not on the ring road like [in my previous neighbourhood] I don't like too much noise and too many cars". Pedestrians and cyclists both express discomfort engaging in physical activity near infrastructure designed for motorized vehicle use as they consider car exhaust and parking areas unpleasant.

Destination

"Just because it is close": nearby destinations' influence on active transportation

Participants appreciate leisure destinations such as parks, recreational facilities, cafés and friends' houses, to be in walking distance from home. Some participants enjoy cycling to work, some use a combination of walking and public transportation, and others drive their private motor vehicles. Most prefer running errands, such as grocery shopping, by car given the inconvenience or physical challenge of carrying bags of groceries. For example, Eva (walkability improver), started cycling for small errands following relocation, but still prefers her car occasionally for groceries: "But for major groceries, I guess it's easier to bring back food [by car]".

For participants who had previously used active transportation, cycling activity decreased after resettling in lower walkability neighbourhoods with fewer amenities and

where car-culture was prioritized. Laura (walkability decliner) points out: "[In previous neighbourhood] they have the paths that are accessible for riding your bikes […] but here you don't see that nearly as much, we're so used to driving our cars places and stuff so it's the whole culture that's already set up like that". However, those who relocated to neighbourhoods with increased walkability were able to change their behaviours and use more active transportation as described by Melina (walkability improver): "So definitely, I'm more active in [current neighbourhood] just because it is close to downtown, it's easy to cycle to the grocery store or downtown or to a friend's house, and some things are walking distance". Notably, some participants report starting to use public transit and thus encompassing daily walking to get to work after moving to a more walkable neighbourhood.

Most participants who improved walkability appreciate destinations near their new homes that encourage them to walk or bike rather than using the car. However, personal characteristics and motivation may lead to increased physical activity in less walkable environments where longer distances need to be traveled. For instance, Emilia (walkability decliner), notes that because she is retired and no longer drives, she has more time available to take longer walks to local destinations: "I walk to my dentist because I don't have a car, and besides I'm diabetic, I prefer to walk 'cause I figure that's better than being in a car anyway. So not having a car, it's just forced me into longer walks (laughter) and more often sometimes". Participants also enjoy actively commuting to neighbourhood recreation destinations including gyms, tennis courts, the library and local cross-country ski areas. Having such destinations within walking or cycling distance from

home could support physical activity, especially where the motivation and time to actively travel to further destinations are lacking.

3.4.2.2 Neighbourhood opportunities that offer "a chance to connect"

Connections with community and family.

Those who maintained regular physical activity habits often use physical activity as a conduit for connections with others and their environments. For example, two participants changed their physical activity habits while building connections with colleagues. Becky (walkability improver) describes: "colleagues definitely encourage me to be active […] as I've been transitioning into biking to work. It helps!" Regardless of their neighbourhoods' walkability, participants value leisure walking within their neighbourhoods for potential to meet others. Rosa (walkability decliner), finds herself walking more for leisure in her new neighbourhood because she feels more engaged in its social fabric than in her previous more walkable neighbourhood: "It's nice going for a walk and meeting someone from the neighbourhood that you know, saying hello, getting engaged with others". Whereas neighbourhoods where social connections are lacking can offer less incentive to walk as highlighted by Marie (walkability improver): "I guess you could walk to anywhere but, I didn't care to do it there [in previous neighbourhood]." Certain neighbourhood spaces support social connections, for example, large parks can provide socializing spaces for adults. Bernadette (walkability decliner) expresses missing her old neighbourhood because of the social space the large park created: "The [large park] was more of a social place for people [who] used to play games, they used to play

soccer […] It was a big park so people would go there, and enjoy themselves". Physical activity connects community members as well as family members. Parents describe changing their physical activity patterns depending on the age and activities of their child(ren). Laura (walkability decliner) claims that after her daughter grew up and moved out of the house, her physical activity levels decreased: "In [my previous neighbourhood], I used to ride my bike more and when my daughter was going to school […], we walked to school […] the [pool] was pretty close and we'd go swimming there sometimes with her school and stuff." Eric (walkability decliner) expresses how the family facilities in his new neighbourhood allow him to be a role model for his children while staying active: "we play soccer at the local community center with my children. And walk and play in the yard and local playgrounds […] I coach". Relocating to a neighbourhood with amenities for winter activities encourages families to stay active all year long. Alexia (walkability improver) lists the ways her new neighbourhood's community centre increases activity levels for herself and her family: "in the wintertime, there's a big arena […] we can skate and play hockey. […] we go tobogganing[…] we get out a little bit more in our [new] neighbourhood because of that".

Neighbourhood school transportation policies and walking routes influence the extent to which neighbouring families socialize. Victor (walkability improver) describes his new neighbourhood as affording more opportunities to connect with other families and engage in physical activity since fewer children take the bus to and from school and the pathways are designed for safe travel with children: "In [our old neighbourhood], the majority of the kids were bussed in to go to school, so the playground would be empty

after school and we didn't really get a chance to connect with a lot of families that lived [nearby]... The pathway system [in our current neighbourhood] is connected right into the neighbourhood so [the kids] can access neighbourhoods without crossing a major street [which] was a barrier for them [in previous neighbourhood]." Enhancing safe family-friendly walking paths can engage entire families in transportation walking. However, living in heavily car-dependent neighbourhoods may pose barriers to physical activity with young children despite parents' intentions to be active with their children as Caroline (walkability improver) notes: "My daughter starts preschool and it's within a ten minute walk […] so I'm thinking: how can I convince [my husband] to walk her there? But I think he's going to just drive her there 'cause that'll be quicker". Features like parks, playgrounds, tobogganing hills, skating rinks, pools, sports fields, low traffic residential streets, and paths to nearby schools are appreciated by parents for increasing opportunities to connect with members of their own family while participating in physical activity.

Some dog owners feel their physical activity increased through walking and connecting via their pet; Eva (walkability improver) claims: "Everyone should get a dog. It will change their lifestyle!" Owners see dog walking as a way of connecting with other dog owners in their neighbourhood as Victor (walkability improver) expresses: "we met a lot of our initial friends when we first arrived through obviously walking our dog and meeting dog walkers". Participants mention built characteristics such as off-leash areas and parks as enablers of local dog walking.

Connecting to nature through sustainability

Participants value physical activity in the form of active transportation for both the positive feelings they experience through connecting with nature noted above, and for being able to give back to nature by defying car culture and reducing their carbon footprint. Victor (walkability improver) expresses satisfaction with his family's active transportation supportive lifestyle as he describes having to work hard to secure this in the face of Calgary's pronounced car-friendly culture: "I think if we can promote this [active transportation] as a generation and pass it on to our kids' generation, then that is going to be a huge factor […] to reduce our footprint". Those who participate in active transportation are often motivated by sustainability. Built characteristics that allow participants to connect with nature and future generations through their desire for sustainable transportation options (e.g. cycle and pedestrian pathways) support physical activity.

