PERCEIVED AND OBJECTIVE NEIGHBOURHOOD BUILT ENVIRONMENT MEASURES AND ASSOCIATION WITH PHYSICAL ACTIVITY AND SEDENTARY TIME IN 9-14-YEAR-OLD CHILDREN IN SASKATOON, CANADA

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ABSTRACT

Background: Canadian children and youth are not getting enough physical activity (PA) and spend on average 8.6 waking hours of their day in a sedentary state. Current trends of PA behavior among children are concerning; has prompted research investigating the correlates and determinants of PA in young people. The neighbourhood-built environment (BE) has increasingly been identified as an important potential contributor to levels of PA. However, the scientific evidence of BE influences on children's PA is still developing, compared to that among adults. A better understanding whether and how BE influence children's PA behaviors may help to identify interventions to promote active lifestyles from childhood.

Research aim: This study seeks to examine the potential influences of both children's perceived and objective BE attributes on objectively-assessed multiple PA outcomes, specifically: Light physical activity (LPA), Moderate-to-vigorous physical activity (MVPA), and Sedentary time (ST), in children aged 9-14 years living in Saskatoon, Canada.

Methodology: This study draws on data from the Smart Cities Healthy Kid's (SCHK), and subsequent Seasonality and Active Saskatoon Kids (SASK) study. Children aged 9-14 years were recruited from the prairie city of Saskatoon, Canada. Neighborhood-scale objective BE characteristics were collected by independent trained assessors using two validated, replicable audit tools (Neighborhood Active Living Potential, NALP, and Irvine Minnesota Inventory, IMI). Children were surveyed on their perceptions of their neighbourhood BE and PA outcomes were objectively monitored (using accelerometer) for one week at three different time periods over a 1 year period. Using a mixed effect model, a multilevel modeling approach was taken to understand the association between BE characteristics and children's PA outcomes.

Results: Children's perceived availability of parks and sidewalks predicted higher accumulation of MVPA and lower accumulation of ST in children. Children's report of the absence of neighbourhood social disorder (e.g. threats from scary dogs/people) was associated with increased LPA, while reported concern for crime was associated with decreased MVPA. As expected, the highest level of observed activity friendliness was associated with decreased ST, however, the highest level of observed safety from crime was associated with increased ST and decreased PA.

Conclusion: Overall safe, walkable, and activity friendly neighbourhoods were found to influence children's activity behaviors. Even so, perceptions of the BE were more strongly associated with children's PA outcomes than with objectively measured BE. Further context-specific studies and understanding of the policy process that influence changes are required.

Key words: Physical activity; Sedentary behavior; Neighbourhoods; Built environment; Objective measures; Perception; Children.

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DEDICATION

This thesis is dedicated to:
My husband, Shubhra Aich

He is my strength, motivation, and hope.

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LIST OF ABBREVIATIONS

BE	Built environment
Kcal	Kilocalorie
Kg	Kilogram
PA	Physical activity
LPA	Light Physical Activity
MPA	Moderate Physical Activity
VPA	Vigorous Physical Activity
MVPA	Moderate-to-Vigorous Physical Activity
SED	Sedentary Behavior
ST	Sedentary Time
IMI	Irvine Minnesota Inventory
NALP	Neighbourhood Active Living Potential
cpm	Counts per minute
SASK	Seasonality and Active Saskatoon Kids
SCHK	Smart Cities Healthy Kids
SPSS	Statistical Package for the Social Sciences
LMEM	Linear Mixed Effect Model
MLM	Multilevel Model
WHO	World Health Organization
CIHR	Canadian Institutes of Health Research
GIS	Geographic Information Systems

GLOSSARY

Accelerometers: Piezoelectric devices worn by individuals, typically on the hip, arm or thigh, capable of detecting accelerations in one to three planes (1)[1]. A device used to directly measure intensity and duration of physical activity or sedentariness.

Built Environment (BE): Anything that is built by humans, for humans, for the purpose of human activity (2).

Device-Based Physical Activity Behaviour: The use of electronic devices (e.g. accelerometers) to quantify physical movement through the measurement of body acceleration in up to three planes.

Irvine Minnesota Inventory (IMI): "An extensive audit tool aimed at measuring a broad range of BE features that may be linked to active living". The IMI is comprised of 229, primarily binary items assessing the absence or presences of specific BE features on a neighbourhood scale (3).

Light Physical Activity: Any waking behaviour of a person with minimal movement of the whole body. Light physical activity includes activities equivalent to $1.5 \leq MET < 3$. Example: standing relatively still.

Metabolic Equivalent Of Task (MET): "One metabolic equivalent is defined as the amount of oxygen consumed while sitting at rest and is equal to 3.5 ml O_2 kg body weight-1 min-1(5)."

Moderate Physical Activity: Any waking behaviour of a person performing tasks of a medium exertion. Moderate physical activity behaviours include actions equivalent to $3 \leq MET < 6$ (6). Example: brisk or purposeful walking.

Neighbourhood Active Living Potential (NALP): A neighbourhood level audit tool aimed at measuring four themes: Activity Friendliness, Safety, Density of Destinations, and Universal Accessibility of the BE. Using this method, observers rated each item on a 6-point scale after walking a pre-defined route in each neighbourhood that connected 10 randomly selected street segments (7)

[1] The references cited in the Glossary are listed separately, starting on page 74.

Objective Measures: In the context of research on correlates of physical activity, the term 'objective measures' generally refers to quantitative data collected directly by researchers using standardized methodologies with replicable results (8).

Physical Activity: "Any bodily movement produced by skeletal muscles that requires energy expenditure,"(9). Physical activity includes physical actions equivalent to MET≥1.5 (10). Physical activity can be described as light, moderate or vigorous in nature, but often, and confusingly, only implies higher intensity movements limited to moderate-to-vigorous physical activity (11).

Physical Activity Behaviour: Any waking behaviour, inclusive of sedentary behaviour and light, moderate and vigorous physical activity.

Physical Inactivity: A lack of moderate-to-vigorous physical activity, which can be inclusive of both light physical activity and sedentary behaviour.

Sedentary Time (ST): Any waking behaviour of a person while they are in a sitting or reclined position with very little movement of the whole body. Sedentary behaviours include actions with a MET<1.5 (12). Examples: sitting in a chair, laying down while awake.

Vigorous Physical Activity: Any waking behaviour of a person performing tasks of a high level of exertion. MET≥6 (6). Example: running.

CHAPTER 1
INTRODUCTION

1.1 General introduction

Physical activity (PA) promotes child's growth and development and has important short- and long-term health benefits in physical, emotional, social, and cognitive domains across the life span (1–3). Specifically, PA reduces the risk for chronic health problems (e.g. pediatric obesity, heart disease, and type-2 diabetes); improves musculoskeletal and cardio-metabolic health and fitness; and reduces stress, anxiety, and depression (4–7). In contrast, sedentary time (ST), such as screen-viewing and excessive time spent sitting, may contribute to health risks independent of the impact of PA (7–10).

Despite the recognized value of regular PA to the health and development of children, prevalence estimates suggest that, most children may not be engaging in enough PA (11). Statistics Canada's The Canadian Health Measures Survey (CHMS) reports that majority (91%) of children and youth (ages 5–17 years) in Canada do not meet Canada's recommended guideline of 60 minutes of moderate-to-vigorous PA (MVPA) daily and spend the majority of their time engaged in sedentary activities (12). Saskatoon youth, in particular, spend on average 9 hours of their weekday leisure time in a sedentary state, (13,14) well above the Canadian Society for Exercise Physiology's (CSEP) recommended limit of children's ST to no more than 2 hours per day (15). Even though children comply with recommended levels of PA, if they are sedentary for much of the rest of the day, they have an increased risk for obesity, cardio metabolic ill health, and premature death (13).

In recent years, interest in both PA and ST during the childhood has increased (16). A wide range of stakeholders in health and health care, ranging from health care providers to researchers, agree that ST may hinder participation in PA and identify the need to develop physical activity promotion strategies with a more sophisticated understanding of the influences on children's PA and ST (17). To date, most intervention strategies to support healthy physical activity behavior have focused on changing individual behaviors, however, they are significantly limited in their ability to cause sustained and meaningful levels of behavioral change across a large portion of the population (18,19). An effective or promising approach for promoting PA needs to take into

account of the complex interactions between individuals and their exposure to a diversity of contexts including the settings where they spend their time, such as environmental factors (20).

Research linking the neighbourhood BE and children's PA behaviors is a relatively new but rapidly expanding field of inquiry from a number of disciplines, including epidemiology, public health, and urban and transportation planning (21–23). Many aspects of the BE that comprises buildings, roads, open spaces, and sidewalks can affect children's PA and ST. Elements that are found to profoundly shape children's daily PA patterns include the availability and accessibility of parks and recreation facilities as well as other neighborhood features such as walkability, safety, and activity friendliness (24–26). Although these patterns have provided important initial direction, these findings have not been consistent within the literature, compared to that among adults (27,28). As children have less autonomy than adults do and their independent mobility often is confined to their neighborhood, these neighborhood environmental characteristics, as well as their perceptions of these characteristics, may have particular impact on their PA and ST (28).

Increasingly, links are being identified between various elements of the neighbourhood BE and PA among younger children, however, essential gaps in knowledge still exist. There is little published research on how children and adolescents perceive their neighborhood BE and how this perception is related to their PA and ST (29,30). While children's perspectives could bring new insights into relevant environmental determinants of activity behavior, most studies to date have been focused on parent's view on potential environmental determinants of their children's activity behavior (31,32).

Although objective measures of BE reduce the subjectivity that is associated with perceived measures and may be more easily interpretable and translatable into policy recommendations, (33) however, perceptions of environmental features may relate better to children's PA (34). This is important, as there is evidence to suggest that environmental perceptions may be equally predictive of PA behavior as objectively measured environments and may capture accurately the relationship, perhaps via different pathways, that exists between children's PA and the environment (35).

Even though PA and ST are separately quantifiable behaviours, (36) evidence suggests that, some neighborhood BE characteristics may not have the same potential influences on limiting ST as they do for supporting PA (37). Nevertheless, very little research has explored both PA and ST in terms of addressing children's overall activity pattern influenced by neighborhood BE

characteristics. In addition, studies to data have largely been cross-sectional which limits inferences about the temporal nature of associations (38).

Since many children and youth in Canada fail to meet PA and ST recommendations, a 2016 Canadian PA report card identified the need to better understand the determinants of PA and ST (39). There have been recent calls for more evidence on the influences of BE on PA and ST that can be implemented in urban planning and design and used to overcome barriers and increase children's participation in regular PA.

My thesis addresses several of these research gaps and identifies the scope of a project. Using longitudinal data on 9-to-14 year old children from a large, nationally representative Canadian cohort, this study explores the influence of neighbourhood BE on accelerometer-assessed PA and ST, taking into account of demographics and using measures (both children's perception and objective) that reflect physical and social characteristics of the neighbourhood BE. Advancing knowledge on how the features of BE impact on children's physical activity levels and exploring when it is important to intervene at the level of children's perceptions and when to facilitate changes to the BE, is, therefore, important for a greater chance of intervention success aimed at promoting children's PA. This study opens a window for building research capacity in Canada on children's everyday experience of their neighbourhood environments, providing insights which help to recognize the role of neighbourhood BE in children's healthy activity.

1.2 Research Aim

The purpose of the study is to examine whether children's (9-14 years of age) perception of the neighborhood BE characteristics, and objective measures of these characteristics, are associated with accelerometer-assessed PA and ST across all four seasons in a year, in Saskatoon.

Specific Objective: To determine which, if any, objectively measured and children perceived neighborhood BE characteristics are associated with children's PA and ST and examine the degree to which the association exist over a period of one year.

1.3 Research Questions

This study seeks to better understand how children's perception of BE, combined with objective measures influence PA and ST over time by asking three questions:

1. What perceived features of neighborhood BE by children predict PA and ST over time?
2. What objectively measured dimensions of a child's neighborhood BE predict PA and ST over time?
3. What the strength of the relationship is between objectively measured and children's perceived measures of BE characteristics with accelerometer-measured PA and ST? Are one set of variables—objective or perceived—more strongly associated than the other?

1.4 Research Hypothesis

Children living in neighborhoods either perceived and/or objectively measured as safe, with good services/facilities, and sidewalks/parks will accumulate more PA and less ST. Given the fact that, children's activity behavior is directly influenced by their image of the BE rather than the BE itself, the perceived BE may have a much stronger effect on children's PA and ST when both are presented in the same model. **Table 1** elaborates on the relevant hypothesis in response to each of the research question.

Table 1 Research Questions and Hypotheses

Research questions	Hypothesis
What perceived features of neighborhood BE by children predict PA and ST over time?	Neighborhoods perceived as safe from crime and traffic, with better pedestrian accessibility (e.g. sidewalks), parks, and better neighborhood conditions (e.g. absence of disorders, aesthetics).
What objectively measured dimensions of a child's neighborhood environment predict PA and ST over time?	Neighbourhoods objectively measured with highest levels of safety from crime and traffic, density of destinations, pedestrian accessibility, attractiveness, and activity friendliness.
Are one set of variables—objectively measured or perceived—more important than the other?	The perceived built environment may have a much stronger effect on activity behavior than the objective built environment

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter describes the current state of evidence and provides a broader rationale for the thesis. Primarily, the thesis is rooted in the decreasing accumulation of PA and the rising prevalence of sedentary behavior (SED) among children in Canada and elsewhere, and the established association of physical inactivity with the development of chronic diseases. Next, empirical studies of a broad range of BE correlates, predictors, and/or determinants of PA and SED are reviewed, examining subjects ranging in age from young childhood to adolescence. Finally, the chapter concludes by summarizing some of the limitations of studies to-date.