3.4.2.3 Adjusting or adapting physical activity behaviours in response to a new environment

Following residential relocation, participants adapted to opportunities within their new neighbourhood to stay active. For example, Eric (walkability decliner) decreased transportation walking and cycling after relocation but also increased his overall physical activity. Yet Eric's new neighbourhood is closer to his work, thus his cycle commute is shorter which explains his reported decrease in transportation cycling. His new neighbourhood, albeit having fewer amenities than his previous more walkable neighbourhood, is more compatible with being physically active with his children as it is

quieter, so he increased his overall physical activity, explaining: "There's better playgrounds and a better park". In other cases, the opposite is true, with participants who decreased their leisure physical activity following an increase in active transportation. Caroline (walkability improver) explains: "I probably do the same [amount of physical activity] because I do less walking of our dog, but [now] I walk to the train, whereas [in previous neighbourhood] we were too far from the train for me to walk." Walkability improvement or decline does not always translate to respective increases or decreases in overall physical activity. Since some participants commute between neighbourhoods and do not attend destinations in their own neighbourhoods, neighbourhood walkability becomes less important for active transportation. In addition, support for transportation physical activity conferred by improved walkability does not always translate to support for leisure physical activity. Participants seek opportunities in their new neighbourhood environments for active transportation, leisure walking, and family activity or community sports, and adjust their physical activity according to what is available and compatible with their lifestyle.

3.5 Discussion

Our hypothesis for transportation cycling was supported as on average, walkability decliners reported a slight decrease in transportation cycling, while walkability improvers on average reported little or no perceived change in their transportation cycling after relocation. Despite only approaching statistical significance, on average, walkability improvers reported a slight increase in transportation walking, while walkability decliners on average reported little or no perceived change in their

transportation walking after relocation. We found no association between overall physical activity and walkability. These findings are consistent with a previous paper that included the same quantitative data with a different analysis (logistic regression) to compare walkability maintainers to those who relocated and increased or decreased walkability (McCormack et al., 2017). This previous study found that compared to maintainers, walkability decliners decreased transportation walking and walkability improvers increased transportation cycling. Our quantitative findings are supported by studies elsewhere showing increases in active transportation following increases in walkability (Beenackers et al., 2012; Giles-Corti et al., 2013; Hirsch et al., 2014). Associations between Walk Score® and leisure walking are mixed with two studies finding no association (Hirsch et al., 2014; Tuckel and Milczarski, 2015) and one study finding that lower Walk Score was associated with decreased leisure walking (Hirsch et al., 2013). Similar to previous qualitative research, we found that greenery, aesthetics, safety and opportunities to connect motivated leisure walking and physical activity (Annear et al., 2009; Belon et al., 2014; Eriksson and Emmelin, 2013). This finding may explain the absence of a relationship between overall physical activity and Walk Score® found in our quantitative analysis. Contrary to previous findings (Zieff et al., 2012), we did not find that fear of crime was a significant barrier to physical activity. It is possible that all neighbourhoods included in this study had low levels of crime and were therefore considered safe for physical activity. A novel finding was that some participants described compensating their leisure time physical activity with active transportation following residential relocation to maintain overall physical activity levels. Notably, there

is mixed quantitative evidence demonstrating compensation or trade-off between physical activity types (Chau et al., 2012; Sahlqvist et al., 2012; Thielman et al., 2015).

Our qualitative findings suggest that neighbourhoods with more intersections and increased connectivity may encourage adults to walk for transportation however, these same neighbourhoods will likely have few cul-de-sacs and potentially more vehicle traffic which could negatively impact perceptions of traffic safety and aesthetics and thus, might lead to less leisure walking. Renalds et al. (2010) also found that fewer street intersections (i.e., less connectivity) and lower traffic volumes as well as enjoyable scenery were positively associated with walking. Quantitative evidence regarding the association between connectivity and physical activity is sometimes mixed however, these differences may be physical activity outcome dependent (e.g., transportation versus leisure walking) (McCormack and Shiell, 2011; Renalds et al., 2010; Saelens and Handy, 2008). Nevertheless, neighbourhood designs that combine grid-like street patterns but with cul-de-sacs or dead-ends that stop vehicles but not pedestrians (i.e., "fused-grid" designs) could encourage more walking. Fused-grid neighbourhoods can support walking trips while discouraging car use (Hawkins, 2010) as well as reduce pedestrian exposure to air pollution and decrease risk of motor vehicle-pedestrian and-bicyclist collisions (Jin, 2010).

In addition to built characteristics, factors such as stage of life, not quantified but presented in our qualitative data, influence physical activity decisions following residential relocation. Our qualitative findings suggest that future research on physical

activity could be enriched by investigating physical activity of entire families as complementary units in interaction with their environment in their attempts to be physically active. Parents who resided in neighbourhoods that allowed them to stay active while working around their children claimed that having children enhanced their physical activity levels. Quantitative evidence shows that parents' physical activity levels and perceptions of the built environment can positively influence child physical activity levels (Garriguet et al., 2017; Tappe et al., 2013; Xu et al., 2017). At the same time, other parents expressed that having young children was a barrier to physical activity when they lived in neighbourhoods with scarce opportunities for family activities, this finding is supported by quantitative evidence that found physical activity decreases in adults with children (Hull et al., 2010). Our study suggests that neighbourhoods that sheltered children from high traffic areas and provided facilities for year-round outdoor activities (i.e. skating rinks, playgrounds, pools, tobogganing hills) enhanced parents' physical activity by facilitating activity between children and caregivers. Parents' perceived neighbourhood safety from crime, availability of parks and playgrounds, decreased connectivity, increased aesthetics and walks and cycle paths have been found to increase children's physical activity in previous research (Tappe et al., 2013; Xu et al., 2017), but increased children's physical activity does not necessarily translate to increased caregiver physical activity (Xu et al., 2017). In addition to bonding with children, bonding with the family dog and other dog owners motivated participants to walk. This finding is congruent with previous research the found that dog owners are more likely to achieve recommended levels of physical activity (Christian et al., 2013; Toohey and Rock, 2011). In the Calgary context, built characteristics such as aesthetics, walkability, nearby off-

leash areas and street pattern are found to be positively associated with frequency of dog walking (McCormack et al., 2016, 2011).

Our quasi-longitudinal mixed method study design included participants' retrospective self-reported change in physical activity, which likely was impacted by memory and recall bias. While the direction and relative magnitude of the change was reported, the absolute change in physical activity could not be ascertained. A longitudinal design where change in physical activity is captured, preferably using objective measures such as accelerometers, before and after participant's move may avoid such biases. The quantitative survey did not capture change in leisure walking because we focused on expecting change in built environment to have more influence on active transportation and less or no influence on recreational walking as has been found elsewhere (Hirsch et al., 2014; Tuckel and Milczarski, 2015). Our study does not account for time elapsed since relocation and we only report changes in physical activity within the first 12 months of moving in the quantitative findings, which may miss changes that occur after 12-months of residence. Our qualitative findings account for changes within 3 years of moving. Notably, physical activity changes immediately after relocation may differ from changes that occur after a longer period of neighbourhood residence once the resident has adapted to their new surroundings (Appleyard et al., 1981). We were unable to recruit an equal number of women and men thus men's voices are underrepresented in our findings. Our small sample of movers used in the quantitative analysis may also limit the generalizability of our findings. A strength of our study is the use of mixed methods and

our qualitative analysis of narratives, which enabled in-depth insights into what changes in neighbourhood environment influence context-specific physical activity.