Clearly, recent evidence supports that regular PA in childhood is crucial to enhance overall health and assist in preventing chronic diseases, developing cardiovascular and aerobic fitness, strength, flexibility, and bone density and improving self-esteem in youth (1,40). In contrast, increased time spent being sedentary have contributed to pediatric obesity, a decrease in cardiorespiratory fitness, and a greater risk for developing chronic conditions (e.g. type 2 diabetes, heart diseases, and metabolic syndrome) (41). Despite the beneficial effects of PA, there is also evidence to indicate that many children and youth in Canada are not getting enough PA and spending the majority of their time engaged in SED (39).

Considering the problem and its determinants, identification of effective population level strategies for increasing children's physical activity levels is critical for improving the overall health of Canadians (42). The increased prevalence of ST in children, as well as recent concerns over children's health issues, particularly the childhood obesity epidemic, (43) has resulted in a call to study what extrinsic factors shape children's PA and ST patterns throughout the day (42).

Attention has recently been directed to neighbourhood settings; with a particular focus on the role of the BE in facilitating or limiting children's PA and ST (44). The BE, in the broadest sense, comprises of anything that is built by humans, for humans, for the purpose of human activity. Aspects of our neighbourhoods, such as the presence of parks, open spaces, and commercial destinations can be predictive of children's PA behaviors.

2.2 The Built Environmental Influences on Physical Activity Behavior: Theoretical Premises

Children's movement represents a complex behavior that is influenced by multiple factors including demographic, biological, social, and psychological and the environments in which they live (45–48). The use of multilevel ecological approaches is widely accepted to guide research identifying determinants of PA and inform interventions within the domain of PA behavior. Ecological frameworks are based on the premise that individuals are nested within multiple levels of environmental contexts (49), and these environments may relate to specific built environmental context that influence activity behavior, and thus, play an important role in shaping youth physical activity.

Within an ecological framework, the operationalization of transactional nature of the individual-environment relationship, may benefit from Gibson's concept of affordances or perceived possibilities, which are perceived absolutely with individual's goals or intension, and both the physical and psychological capabilities of the perceiver as the effects of environments (50).

The ecological perceptual framework, described by Ergler (2013) includes the concepts of affordance, actualization and habitus, developed by James Gibson and Pierre Bourdieu. As Ergler (2013) explains, "objects…may afford possibilities of throwing, hiding behind, hanging or falling from, whereas surfaces may afford running, climbing, balancing or tripping. How, and to what extent, an action is carried out depends, however, on what the individual child perceives in the environment and how they evaluate its possibilities for action" (p. 179). In addition, the environment in which a child lives and interacts with must offer something that a child can recognize as either an enabler or inhibitor of a specific action or behaviour (51).

Bronfenbrenner Ecological Systems Theory, (52) described by Davison and Birch (2001), includes the concept of human behavior such as physical activity participation within a broader context and interactions between and within these contexts that affect behavior. As Davison et al. (2001) explains, "development occurs as a result of interactions within and among these contexts; that is, characteristics of the child interact with processes in the family and the school, which themselves are influenced by characteristics of the community and society at large" (p. 160). As they highlighted the importance of explaining or predicting the behavior change considering the context or ecological niche in which the individual exists (e.g. the home), this context, in turn, is situated within a broader context, such as the neighborhood and wider society (53).

2.3 Studies Linking the Built Environment with Children's Physical Activity Outcomes

A growing body of research, particularly in the fields of planning and public health, indicates that specific BE characteristics may influence children's decision whether they engage in physical activity (54–57). Previous studies in children have reported some possible associations between BE characteristics and different PA domains (58–60). In contrast to the consistent findings in adults, (61–64) these findings, however, have not been consistent within the literature (24) ; some find an association (57,59,65–69) and others do not (56,70).

In a recent systematic review of environmental correlates of PA among children, Ding et al. found a large proportion of null associations (no association between BE and PA could be established in two-third of the studies) (24). In their extensive review, Salmon et al. identified factors such as safety, access and availability of public open spaces and sports facilities, and social interaction that predicted higher accumulation of PA in children, however, the results remain inconsistent. Authors argued that, inconsistent findings across studies, may, in part, be explained by using measures of global PA (rather than context-specific measures of PA, e.g. walking in the neighborhood) (71). Another systematic review, conducted by Karina et al. also found inconsistency in the results from observational studies examining the relationship between BE and children's PA behaviors, and revealed that construction of such infrastructures does not necessarily guarantee increases in PA (72). Comparably, Panter et al. (73) and Davison et al. (74) identified many environmental factors such as the presence of facilities, general aesthetics, and safety which were inconsistently associated with PA and SED in children.

Inconsistency in the results across studies, may, partly be explained by the differences in measurement assessment of the outcome or exposure (e.g., objective vs. perceived). The BE can be measured through both objective and perceived measures and may have independent role in shaping youth PA and ST. In the context of BE, objective measures generally refer to quantitative data collected independently by researchers using standardized methodologies/replicable results, whereas, perceived measures are of perceptions of the built environment, generally assessed using surveys, validated questionnaire, and scales. Similarly, in the context of PA outcomes, objective measures generally refer to a device-based measures (e.g. accelerometer), or the assessment of physical activity by trained researchers. Self-reported or travel logs/diaries are generally

considered to be less reliable than objective measures for the assessment of certain critical dimensions of physical activity in children (75).

2.4 The Association between Specific BE Characteristics with Children's Physical Activity and Sedentary Behavior

Associations of BE predictors with PA outcomes are grouped in the following sections as: parks and recreational facilities, pedestrian infrastructure (e.g. provision of amenities such as sidewalks/trails and street lights, road hazards such as traffic volume/density, crossings etc.), neighbourhood quality (e.g. social and physical disorder and neighbourhood aesthetics), safety (general safety as well as safety from traffic and crime), and the social support and/or the presence of active role models (e.g. seeing others do exercise).

2.4.1 Parks and Recreational Infrastructure

Availability of parks and recreational facilities have frequently been identified as built environmental correlates of children's physical activity outcomes (76–78). A number of researchers have reported that, neighbourhoods with greater access to parks and other recreational facilities such as open space, playgrounds, and gym, the quality of recreational infrastructure, and closer proximity to the nearest parks predict children's higher accumulation of PA and lower accumulation of SED. For example, Timperio et al. found that children's report of availability of parks and playgrounds was associated with higher levels of objectively assessed PA, and the highest number of local independent destinations travelled (79). In a recent study conducted in London, Canada, researchers found that children (aged 9–14, n = 435) from neighbourhoods with greater access to parks with sports fields and multi-use path space had significantly higher levels of device based MVPA (80). Nearby public open space features were negatively associated with parental report of TV viewing and computer/e-game time in very young children (4-5-year old). However, device-based ST was not associated with select features of the neighbourhood public open spaces measured (81).

Inconsistency among studies examining the association between the presence of parks and recreational facilities and youth PA has commonly been observed. A survey including 5,471 grade five students and their parents in the province of Nova Scotia, Canada, revealed that, children living in neighborhoods with good access to playgrounds, parks, and recreational facilities were

reportedly more active and were less likely to be overweight or obese (66). However, a cross-sectional questionnaire-based study, conducted in Birmingham, UK, demonstrated an inverse association between children's report of the availability of parks or sports facilities and PA levels. Authors reported that, children (n=473, 9-11 years) accumulated lower (rather than higher) levels of walking in the neighbourhood if they perceived their neighbourhoods as good with parks and other recreational facilities (82). Another survey including 34, 369 students from secondary schools in Hong Kong, reported that, perceived availability of recreational facilities was associated with adolescents' self-reported higher levels of physical activity (83). In contrast, Dunton et al. found no association between children's report of parks and self-reported physical activity (84). Amy et al. examined both perceptions and objective measures of neighbourhood environments and linked these environmental features with device-based youth PA. Authors demonstrated that, adolescents' report of recreational facility availability (but not the objective availability) was associated with an increased accelerometer based MVPA (85). However, Sarah et al. (70) found no association between perceived availability of play spaces and proximity of playgrounds and parks and objectively measured physical activity. Objective recreation environment such as the number of recreational facilities and parks were positively associated with objectively measured MVPA (59), however, Scott et al. found no association between objective recreation facilities with youth accelerometer assessed MVPA (86). Some of these inconsistencies, may be explained by the differences in the study context, the impact of study design and confounder adjustment strategies on the association between BE and PA behavior, and a lack of uniform definition of exposure, outcome and confounders.

2.4.2 Pedestrian Infrastructure (Sidewalks, Streetlights, Traffic Volume, Road Crossing)

Another important predictor expected to influence children's PA is the pedestrian or transport infrastructure such as provision of amenities including sidewalks, walking and cycling paths/trails, and streetlights, and road hazards including traffic volume/speed (87–89). Jago and colleagues studied 210 male adolescents (aged 10-14) in Houston, Texas to determine whether environmental features were associated with PA. Authors examined the impact of several BE features (by direct observations) on children's accelerometer assessed physical activity and found that, objectively assessed positive sidewalk characteristics was associated with higher objectively assessed light intensity PA and lower levels of ST (90). Boarnet et al. undertook an evaluation of the Safe Routes

to School (SRS) programme in California. The programme provides funding to improve the environment for active travel to and from school (e.g. sidewalk improvements). The authors reported that, children who passed areas in which sidewalks were installed were more likely to walk or cycle to school than children who did not pass such areas (91).

Children's PA is greatly influenced by parental perceptions of pedestrian facilities in the neighbourhood (e.g. sidewalks, traffic volume, and street connectivity) (92). For example, De messter et al. demonstrated that, parent's report of the shorter distances to school and availability of walking/cycling infrastructure (sidewalks, walking trails) were positively associated with children's reported physical activity (89). Similarly, Francisco et al. found that, parent's report of the traffic volume and street intersections were related to youth active travel to and from school (93).

Inconsistency among studies examining the association between the pedestrian facilities and youth PA are common. For example, Larsen et al. examined environmental influences on a child's mode of travel between home and school and found that, higher traffic volume (Geographic Information Systems (GIS) assessed) were associated with adolescent's reported lower rates of walking or cycling to and from school (94). In contrast, Carver et al found a positive relationship between parent's report of heavy traffic and adolescent's boys objectively measured physical activity (95). A survey including 3,421 grade five students and their parents in Alberta, showed an association between parent's report of the neighbourhoods with good sidewalks and less traffic and children's higher reported levels of PA (96). Similarly, girl's reports of the presence of walking/biking trails on most streets in the neighbourhoods was positively associated with higher levels of self reported physical activity (97). In contrast to these findings, Mota et al. (78) found no association between adolescent's report of availability and quality of sidewalks and cycling infrastructure and adolescents' self-reported physical activity.

A cross-sectional study of children aged 8–9 years (n = 188) and adolescents aged 13–15 years (n = 346) examined associations between objective measures of neighbourhood BE and youth PA and demonstrated that, observed positive road environment (the presence of sidewalks, street/pedestrian lights) was positively associated with adolescent's girl's objectively assessed MVPA (95). In contrast to these findings, Deforche et al. (98), however, found no association between availability and quality of sidewalks and cycling infrastructure and adolescents' observed

physical activity. Similarly, McMillan found no association between the proportion of street segments with a complete sidewalk system (i.e., sidewalk on both sides of the street with children's active communicating (walking/cycling) to school (99).

2.4.3 Neighbourhood Quality (Social and Physical Disorder and Aesthetics/Attraction)

Only a few studies have examined the association between neighbourhood quality including general neighbourhood aesthetics/appearance, nearby attraction, and physical and social disorder and children's physical activity outcomes. For example, Kerr et al. found that parent's report of higher neighbourhood aesthetics was positively associated with adolescent's active commuting to school (100). Conversely, children whose parents perceived the neighborhood as very unpleasant for activity were less likely to actively commute (101). Adolescent's report of neighbourhood aesthetics was inversely associated with objectively measured ST (102). However, de Brujin et al. found no direct association between children's reports of neighbourhood conditions including general aesthetics, attraction, and overall pleasantness with adolescent's intention to be physically active (103).

In line with other BE features, results remain inconsistent across studies investigating the relationship between neighbourhood aesthetics and youth PA. Mota et al. found a positive association between adolescents' reports of the neighbourhood general aesthetics with their self-reported physical activity (78). In contrast, Evenson et al. found that adolescent girl's report of lack of neighbourhood pleasantness with exhaust fumes or other bad smells was related to higher(rather than lower) levels of walking and cycling (104). Diana et al. found that, higher levels of perceived neighbourhood greenness was associated with higher levels of objectively measured children's physical activity (105). In contrast, Jago et al. (90) and Grow et al. (106) found no association between adolescent's perceived neighborhood aesthetics with objectively measured physical activity.

One feature of urban neighborhoods that has been hypothesized to contribute on children's decision of engaging in outdoor play is the level of neighbourhood social (107) and physical disorder (108). For example, Molnar et al. showed that, children's perception of both physical (e.g., graffiti, empty beer bottles) and social (e.g., alcohol in public, people selling drugs) disorder were associated with parent's reported lower levels of recreational activity (e.g. walking to parks) (109). A qualitative study involving four hundred households in England found that, parent's

report of the social disorder (e.g. stranger danger) was inversely related to children's participation in outdoor play (110). Similarly, Nicholas and colleagues found that, a sense of safety from neighbourhood social disorder reflecting the concept of 'stranger-danger' facilitated children's involvement in active free play (111).