Our qualitative analysis added important context to our quantitative findings. Specifically, we found that more walkable neighbourhoods may explain increases in transportation walking and cycling. However, participants may compensate changes in transportation walking and cycling with increases or decreases in leisure physical activity to maintain similar overall physical activity levels – not found to be associated with walkability. Leisure physical activity included both leisure walking and cycling as well as activities that allow participants to form connections with family, community and nature. These findings have implications for urban and transportation planners and policymakers. Specifically, urban and transportation policies and design that reduce local motorized traffic (e.g., fused-grid street patterns), support public transportation, and create direct and connected walking and cycling paths separated from motorized traffic to nearby destinations could support changes in transportation walking and cycling. For adults who reside in less walkable neighbourhoods, built environment features that foster leisure physical activity such as natural aesthetic elements, interesting places to explore, and facilities such as large parks, soccer fields, playgrounds and skating rinks could help improve physical activity. Neighbourhoods, where many young families reside, could leverage the caregiver relationship to promote physical activity in both adult and child through the creation of family-friendly community activities, especially in neighbourhoods with designs that do not support walking.

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CHAPTER 4

Conclusion

4.1 Overview of findings

This thesis project sought to understand neighbourhood environmental determinants of physical activity changes in adults resulting from residential relocation. The findings of the systematized review of qualitative studies (Chapter 2) described adults' experiences of the built environment in their attempts to be physically active. Following from the review, the mixed methods study (Chapter 3) estimated the associations between perceived changes in walking and cycling for transportation and overall physical activity and changes in objectively-assessed neighbourhood walkability (Walk Score®) using quantitative data and described perceived built environment barriers and facilitators to physical activity following neighbourhood relocation using qualitative data.

Using a framework to assess environmental determinants of walking and cycling developed by Pikora et al. (Pikora et al., 2003), our systematized review of qualitative studies provided insight into functional, aesthetic, destination, and safety characteristics that are associated with physical activity. Our review findings are congruent with the socio-ecological framework which posits that multiple levels (e.g., individual, social environment, physical environment and policy factors) interact to determine physical activity behavior (Sallis et al., 2006). Sociodemographic characteristics were found to impact the relationship between the built environment and physical activity.

In the mixed methods study, quantitative data suggested positive associations between self-reported changes in transportation walking and cycling and improvements in objectively measured neighbourhood walkability (Walk Score®) following residential relocation. Findings from the qualitative semi-structured interviews reinforced the quantitative findings and specifically highlighted the importance of having access to safe walking and cycling paths and nearby destinations that support active transportation. The interview data also suggested that neighbourhood opportunities that allow adults to connect with community, family and the environment while being active support enjoyable physical activity. Notably, some participants also reported compensating time spent on active transportation with time spent on leisure physical activity.

The combined findings from both our review and mixed methods study reinforce the importance of the influence of socio-demographic factors on the built environment physical activity relationship. Although emphasis was put on the physical environment's (built environment characteristics) influence on physical activity, our combined findings demonstrate how the different levels of the socio-ecological model (i.e. social, physical and policy) are interdependent and interact to influence both transportation and recreation physical activity (Sallis et al., 2006). More specifically, our mixed methods study explores how different domains of active living could interact and influence one another as some individuals adjusted their recreation and transportation physical activity to maintain overall physical activity levels. Our findings show how the built environment characteristics interplay with the different levels of the socio-ecological framework relating to both transportation and recreation physical activity.

4.1.1 Overview of findings from the systematized review of qualitative studies

The findings from Chapter 2, based on a review of 36 qualitative studies, complemented existing quantitative evidence (Sugiyama et al., 2012; Van Cauwenberg et al., 2011) and confirmed the importance of the neighbourhood built environment for influencing different types of physical activity (transportation walking, recreational walking, bicycling, running, sports, and other outdoor activities) among adults. Increased street or pedestrian connectivity, nearby destinations and environments that support different transportation modes were important for supporting transportation walking. Appropriate street lighting, safe public areas for socializing, and infrastructure that shelter pedestrians and cyclists from motorized traffic increased feelings of safety and were found to facilitate physical activity. Aesthetic features (e.g. natural elements, greenery, attractive or interesting views) motivated adults to be physically active and provided restorative benefits while participating in outdoor leisure activities.

Age and other sociodemographic characteristics contributed to perceived built environment enablers and barriers of physical activity. For instance, older adults with chronic health conditions found that rest areas with benches and toilets in addition to nearby destinations were important for transportation walking, which was consistent with previous evidence (Moran et al., 2014). Although there has been a previous review of qualitative studies that focused on the built environment and physical activity among the elderly (Moran et al., 2014), our review is the first in adults of all ages. Given that many studies we reviewed tended to focus on sociodemographic characteristics such as age, gender and ethnicity, our review allowed us to gain perspective on similarities and contrasts between the barriers and supports to physical activity in different sociodemographic groups. Although our review of qualitative studies

illuminated important environmental determinants of physical activity, the studies included in the review did not capture temporality in relation to changes in neighbourhood environment and physical activity change (e.g., as part of residential relocation). The findings from this review informed the design of the mixed methods study in Chapter 3.

4.1.2 Overview of findings from the mixed methods study

The qualitative information gathered and presented in Chapter 2 informed the mixed methods study presented in Chapter 3 which explores perceived barriers and supports to physical activity in relation to objective changes in the built environment. Our quantitative phase findings show that on average, walkability improvers reported a slight increase in transportation walking, while walkability decliners on average reported little or no perceived change in their transportation walking after relocation. Walkability decliners reported on average a slight decrease in transportation cycling, while walkability improvers on average reported little or no perceived change in their transportation cycling after relocation. These findings are consistent with previous studies (Beenackers et al., 2012; Giles-Corti et al., 2013; Hirsch et al., 2014). There was no association between overall physical activity and walkability change. Reasons behind the change in physical activity were further explored during qualitative interviews that were informed by an existing conceptual framework developed to assess the built environment determinants of physical activity (Pikora et al., 2003). Given that the same framework categorized well the existing qualitative evidence in Chapter 2, it was used again to inform the interview guide for the qualitative study phase.

The qualitative findings for the mixed methods study were categorized into three broad themes of influences on changes in physical activity after relocating: 1) the *built environment and getting "around"*; 2) *neighbourhood opportunities that offer "a chance to connect"*, and; 3)

adjusting or adapting physical activity behaviours in response to a new environment. The *built environment and getting "around"* theme explores how safe paths connecting to nearby destinations increased transportation walking and cycling after relocation. In addition, elements such as aesthetics, safety and interesting walking routes promoted leisure walking and cycling. The "*neighbourhood opportunities that offer "a chance to connect"* theme explored how participants increased their leisure physical activity following exposure to appealing characteristics in their new neighbourhoods such as large parks with greenery and recreational destinations that offer opportunities to connect with community, family and nature. Finally, some narratives described participants adjusting their leisure physical activity levels to compensate for changes in transportation walking and cycling resulting from residential relocation which was covered in the "*adjusting or adapting physical activity behaviours in response to a new environment"* theme.