Inconsistencies in the results across studies have clearly been identified for the association of neighbourhood quality with youth PA. For example, Alton et al. found that, child's reported concerns regarding the social disorder (stranger dangers) was inversely associated with their participation in active play (82). However, Timperio et al. (79) and Carver et al. (95) found no association between children's and parent's perceptions of stranger danger (a source of social disorder) and levels of physical activity among youth. Similarly, Motl et al. found no association between adolescent's girl's reports of neighbourhood social disorders (e.g. presence of scary dogs) with objectively assessed physical activity (112).

2.4.4 Safety from Traffic and Crime

Parents and children's concerns about neighbourhood safety have been underscored as an important factor affecting children's physical activity behavior (113). As Kawachi and Berkman suggested, perceived safety from crime is a stronger predictor of activity behaviour (e.g. decision to go/not to go outdoors to play) than are actual crime rate, and research on the association linking neighbourhood safety and children's physical activity have been predominantly focused on perceptions of safety in the neighbourhood (rather than observed) in relation to children's physical activity (114). Voorhees and colleagues, for instance, studied eight hundreds and ninety girls to demonstrate that, girl's report of neighbourhood safety (from crime) was positively associated with their reported active travel between home and school (115). In a recent study using participatory mapping and qualitative GIS methods, Katherine et al. examined how children's perceptions of their environments influence their school journey experiences and found that, neighbourhood safety related features including traffic speed, concerns for crime, challenges crossing roads, and the presence of unattended dogs/creepy people were few of the identified barriers to children's active transportation to/from school (116).

Although a number of studies have identified an association between objective safety and youth PA, no firm conclusion can be drawn on the associations. For example, observed crime in the neighbourhood was associated with the lower levels of adolescent's reported MVPA (117).

However, Mitchel et al. found no association between objectively-assessed neighbourhood general safety with objectively-assessed PA in children (118). Monika et al., one of the few studies examining both objective and perceived BE features in relation to youth PA, found that, objective measures of neighborhood safety and traffic risk (GIS measured) were inversely associated with children's accelerometer assessed after-school MVPA (119). Authors demonstrated that, children accumulated lower levels of MVPA if the neighbourhoods where they live were rated as safe.

Children's participation in physical activity is largely influenced by parental perceptions of the safety related features in the neighbourhood (120). For example, Elizabeth and colleagues found that parental reported concerns of safety from traffic and crime were positively correlated with higher levels of sedentary behavior among children (121).Conversely, parental restriction of children's active transport and physical activity outside school hours due to safety concerns was associated with lower levels of MVPA among younger children (122). Hillman and colleagues demonstrated that, over 40% of English parents restricted schoolchildren aged 7–11 years from active communicating to and from school because of traffic danger (123). On the contrary, parent's satisfaction with safety related features in the neighbourhood was positively associated with adolescent's increased participation in outdoor play (124).

2.4.5. Social Support/Active Role Models

While not classifying as neighbourhood built environmental characteristics specifically, measures of the social interaction/community support including the presence of active role models within the local neighbourhood have also been linked to children's physical activity (125). In general, studies indicate that children are more physically active in their neighbourhood when they have supportive friends and/or peer, having positive social support/social interaction, and active role models (seeing others, especially young people of similar age nearby to do exercise) (10,126,127). For example, Carver et al. (128) found that important explanatory factors related to positive social interaction or community support for adolescent's increased physical activity. Maria et al. showed a significant association between boy's physical activity, but not girl's and report on the presence of people being active in the neighbourhood (OR=1.59; 95% CI 1.05–2.40) (129). Luisa et al. found that, positive social interaction, but not other built environmental variables, was positively associated with children's physical activity and negatively associated with sedentary behavior (130).

2.5 Characterizing Children's Physical Activity and Sedentary Behavior

Physical activity is commonly described in terms of duration, frequency, intensity and type or mode (131). In general, duration refers to the length of time that children engage in physical activity, often expressed in terms of specific episodes or bouts of physical activity. Frequency refers to the number of bouts of physical activity engaged in over a given period, usually a day or a week. Intensity describes the level of exertion at which a physical activity is performed, or the "magnitude of the physiologic response to physical activity" (132). Intensity thresholds may be quantitatively defined in terms of metabolic equivalents (METs), which are multiples of resting metabolism (133). Commonly used thresholds for the different intensities of physical activity, expressed in terms of METs, are highlighted in **Table 2**, together with examples of activities corresponding to the different intensities (134,135).

Table 2: Thresholds for the different intensities of physical activity with examples

Intensity	METs	Examples of corresponding activities
Sedentary	<1.5	watching TV, playing video games
Light	1.5-3	Slow walking
Moderate	3-6	Brisk walking, swimming, outdoor play
Vigorous	>6	Running, jogging, playing soccer

(Source: Adapted from Ainsworth BE, Haskell WL, Leon AS, et al. Compendium of physical activities: classification of energy costs of human physical activities. Medicine and Science in Sports and Exercise 1993;25(1):71-80)

2.6 Objective vs. Perceived Built Environment: What Matters Most to Physical Activity?

There is a lack of evidence of any sort which would suggest whether perceived or objective built environment variables more consistently predict youth PA (138). As the "image" theory suggested (136), human behavior is predominantly based on the perception of what reality is, not on reality itself. Thus, perceptions of the environment may not correspond well to the objective environment and the perceived built environment may have a much stronger effect on activity behavior than the objective built environment (137). Most studies to date examining the mismatch between perceived and objective measures of physical activity environments have primarily focused on adult's activity behavior (rather than children's). In the context of physical activity, Stephanie et al. systematically reviewed literature of agreement between perceived and objective BE and

confirmed that, perceived neighborhood environment variables (rather than objective) were significantly associated with physical activity at slightly higher rates (20.1% and 13.7%) (138). Similarly, Gebel et al. found that**,** respondent's perception of high-walkable neighborhood as low-walkable decreased their walking activities significantly more than those with matched perceptions and concluded that perceptions may be more strongly associated with activity behavior(vs. objective measures) (139). This literature review suggests that, both the objective and perceived BE may have different effects and/or independent role in shaping youth physical activity and sedentary behavior, while perceptions, either parent's or children's, may play a much larger role than the objective environment to predict PA behavior.

2.7 Concordance between Perceived and Objective BE Measures

Only a few studies, in the context of PA, have investigated the concordance between perceived and objective BE measures in which low to modest agreement was detected (140–145). Some researchers have postulated that the low level of agreement between BE measures suggests that perceived and objective features influence health-related behaviours through different mechanisms (146). One possible explanation for this low agreement is to capture different constructs/dimensions of the built environment or physical activity (147,148). Several methods are being used across studies to measure BE characteristics. Self report instruments assess individual's perceptions of their BE and observational techniques such as neighbourhood audits and technology such as GIS assess BE features more directly (144). Perceived or objective measures may or may not reflect similar features of the built environment (138). For example, self reported accessibility to parks and other recreational facilities may seem conceptually similar to the measured accessibility to facilities, however, researchers reported low levels of agreement between these two measures of the neighbourhood environment (143). Another potential explanation is that there exists a difference between residents' notions of neighbourhood boundaries and/or barriers/enablers to PA and the way boundaries are defined by researchers (149). In addition, objectively measured neighborhood boundaries should be different depending on area and resident characteristics

2.8 Research Gap: Limitation in Current Literature

As noted by Davison et al. (53) and Sallis et al. (48), the vast majority of studies linking BE and children's PA are based on a cross-sectional research design, which can only be used to identify

associations between variables (rather than making causal inferences). Longitudinal studies, however, may be more appropriate for gaining insight into causal effects (38).

A demonstration of the generalizability and comparability across studies is limited by the different built environment contexts studied and inconsistencies in methods and measures used both for PA and built environmental correlates of PA. This limitation may partly explain inconsistencies in results noted. There are relatively few studies of built environmental correlates of children's PA that occurred within Canada, and the context-specific ethnic classifications used in international studies may not be directly comparable with the multi-ethnic context of major Canadian metropolitan areas.

Another major gap identified across studies that may limit the generalizability of results is the inconsistency in measures used for both PA and BE. As discussed above, some studies rely on objective measures of BE, while others on perceived measures. Besides, most studies focus on parental perception of BE (rather than children's perception that could bring new insights into this relationship). Our understanding of how children interact with their physical environment is only in its infancy and much remains to be learned. In addition, most studies rely on global measures of PA (rather than context-specific measures, such as, walking in the neighbourhood). It should be noted, however, that many studies in the area of research on children's physical activity has focused on PA, which may not be able to capture children's overall activity patterns in relation to their built environment. Taken together, the absence of information regarding children's perceptions of the neighborhood built environment, more focus on PA (vs. ST) in terms of addressing children's activity behaviors, and the lack of evidence based on longitudinal studies, may, in part, explain the limited knowledge that currently exists in the literature regarding the relationship between BE and children's PA and ST.

Another limitation is that empirical analysis is often emphasized with little corresponding development of or linkage to underlying theoretical frameworks. The value of ecological frameworks of PA behavior is increasingly recognized (48), however, often fail to specify the mechanisms underlying relationships between neighbourhoods BE and specific domain of PA. Thus, more sophisticated models emphasising on wide ranging correlates spanning individual and multiple environmental contexts to describe children's PA is warranted.

CHAPTER 3
THEORETICAL FRAMEWORK

3.1 Introduction

This chapter presents the theoretical constructs, models and frameworks used in the conceptualization of the model developed for this thesis. Children's use and experience of the local environments plays a key role in their physical activity behaviors; however, researchers acknowledge that this relationship is complex and difficult to untangle (150). Exploring the relationship between children and their primary environments, and its impact on children's PA outcomes, requires a conceptual framework that can represent the diverse and multi-faceted nature of both children and their environmental connection (151,152). As outlined by Spence et al. (153) there is no single universally accepted theory or model of physical activity behavior, instead the health behavior models informed by a number of theories help to understand a specific problem (e.g. physical activity) in a particular setting or context.

Increasingly, the ecological frameworks are being used to better understand the complex factors that influence individual and population health. Ecological Framework for Conceptualizing Correlates of Child Physical Activity, developed by van Loon et al. (154) describes multiple environments in which children live and several correlates of physical activity corresponding to the individual child and their perceptions of the environments they are regularly exposed to (e.g. school, home, and the neighbourhood). Environmental determinants of active travel in children framework, developed by Panter's (73) encompasses diverse physical environmental factors including characteristics of the neighbourhood, destination, and route environment that influence active travel behaviours in children and youth.

The Hierarchy of Walking Needs, proposed by Alfonzo (155), represents a modified version of the socio-ecological model of physical activity that describes physical environmental factors as antecedents of physical activity, with social group-level factors moderating the relationship between environmental factors and the final decision to be physically active. As Alfonzo explains, "The elements within the hierarchy serve as the antecedents within the walking decision-making process. These variables are either present or absent within the setting (or within the person in the case of feasibility) in which the decision to walk occurs. It is the affordance of these needs, however, that ultimately may affect the decision to walk" (P. 819).

3.2 Conceptual Model Developed for This Thesis

A typology of built environmental factors that predict children's physical activity, developed for this thesis, can be found in **Figure 1**. This typology represents the neighbourhood physical activity opportunities for children taking into account a notion that, some physical environmental factors are more fundamental than others when deciding to be physically active outdoors. At the most fundamental level, there must be opportunities for PA (e.g. provision of amenities or neighbourhood facilities such as parks and playgrounds). At the next level, the decision to be physically active outdoors may depend on safety considerations, personal safety as well as crime and road safety. Next, being physically active outdoors may depend on comfort, which reflects the convenience of walking, running, biking, or outdoor playing. Comfort can be operationalized by sidewalks and street conditions and traffic volume. Finally, outdoor physically activity may be more likely to occur in environments that are pleasurable, such as neighborhoods with trees lining the street, well-tended yards, and residents who spend time outdoors (e.g. the presence of active role models of PA).

To merge these independent BE factors into a dynamic network of what influences children's activity outcomes, a theoretical framework **(Figure 2)** was developed using concepts derived from Bronfenbrenner Ecological Systems Theory (52), Van loon's "An Ecological Framework for Conceptualizing Correlates of Child Physical Activity" (154), Panter's environmental determinants of active travel in youth framework (73), and Alfonzo's "the hierarchy of walking needs" (155). In the proposed conceptual model developed for this thesis, child activity behaviours are explored in relation to child's characteristics and the neighbourhood built environment in which the activity is experienced. As children's physical activity occurs in specific places, such an approach, therefore, is useful to examine characteristics of places that facilitate or constrain physical activity behaviors. This model provides a means of organizing and analysing the scope and nature of children's activities within their neighbourhood environments, and how these neighbourhood PA opportunities, coupled with individual-level factors such as child's age and sex, operate on children and facilitate their decision making process of being physically active outdoor. In terms of PA behavior, this study was particularly focused on light physical activity (LPA), a summation of moderate and vigorous physical activity (MVPA), and sedentary time (ST).