This research contributes to the growing body of evidence linking the neighbourhood built environment to changes in physical activity (McCormack and Shiell, 2011; Renalds et al., 2010; Wendel-Vos et al., 2007). Characteristics such as nearby destinations which are measured by the original Walk Score® are associated with transport walking and cycling as we expected from consistent previous literature (Beenackers et al., 2012; Giles-Corti et al., 2013; Hirsch et al., 2014). We found overall physical activity not to be associated with Walk Score®, suggesting there may be compensation or trade-off between physical activity types. Evidence supports compensation between leisure and occupational physical activity (Chau et al., 2012). However, previous quantitative studies that explore the compensation phenomena between active transportation and leisure physical activity showed mixed findings (McCormack and Giles-Corti,

2004; Sahlqvist et al., 2012; Thielman et al., 2015). Increases in active transportation have more often led to increases in overall physical activity suggesting no compensation phenomena for active transportation (McCormack and Giles-Corti, 2004; Sahlqvist et al., 2012).

The mixed methods study contributes to our understandings of the causation between the built environment and physical activity (Bradford-Hill, 1965). Sir Bradford-Hill established nine criteria to determine under what circumstance epidemiological associations can be determined to be causation. His criteria are as follows: 1) strength of association: larger effect size is more likely causal, 2) consistency: repeated consistent findings in different circumstances, 3) specificity: specific association between factor and effect with no other likely explanation, 4) temporality: the effect occurs after the hypothesized cause, 5) biological gradient: the greater the exposure, the larger the effect size, 6) plausibility: there is a reasonable explanation for why the cause leads to the effect, 7) coherence: epidemiological findings are coherent with other scientific knowledge such as laboratory or pathological findings, 8) experiment: the epidemiological association is supported by experimental evidence where possible, 9) analogy: considers the effect of similar factors (Bradford-Hill, 1965). Our mixed methods study contributes to causation by providing temporal evidence whereby changes in physical activity after exposure to a new neighbourhood environment following relocation were explored. The participants' stories from the qualitative phase illuminate plausibility by providing credible lived experiences of how a change in neighbourhood built environment modified physical activity. The findings from our quantitative phase provided some evidence to support the criteria strength of association and consistency in regard to the walkability-physical activity relationship (Beenackers et al., 2012; Giles-Corti et al., 2013; Hirsch et al., 2014). In addition, the recent

residential relocation of participants in our sample acted as a natural experiment and contributed to scarce experimental evidence on the relationship between the built environment and physical activity (McCormack and Shiell, 2011). The small sample size of the study did not allow us to adjust for confounders to determine specificity. The study was not designed to determine biological gradient or analogy.

4.2 Discussion

4.2.1. Caregiver role and links between child and adult physical activity

Parents in this study felt that built environment characteristics such as reduced neighbourhood traffic and having access to year-round family friendly activities such as ice rinks and swimming pool helped support them and their family's physical activity. These findings are congruent with evidence that children's outdoor playtime increased when mothers perceive that the neighbourhood is a good place to bring up children, is safe to play in, and has good parks or playgrounds (Xu et al., 2017). This suggests that by modifying built environment characteristics, both mother and child could benefit through increases in physical activity. Our qualitative sample included overrepresentation of females. The traditional role of women as caregivers might influence our findings that child-friendly neighbourhoods could increase caregiver physical activity. However, qualitative studies from our review suggest that childcare can be a major barrier for mother's to participate in physical activity (Ball et al., 2006; Caperchione et al., 2009; Dunn, 2008; Mama et al., 2015). Whereas qualitative data from our mixed methods study suggests that parents who live in neighbourhoods that support physical activity with children can use time with their children to achieve their physical activity needs and parents who live in

perceived unsupportive neighbourhoods for children's play experienced decreases in physical activity because of their caregiver role. These findings are consistent with evidence showing that women are motivated to be active by supportive family and social structures (Bjornsdottir et al., 2012; Eyler et al., 2002; Mama et al., 2015). The need for social support was not only found in women, for example one study that focused on men found that social isolation and loneliness negatively impacted physical activity (Lord and Bush, 2012). The two fathers in our sample expressed similar motivation to be physically active with their children. The qualitative findings from our mixed methods study found that built environments that promote social forms of physical activity, especially physical activity that include children, could potentially increase physical activity levels among parents.

4.2.2. Evidence for equity in built environment interventions for physical activity

Health equity is the fairness in the distribution of resources needed for health, access to available opportunities and support offered to people (National Collaborating Centre for Determinants of Health, 2013). Health equity aims at decreasing excess burden of ill health amongst disadvantaged populations. The opposite of equity would be an inequity where there are systematic, unfair and avoidable differences in health between individuals of different socioeconomic status. Socioeconomic status is a person's social stratification which is dependent on income, education, financial resources, rank in society, occupation, race and ethnicity (Cutler et al., 2012). Research has shown that individuals who are socioeconomic advantaged have better health outcomes (Cutler et al., 2012) and are more likely to engage in leisure physical activity (Adlakha et al., 2016; Ball et al., 2006). In contrast, the highest contributor to overall physical activity in populations facing socioeconomic disadvantage is active transportation (Adlakha et

al., 2016; Ball et al., 2006). Moreover, adults living in neighbourhoods facing socioeconomic disadvantage are more likely to experience environmental barriers to physical activity related to lack of safety and higher encounters with criminal activity when compared with adults in higher socioeconomic neighbourhoods whose main barriers are psychological and cognitive factors (Cassou et al., 2011; Foster and Giles-Corti, 2008). A review of crime-related constraints to physical activity in the built environment found inconsistent findings where groups such as women, older adults and individuals facing socioeconomic disadvantage were more likely to perceive safety constraints to physical activity (Foster and Giles-Corti, 2008). Built characteristics that interplayed with demographic and socioeconomic factors in perceptions of safety were density, lighting, presence of incivilities and maintenance. At the community and interpersonal-levels, confidence in the community and presence of natural surveillance (pedestrians and neighbours who are present or watching on the streets) contributed to feelings of safety (Foster and Giles-Corti, 2008). Our review of qualitative studies supports Foster and Giles-Corti's findings in that safety was more of a barrier for women, elderly and socioeconomic disadvantaged populations. In accordance with the principle of equity, resources should be allocated in ways that reduce socially produced health gaps between populations that are avoidable and unacceptable (Whitehead, 2007). These findings highlight the importance of addressing safety features, especially in neighbourhoods facing socioeconomic disadvantage, to promote physical activity in the most vulnerable populations. Although our review of qualitative studies found safety from criminal activity to be important in low socio-economic status neighbourhoods, in our mixed methods study's qualitative phase participants interviewed did not mention changes in crime between previous and current neighbourhood as a factor contributing to changes in their physical activity following residential relocation. Our qualitative data did not

suggest any important perceived differences in crime levels between the neighbourhoods where participants were living. However, participants perceived important variations in traffic safety between neighbourhoods that they lived in which influenced changes in both leisure and transportation walking and cycling following relocation. A study from Calgary suggests that neighbourhood socioeconomic disadvantage is linked to poor health outcomes related to physical inactivity such as higher waist circumference and higher body mass index, and that this relationship may be exacerbated by the impact of less walkable street patterns (curvilinear) (McCormack et al., 2017a). Socioeconomically disadvantaged neighbourhoods may have increased presence of characteristics such as poor sidewalk maintenance, litter and abandoned buildings that discourage walking (Kelly et al., 2007) in addition to decreased presence of recreational facilities for leisure physical activity (Powell et al., 2006). Interventions in the built environment that are targeted at socioeconomic disadvantaged neighbourhoods that are less walkable (modifying street patterns, increasing safety, sidewalk maintenance and cleanliness) and have a low number of recreational facilities can possibly improve living conditions of vulnerable populations. Research on the impact of the built environment and equity is limited. The majority of current evidence points to there being no differential impact of socio-economic status on the increases in physical activity associated with interventions such as streetscape improvements and increased density of recreation facilities (Smith et al., 2017). There is however, scarce evidence that suggests a differential impact whereby high socioeconomic status individuals may benefit more from interventions such as new cycling and pedestrian infrastructure and improved park conditions (Smith et al., 2017).

Modifying the neighbourhood built environment to increase physical activity is a

population health intervention that attempts to address the causes of physical inactivity in a population rather than individual risk factors(Rose, 1985). Such an approach intervenes on the environment to shift the entire distribution of the population rather than only those at high risk. However, modifying the built environment could inadvertently exacerbate health disparities if they miss vulnerable populations (Frohlich and Potvin, 2008). In the context of the built environment and physical activity, further research on inequities in the built environment-physical activity relationship as well structural interventions that benefit the entire population and reduce absolute disparities is warranted to ensure equity, which is one of the greatest challenges in public health today (McLaren et al., 2010; Smith et al., 2017; Whitehead, 2007).

4.2.3. Natural and sustainable built characteristics' impact on physical activity

In both the review and in our qualitative findings, adults felt that environments that connected them with nature increased their outdoor leisure physical activity. Moreover, adults described positive feelings of restoration and wellbeing while being around nature. Previous evidence suggests that adult contact with nature in nearby parks may increase physical activity (Coombes et al., 2010). However neighbourhood socioeconomic deprivation may lead to decreased use of green spaces as they are perceived as less accessible and unsafe (Jones et al., 2009). Previous literature has linked green space with improved mental health, reduced cardiovascular morbidity and mortality, obesity and risk of type 2 diabetes, and improved pregnancy outcomes (Kardan et al., 2015; World Health Organization Regional Office for Europe, 2016). Green space leads to improved health outcomes through psychological relaxation and stress alleviation, reduced exposure to air pollutants, noise and excess heat (World Health Organization Regional Office for Europe, 2016). Neighbourhoods that contain safe and

accessible natural areas facilitate enjoyable physical activity in addition to providing numerous health benefits.

Participants valued natural elements and were motivated to use active transportation by a desire for an environmentally sustainable lifestyle. A large body of urban design research focuses on neighbourhood built characteristics that improve environmental sustainability, such as improved public and active transportation systems, increasing density and avoiding urban sprawl. Such built characteristics that improve sustainability often coincide with those that support physical activity (Sugiyama, 2008). Knowledge on sustainable development may contribute to both physical activity improvements in addition to promoting sustainability (Sugiyama, 2008).

4.3 Reflexivity

In terms of reflexivity, as a researcher in population and public health in the Department of Community Health Sciences (Cumming School of Medicine, University of Calgary) and as a healthcare professional, I have a vested interest in population health and I am driven by a sense of urgency to explore interventions that will address the upcoming increases in chronic diseases due to physical inactivity. My healthcare lens may have influenced both the collection and interpretation of the data. I acknowledge that non-healthcare practitioners may interpret the data differently. Our team consisted of professionals involved in disability studies, population health and kinesiology, which strengthened the interpretation of our results by offering diverse view points. My experiences relocating to and living in diverse cities and suburbs of Eastern, Western and Northern Canada and Europe heave left me with many personal experiences of health

behaviour changes following residential relocation. These personal experiences could have influenced the collection and interpretation of the data. In addition, this research draws upon "feminine skills" that both men and women are increasingly called upon to perform (Bondi, 2009). Such "feminine skills" involved careful listening during the interviews and seeing participants in terms of their relationships with others during the interpretation of the data. This approach may have led to femininity being more represented than masculinity in this study. Recognizing that the encounters with participants are co-constructed, interviews consisted of open questions with in depth listening to ensure that participant replies are not influenced by any preconceived public health beliefs. Recognizing these influences is important for increasing transparency and allows the reader to understand the thought process that led to these findings; thus contributing to the confirmability and transferability of this research.

4.4 Strengths and limitations

4.4.1 Strengths and limitations of the review of qualitative studies

The mixed methods study was preceded by a systematized review of qualitative studies, which informed the interview questions and interpretation. Given limited resources, this review did not include procedures for preserving internal validity specific to systematic reviews, such as having two reviewers at each stage of the review, assessing study scientific quality using a validated tool or comparable qualitative quality appraisal measures, weighting of findings, or excluding studies based on methodological quality, or pooling results to undertake meta-analysis (Grant and Booth, 2009). Synthesis of qualitative evidence however, does not lend well to the traditional tools used to appraise and summarize the quantitative evidence. The quality assessment process for

synthesis of qualitative evidence is still in development phase but is becoming clearer over time (Carroll and Booth, 2015). Some qualitative researchers may argue that quality assessment of qualitative research is not valuable as it is too subjective (researcher interpreting other researchers' interpretations and quotes from qualitative studies) and may not be worth the time and resources. Given time constraints, no formal qualitative appraisal was undertaken for our review but attention to different qualitative methodologies was noted in our review results in an attempt to preserve internal validity.

4.4.2 Strengths and limitations of the mixed methods study

Several factors limit the internal validity and external validity of the quantitative analysis phase. Internal validity can be determined by analyzing potential sources of bias through objective critical appraisal that considers selection bias, measurement bias, confounding, effect modification and role of chance (Patten, 2015). Establishing internal validity is a necessary precondition for considering whether a study is externally valid and if the conclusions of the study could be generalized to larger populations (Patten, 2015). Internal and external validity can arguably also be applied to the qualitative research (Morse, 2015a, 2015b). However, different criteria for the critical appraisal of qualitative evidence are commonly used to establish trustworthiness that include dependability, transferability, and credibility (Green and Thorogood, 2014). The following section addresses strengths and limitations of our study and acknowledges the implications of the limitations on the study's validity.