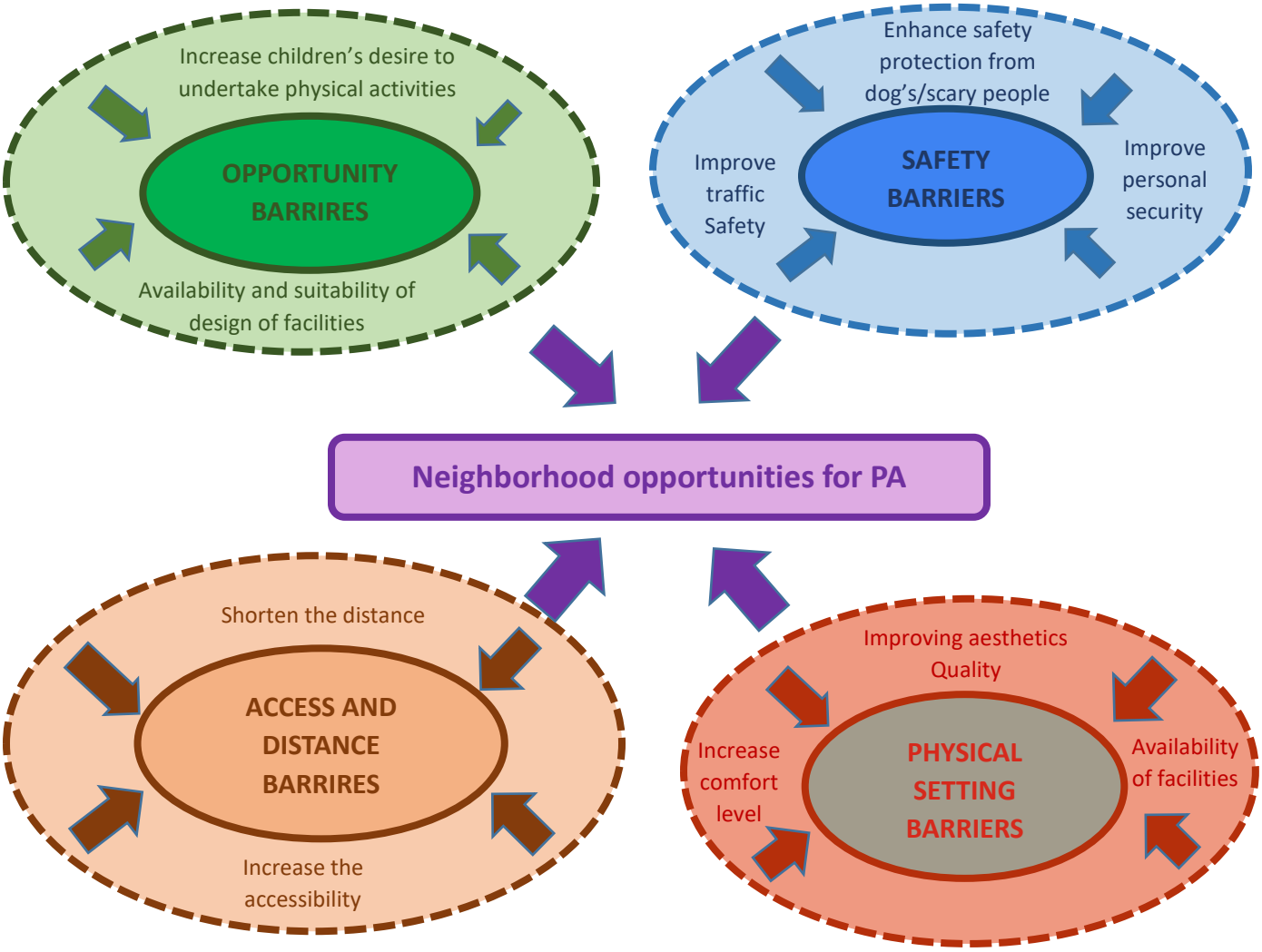

Figure 1 A typology of built environment correlates of physical activity, developed for this thesis.

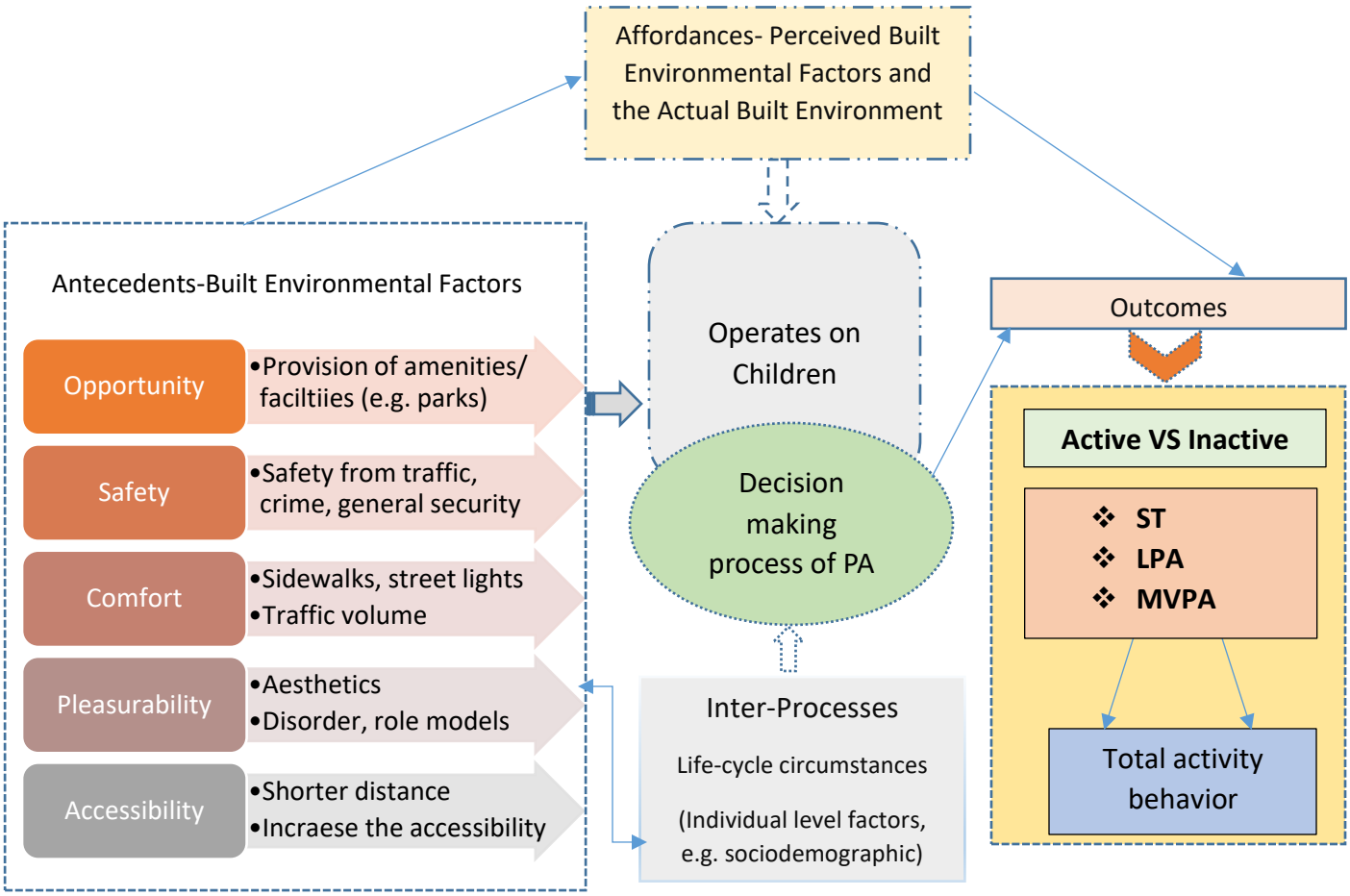

Figure 2 Conceptual model of built environmental factors predicting children's physical activity and sedentary time

CHAPTER 4

METHODOLOGY

4.1 Research Setting

This study is an analysis of secondary data from The Smart Cities, Healthy Kids (SCHK), and subsequent Seasonality and Active Saskatoon Kids (SASK) study (13). This master's degree thesis is part of the CIHR funded, "A Step towards Creating Active Urban Communities: Informing Policy by Identifying and Mapping Locations of Seasonal Activity Accumulation," grant (Beh 14-83), led by Dr. Nazeem Muhajarine, which aims to expand our understanding of how local neighbourhood environmental factors influence children's activity behaviors gained in the first 2010 SCHK study.