One of the strengths of the mixed-methods study is the use of residential relocation, a natural experiment, while combining quantitative and qualitative data to provide temporal

evidence and plausibility to the built environment physical activity relation (Bradford-Hill, 1965). The sample of adults from which we drew our participants was stratified by street pattern (grid, warped-grid, and curvilinear) and socioeconomic quartiles (estimated from census variables including: proportion of 25–64-year-olds whose highest education is below a high school diploma; proportion of single-parent families; proportion of rented private dwellings; proportion of the divorced, separated, or widowed among those ≥15 years of age; proportion of the unemployed among those ≥25 years of age; median gross household income; and average value of dwellings). The larger "Pathways to Health" study used a cross-sectional design and was originally undertaken to understand how contextual (neighbourhood built characteristics) and compositional (neighbourhood-level socioeconomic status) neighbourhood characteristics influence physical activity, diet and weight status in the Canadian context study (McCormack et al., 2017b; McInerney et al., 2016). The sampling of adults who recently relocated was opportunistic and was not part of the original focus of the Pathways to Health Study, which explains the small sample size included in the mixed methods study (Chapter 3). The small sub-sample of movers may limit the generalizability of our quantitative findings. Future research that is designed specifically to capture physical activity data from participants relocating neighbourhood and that includes larger samples to explore changes and compensation in active transportation and leisure walking and cycling in relation to the built environment is warranted. The aim of this secondary mixed methods study with a predominant qualitative phase is not generalizability but rather to generate findings that illustrate plausibility and mirror temporality in the built environment and physical activity relation as wells as potential theoretical jumping off points. The sample size chosen for the interviews was appropriate for the qualitative research phase as it generated rich data.

4.4.2.1 Quantitative phase

Selection bias

The sampling strategy for the quantitative phase is affected by study self-selection bias since it depended on participants volunteering or choosing to complete the survey at home. It is possible that individuals whose physical activity was impacted by the built environment may have felt more compelled to complete the survey (Olsen, 2008). Such bias could lead to an overestimation of the impact of the built environment on physical activity, which may compromise the internal validity of the quantitative findings. In addition, adults facing socioeconomic disadvantage may be less represented, as the original sampling also required that participants had Internet connection and English language proficiency; which may affect the external validity of this study.

Measurement bias

As part of a physical activity, health and demographic questionnaire, the participants reported physical activity changes on a 5-point scale. Perceived changes in physical activity have been captured with similar response options in previous quasi-longitudinal studies (Aditjandra et al., 2015; Milakis et al., 2015) and have acceptable test–retest reliability (Handy et al., 2008). However, since physical activity was not objectively measured before and after relocation, the quantitative findings are susceptible to recall bias (Raphael, 1987). In addition, the study is susceptible to social desirability bias, which can lead to over-reporting of physical activity (Sallis and Saelens, 2017) and affect the study's internal validity.

Walk Score® was used for its convenience and availability to measure objective neighbourhood walkability. Walk Score® is a publically available, objective measure of walkability that captures the proximity to twelve important amenities associated with walking (Duncan et al., 2011). The Walk Score® used in this study is based on access to destinations and may miss other important characteristics associated with walkability. In addition, due to the small sample, we were unable to undertake a sensitivity analysis to test the influence of other Walk Score® cut-points for identifying walkability improvers or decliners. Moreover, we objectively measured walkability change using the neighbourhood the participants lived in, whereas our qualitative findings suggest that participants frequently commute between neighbourhoods especially for work. Health-promoting opportunities beyond the residential setting and infrastructure that connected different neighbourhoods can support active transportation in this group (Salze et al., 2011).

Confounding

The t-test did not adjust for unmeasured and measured confounders that may explain physical activity differences between walkability decliners and walkability improvers. Despite finding no statistically significant differences in the sociodemographic characteristics between walkability decliners and walkability improvers, it is still possible that sex, dog ownership and motor vehicle access, for example, contributed to the differences found in transportation walking and cycling between these two groups.

4.4.2.2 Qualitative phase

Impacts of participant recruitment and data collection methods

For the qualitative interviews, the individuals recruited had already agreed to be contacted for further research based on responses provided in the "Pathways to Health" survey. This is a strength of the study because these participants were motivated to share their stories and provided rich data for analysis. However, it may also be considered a limitation because these individuals could have a vested interest in the built environment and health that motivated them to participate in further research and we may have missed voices from those who do not feel as impacted.

As in most qualitative research that is not ethnographic, our data are limited to self-reports and does not necessarily reflect the actions or behaviours of participants. Acknowledging that the interview participants were fully aware that the study pertained to the relationship between the built environment and physical activity, they may have decided to share stories they believed we wanted to hear. Most research carries this issue of concern as participant will only share what is intended to be given (Croft and Beresford, 1992). However, the qualitative phase of the thesis was intended to gather collective perspectives and the relevance of whether each detail is accurate becomes therefore less important (Morse, 2015b).

Qualitative semi-structured telephone interviews were chosen to ensure feasibility of the study within the time constraints of the researcher's residency program. Such interviews do not allow for the researcher to interpret body language as face-to-face interviews would allow (Green and Thorogood, 2014).

Analysis of narratives strengths

Based on findings from our review in Chapter 2, previous qualitative studies exploring the relationship between the built environment and physical activity did not explicitly mention analysis of narratives. Content or thematic analyses were the most used methods of analysis. However, given that the objective of this qualitative phase was to explore changes in physical activity following changes in the built environment, analysis of narratives was most appropriate. Analysis of narratives relies on stories that have a beginning, plot and denouement allowing us to understand present choices by linking them to prior events and thus providing temporal linkings (Creswell, 2013; Green and Thorogood, 2014; Polkinghorne, 1995). The interview stories consisted of how residential relocation and the changes in the built environment that followed influenced physical activity behaviour change. Narrative analysis has been effectively utilized in previous physical activity research as it is well suited to explore subjective experiences, intentions, patterns of reasoning, and attempts to find meaning in personal experiences (Smith and Sparkes, 2009). Although our analysis of narratives touches on many of the themes already explored in the review of qualitative studies, such as safety, aesthetics, the importance of destinations and of neighbourhood design, the stories allow us to truly understand how changes in these themes translate into changes in physical activity. The use of analysis of narratives produced rich data findings that included three dimensions: interactions (social, individual), continuity (time, before and after the move) and situation (physical environment) (Connelly and Clandinin, 1990).

Trustworthiness

For qualitative research to be trustworthy, it must be credible, transferable, dependable and confirmable (Green and Thorogood, 2014). In order for the study to be credible, strategies including peer debriefing with supervisory committee and live member checking during interviews were used. To enhance transferability, the particularities of each story were described to provide context and relevance to other settings. Dependability and confirmability were maintained through the use of an audit trail(Creswell, 2013).

4.4.3 Other considerations

This thesis project was informed by the social ecological framework developed by Sallis et al. (2006) and sought to understand the neighbourhood environment determinants of physical activity changes in adults resulting from residential relocation. Using a social ecological framework was a strength of the study as it illuminated the interactions between individual, social and environmental factors. The social ecological framework developed by Sallis et al. describes four domains of active living: household, occupational, transportation and recreation (Sallis et al., 2006). Given that the study's focus was on the built environment and physical activity, our interview and analysis considered the two domains of active living that were most likely to be affected by changes in neighbourhood built environment: recreation and transport. However changes in household and occupational physical activity following relocation are likely to have impacted overall physical activity and may have led to interaction with the other domains of active living that are not covered in this thesis.

4.5 Implications

Our study findings are policy relevant and respond to recent calls for more evidence on the built environment and physical activity that can be easily implemented in urban planning and design (Giles-Corti et al., 2015) to improve the supportiveness of neighbourhood built environments for physical activity in Calgary and elsewhere.

Although neighbourhood physical infrastructure that supports physical activity is important, this thesis, along with previous research (McCormack et al., 2010; Moran et al., 2014), show that it is not a sufficient enabler for physical activity and that the sociodemographic profile of the neighbourhood as well as other social environmental, cultural, and historical factors need to be considered. Incorporating our knowledge of these factors into the built environment interventions destined to increase physical activity are necessary and have proven successful in increasing physical activity in adults (Brown et al., 2006). Community consultation could help understand underlying social, environmental and historical factors that will affect how individuals interact with their neighbourhood environment during their attempts to be physically active (Edwards, Peggy; Tsouros, 2008).

4.5.1 Suggestions for interventions

Our findings have implications for possible future interventions in less dense and less walkable neighbourhoods, suggesting that in addition to trying to improve walkability, characteristics in the built environment that promote leisure physical activity and favor social gatherings such as large parks, sledding hills, skating rinks and cross-country ski tracks could be introduced to promote leisure physical activity. In light of our findings that support previous literature in suggesting that both increased connectivity (McCormack and Shiell, 2011) as well as lower traffic (Renalds et al., 2010) support physical activity, "fused-grid" neighbourhood designs

that combine grid-like street patterns but with cul-de-sacs or dead-ends that stop vehicles but not pedestrians could support more walking (Hawkins, 2010).

From an equity lens, North American evidence suggests that neighbourhood interventions that improve amenities and sidewalks in more walkable neighbourhoods can increase home prices in these neighbourhoods, making them less accessible to socioeconomically deprived populations (Li et al., 2015). Such interventions could be accompanied by policies aimed at increasing affordability of walkable neighbourhoods or programming for socioeconomically disadvantaged individuals in order to maximize the effectiveness of the intervention for all socioeconomic strata (Read and Sanderford, 2017). Caution should be taken to ensure that interventions on the built environment in lower income neighbourhoods do not raise costs of living in those neighbourhoods that would make them unaffordable to its current residents.

4.5.2 Future research

We initially set out to explore the built environment characteristics that support or act as barriers to physical activity in adults. However, we found that adult's roles as caregivers to children influence the built environment characteristics they perceived important for their own physical activity. Although previous research has focused on parental perceptions of the built environment's influence on childhood physical activity (Roberts et al., 2017; Xu et al., 2017), few studies explore the influence of children on parents. Current evidence suggests that having children may decrease physical activity in adults (Hull et al., 2010). Findings from recent Canadian study using accelerometer-measured physical activity and sedentary time found that parents' measured moderate-to-vigorous physical activity (MVPA) was associated with

children's MVPA (Garriguet et al., 2017). Our qualitative findings complement these quantitative findings by suggesting that reasons behind these associations are not limited to role-modeling but may also be due to participating in physical activity together. Our qualitative findings reveal ways that physical activity decreases in parents could be mitigated through interventions in the built environment that allow for parental-child connections through physical activity. Future research on built environment physical activity relationship could study physical activity of families as a whole as opposed to focusing on children (Tappe et al., 2013), adults (Sugiyama et al., 2012) or older adults (Moran et al., 2014; Van Cauwenberg et al., 2011) separately.

Our findings suggest that there may be a compensatory effect where individuals adjust leisure physical activity in response to changes in active transportation. The compensation phenomena has mostly been studied in cross-sectional studies with mixed findings (Chau et al., 2012; McCormack and Giles-Corti, 2004; Thielman et al., 2015). However, to our knowledge, the scarce longitudinal evidence on compensation between active transportation and overall physical activity that exists (Sahlqvist et al., 2013) does not support the phenomenon. Future longitudinal research is needed to explore how different types of physical activity (i.e. transportation, leisure, occupational, household) change in time in response to changes in the built environment.

4.6 Conclusion

This thesis explored the built environment's influence on physical activity among adults by using a systematized review of qualitative studies and a quasi-longitudinal mixed methods

analysis of primary data. The systematized review provided insight into qualitative experiences of functional, aesthetic, destination, and safety characteristics' that are associated with physical activity and their interactions with sociodemographic characteristics. Our mixed methods study is novel in that it contributes to understanding how and why participants change their behaviour following a change in their neighbourhood environment. Our qualitative findings complement our quantitative results and help explain outliers. This thesis supports the assumptions of the socio-ecological framework and conclude that there are multiple levels of interacting influences on physical activity, including interactions between sociodemographic and built environment characteristics.

4.7 References

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APPENDIX A: Copyright Permissions

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Salvo G, Lashewicz BM, Doyle-Baker PK, McCormack GR. *Neighborhood built environment influences on physical activity among adults: A systematized review of qualitative evidence.*

and

Salvo G, Lashewicz BM, Doyle-Baker PK, McCormack GR. *A mixed methods study on the barriers and facilitators of physical activity associated with residential relocation*.

If you agree, please email me your permission. As per the email below, the University requires all your permissions since you are all co-authors, an email correspondence should be enough.

Thank you,

Grace

Permission from me as well.
Bonnie

Dr. Bonnie Lashewicz
Associate Professor
Community Rehabilitation & Disability Studies
Department of Community Health Sciences
Cumming School of Medicine
Phone: 403 220-4980

From: Patricia Doyle-Baker
Sent: January 23, 2018 10:14 PM
To: Gavin McCormack; Grazia Salvo; Bonnie M. Lashewicz
Subject: Re: Copyright permissions

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Dr. Tish Doyle-Baker

From: Gavin McCormack
Sent: Tuesday, January 23, 2018 9:21:31 PM
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Permission from me.

Thanks,
Gavin

Gavin McCormack, PhD MSc

APPENDIX B: Framework for the assessment of environmental determinants of walking and cycling

Physical environmental Factors	
Functional	Direct route, intersection design, path continuity, path location, path maintenance, path surface, street design, street type
Destination	Local shops and services, public transportation, bike parking
Aesthetic	Greenery, natural areas, gardens, views, trees, architecture
Safety	Safety from crime: lighting, absence of drug paraphernalia, surveillance Safety from traffic: crossing lights, traffic speed, traffic volume

Adapted from Pikora, T., Giles-Corti, B., Bull, F., Jamrozik, K., Donovan, R., 2003. Developing a framework for assessment of the environmental determinants of walking and cycling. Social Science and Medicine. 56, 1693–1703.

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APPENDIX C: Transcriptionist confidentiality pledge

FACULTY OF MEDICINE | UNIVERSITY OF CALGARY

Department of Community Health Sciences
3280 Hospital Drive NW
Calgary, AB, Canada T2N 4Z6
[redacted]

PLEDGE OF CONFIDENTIALITY

In order to ensure that the Researchers of the Cumming School of Medicine at the University of Calgary fulfill their obligations to the Study Participants and under the Ethical Approval of the Conjoint Health Research Ethics Board, anyone with access to confidential information of third parties must make this Pledge of Confidentiality.

1. I, **Louisa Plehwe** , recognize and acknowledge that in the course of my work as Transcriptionist in the "Barriers and Supports to Physical Activity following Residential Relocation" study, I may gain access to certain "Confidential Information" (as defined below). I shall not use any Confidential Information at any time except for purposes of performing my duties with respect to the Research Study. I shall not disclose any Confidential Information in any manner at any time to any individual or entity who is not bound to confidentiality provisions with the University of Calgary and/or any Research Partners similar to the ones imposed by this Agreement. I shall continue to observe strict confidentiality on this information when I cease to be involved with the Research Study.

2. "Confidential Information" means information you gain access to in the course of your participation in the Research Study, which information is private information of an individual or organization or which is of a confidential or secret nature and that may be related to the Research Study including, without limitation, the protocol, methods, processes, procedures, strategies developments, results, and outcomes.

3. I acknowledge that I have had sufficient time to review this Agreement and fully understand its contents and its effect on me.

4. This Agreement is signed effective upon the earlier of the receipt of information relating to the study, participation in the study, or execution of this agreement.

EMPLOYEE WITNESS

APPENDIX D: Data extraction form used for systematized review study

Title

Authors

Year of publication

Location of study

Sample design (n) and characteristics

Data collection method

Analysis framework discussed and qualitative study type

Limitations

Key Findings

Built environment findings separated according to

- Functional features
- Aesthetics
- Destinations
- Safety

Other important findings and comments

APPENDIX E: The Physical Activity and Health Questionnaire: Questions about changes in physical Activity patterns

7b. If you have moved neighbourhoods within the past 12 months, please indicate how your level of physical activity has changed since moving to your current neighourhood? *If you did not move in the past 12 months skip to question 8a.*

	A lot less now	A little less now	About the same	A little more now	A lot more now
I walk for transportation (to get to or from places)...	○	○	○	○	○
I cycle for transportation (to get to or from places)...	○	○	○	○	○
My overall levels of physical activity are...	○	○	○	○	○

APPENDIX F: The Physical Activity and Health Questionnaire: Questions about neighbourhood relocation

8b. How long have you lived in your CURRENT neighbourhood?
If you have moved away and then returned please record only the most recent period.

Years: ⌊__⌋⌊__⌋ Months: ⌊__⌋⌊__⌋ Days: ⌊__⌋⌊__⌋⌊__⌋

8c. **So that we can compare neighbourhood features, where possible indicate the country, province or state, postal code or zip code, and the neighbourhood name you lived in before your current neighbourhood.**

Country of previous neighbourhood: ⌊_____⌋

Province/State of previous neighbourhood: ⌊_____⌋

Postal/Zip code of previous neighbourhood: ⌊_____⌋

Name of previous neighbourhood: ⌊_____⌋

APPENDIX G: Interview Guide

Preamble

Hello/Good morning/Good afternoon,

May I speak with Mr/Mrs [insert name here]?

My name is Grace Salvo and I'm doing research at the University of Calgary's Medical school. I'm conducting interviews on neighborhood physical activity under the direction of Dr. Gavin McCormack. I'm calling because you agreed to participate in future research when you completed our Pathways to Health survey in 2014 and I would like to invite you for a one-on-one phone interview as part of our current research. If you decide to participate, I will send you a $20 voucher for Tim Horton's to thank you for your time. The interview takes about 30 to 50 minutes to complete; it can be done now or whenever works best for the both of us.

What do you think?

Before we start, I'd like to ensure you that you don't have to answer any questions that you don't want to. You can stop at any time, even partway through the interview if you wish to. All the information you provide will be kept confidential and your name will be removed for all of our data.

Are there any additional questions or concerns you have at this point?

May I turn on my tape recorder?

Interview Questions:

I have prepared an outline for todays interview. My questions are broad so please feel free to expand on them with examples or stories.

To start, I want to know all about your physical activity, in terms of and individual and where you live.

- Can you tell me a bit about your physical activity in your neighbourhood?
    - What types of things do you do in a typical week?
    - What physical activities do you enjoy? Not enjoy?
- Do you walk or cycle instead of driving places?
    - Where might you walk or cycle?
- Could you tell me about any barriers you face in getting physical activity

Next, I want to explore how the environment around you might influence your PA.

- I understand that you moved sometime in 2013-2014 from […] to […] neighbourhood. Are you still living there, have you moved since?
    - How long have you lived in this neighbourhood?
    - Why did you choose to live in this neighbourhood?
- How do your physical activity habits living in this neighbourhood compare to your habits living in previous neighbourhood?

    - Why do you think there was a change or no change in your physical activity habits?
- How does your current neighbourhood compare to your previous neighbourhood in terms of interesting places to go?
    - How do you typically travel to these places?
    - Did this change have an impact on your physical activity? If so, how?
- How does your current neighbourhood compare to your previous neighbourhood in attractiveness and aesthetics?
    - What is it that makes a neighbourhood attractive or not?
    - Did this change have an impact on your physical activity behaviours? If so, how?
- How does your current neighbourhood compare to your previous neighbourhood in terms of safety?
    - What is it that makes your neighbourhood feel safe or not (in terms of traffic vs crime)?
    - Did this change have an impact on your physical activity behaviours? If so, how?
- How does your current neighbourhood compare to your previous neighbourhood in terms of ease to get around on foot or by bike?
    - What is it that makes your neighbourhood easy to get around or not?
    - Did this change have an impact on your physical activity behaviours? If so, how?
- What does the term walkability mean to you?
    - Is your neighbourhood walkable why or why not?
    - What in your neighbourhood could encourage you to walk or cycle more?

Now I will move on to asking questions about social influences on your physical activity habits:

- Do you see other people in your neighbourhood being physically active?
    - Could you describe who these people are and what you see them doing?
    - Why do you think you see so many people or so little people being physically active?
    - How does this compare to your previous neighbourhood?
- Do you participate in physical activity with anyone else (eg: friends, work colleagues, family or pets)?
    - Can you comment on how this influences the amount or the type of physical activity you do? If so, how?
    - What about your neighbourhood makes it easier or more difficult to walk your dog?

That's all for my questions. Thank you very much for taking time out of your busy schedule to share your story with me today. Do you have any final questions for me before we end the interview?

It is possible that I may have some follow-up questions after reading the transcript of our interview. Would you allow me to contact you in the future if any follow-up questions present themselves?

Also, before hanging up, may I please confirm your address to ensure that your voucher is sent to the proper address?

Thank you and good-bye!