4.2 Design of the Study

The current study is the secondary analysis of existing longitudinal data from the SCHK, and subsequent SASK study conducted in Saskatoon, Canada. The SCHK (2009-2012), and subsequent SASK study (2014-2017) is a longitudinal cohort study developed in Saskatoon to examine the effects of the neighbourhood BE on child health, through physical activity opportunities, across all seasons, among children aged 10-14 years (13). The SCHK study includes vital information regarding children's demographics and health, physical activity, and objective measures of neighbourhood BE. Currently, Saskatoon's metropolitan area population of 271,000 (156) is spread across 65 residential neighbourhoods. However, during the conceptualization and implementation of the first SCHK study, Saskatoon had 60 neighbourhoods. The subsequent SASK study includes information pertaining to children's perception of neighbourhood BE, socio-demographics, and self-reported and objective measures of physical activity behaviors (2014–17 school years).

4.3 Data Source

4.3.1 Exposure and Outcome Measures

This thesis benefited from the use of secondary sources of data on measures of children's perceptions of BE, in addition to objective measures of both BE characteristics and PA behavior. The objective BE measures were derived from the first SCHK study (2009-2012) and children's perceived BE measures and the objective PA measures were derived from the SASK study (2014-

2017). The primary exposure utilized in this study is the BE characteristics-both perceptual and objective measures, and the outcome is objective measures of PA behaviors.

4.3.2 Objective Built Environment Measures: SCHK Study (2009-2012)

In 2009, specific built environment characteristics of all 65 residential neighbourhoods in Saskatoon were measured (157,158). For SCHK, a specific construct to select built environment measurement tools were utilized ─ the degree to which neighbourhood environment supports and encourages PA and discourages ST. Another criterion for selection was previously validated tools which generate generalizable results (159). Based on these criteria, two replicable tools called the neighbourhood active living potential (160) and the Irvine-Minnesota inventory (161) were used to measure specific aspects of built environment. Neighbourhood active living potential is an 18 item tool that was validated by the SCHK team (162) by measuring dimensions of safety, density of destinations, universal accessibility, and activity friendliness. In implementing this tool, pairs of observers independently rated neighbourhoods'-built environment by travelling a predetermined route created by random selection and connection of block segments to determine a walking route. Similarly, two observers were employed to administer the Irvine Minnesota Inventory to measure built environment of neighbourhoods in five dimensions: diversity of destinations, pedestrian access, and attractiveness, safety from traffic and safety from crime (159–162).

4.3.3 Children's Perceived Built Environment Measures and Objective Physical Activity Behaviors: SASK Study (2014-2017)

4.3.3.1 Neighbourhood Selection, Recruitment, and Study Participants

Before proceeding to recruitment, ethics approval from the University of Saskatchewan's Research Ethics Board and from both Catholic and public-school boards of Saskatoon was obtained. Participants were grade 5 to 8 children aged 10-14 and their parents who were recruited to the "A Step towards Creating Active Urban Communities" project (n=758) in Saskatoon, Canada. In the school year prior to study commencement (June – July 2014), a multi-stage clustered sampling method was employed to recruit children from a sampling frame that consisted of all 65 residential neighbourhoods in Saskatoon. First, neighbourhoods representing all three neighbourhood types of Saskatoon were identified. The, the recruitment was occurred through elementary schools in

each selected neighbourhood by identifying intact classes for recruitment (four classrooms at each elementary school, from Grades 5 to 8). All schools in Saskatoon situated in all three types of neighbourhoods were invited to participate in the study. Of the 82 invited schools, 33 (40.2%) participated in the study. From the participating schools, children and their parents were invited to participate in the study through a written informed consent letter disseminated by home classroom teachers. Children were instructed to bring the consent letter home to their parents and return it to their home room teacher within a specific time frame. Parent/guardian written informed consent was required for children and their parents/guardians to be enrolled in the study. Child and parents were instructed their enrollment was voluntary. Additionally, the consent form provided a section to explicitly decline study participation. Recruitment occurred in classrooms and schools where home room teachers and principals permitted research staff to deliver recruitment materials. Of the 4615 eligible students in those 33 schools, 922 (20.0%) students and their parents consented. In 2014, after obtaining informed consent from parents/guardians of the children, objective physical behaviour measures in children were collected in conjunction with the Saskatchewan Population Health Evaluation Research Unit research team over three time frames from September 2014 to January 2015, January to April 2015, and May to September 2015 (excluding August 2015) using GPS equipped accelerometers. At the first (Sept-Dec 2014), second (Jan - Apr 2015), and third (Apr - Jun 2015) data collection time points 58 (7.1%), 59 (7.2%), and 76 (9.3% of the original consenting population) students were lost to follow up (either absent, had moved to a different school or province, or declined to participate further), respectively. The total number of consenting participants at the first, second and third collection point therefore included 758, 699, and 623 child-parent dyads from 31 schools. The validated Seasonality and Active Saskatoon Kids (SASK) questionnaire was administered in each collection period to capture children's behaviour and perception of a range of factors that influence their activity, household (including family socioeconomic factors), parental, peer and neighbourhood influences on PA behaviors. A total of 656 child-parent dyads responded to the SASK questionnaire at least once (86.5% of 758 participants present at the first time point). The child survey data were collected on children's participation in both home and neighbourhood-based activities, their perceptions of the neighbourhood-built environments, and demographics. Individual level variables were used to account for factors specific to each child that may influence their physical activity. These variables used include (with the reference category italicized): gender (male versus *female*); age in years

(continuous); and annual household income. The focus of this study was not to identify the independent effects of the sociodemographic variables on physical activity. Instead, this study aimed at examining the associations between the perceived and objectively measured neighbourhood BE characteristics and PA and ST, controlling for the effects of well-known covariates, child's age, gender and family household income. Household income was collapsed from a 7-level to a 4-level categorical variable: $20,000 or less (reference), $20,001-$60,000, $60,001- $100,000, or more than $100,000 and choose not to answer/unknown/missing data.

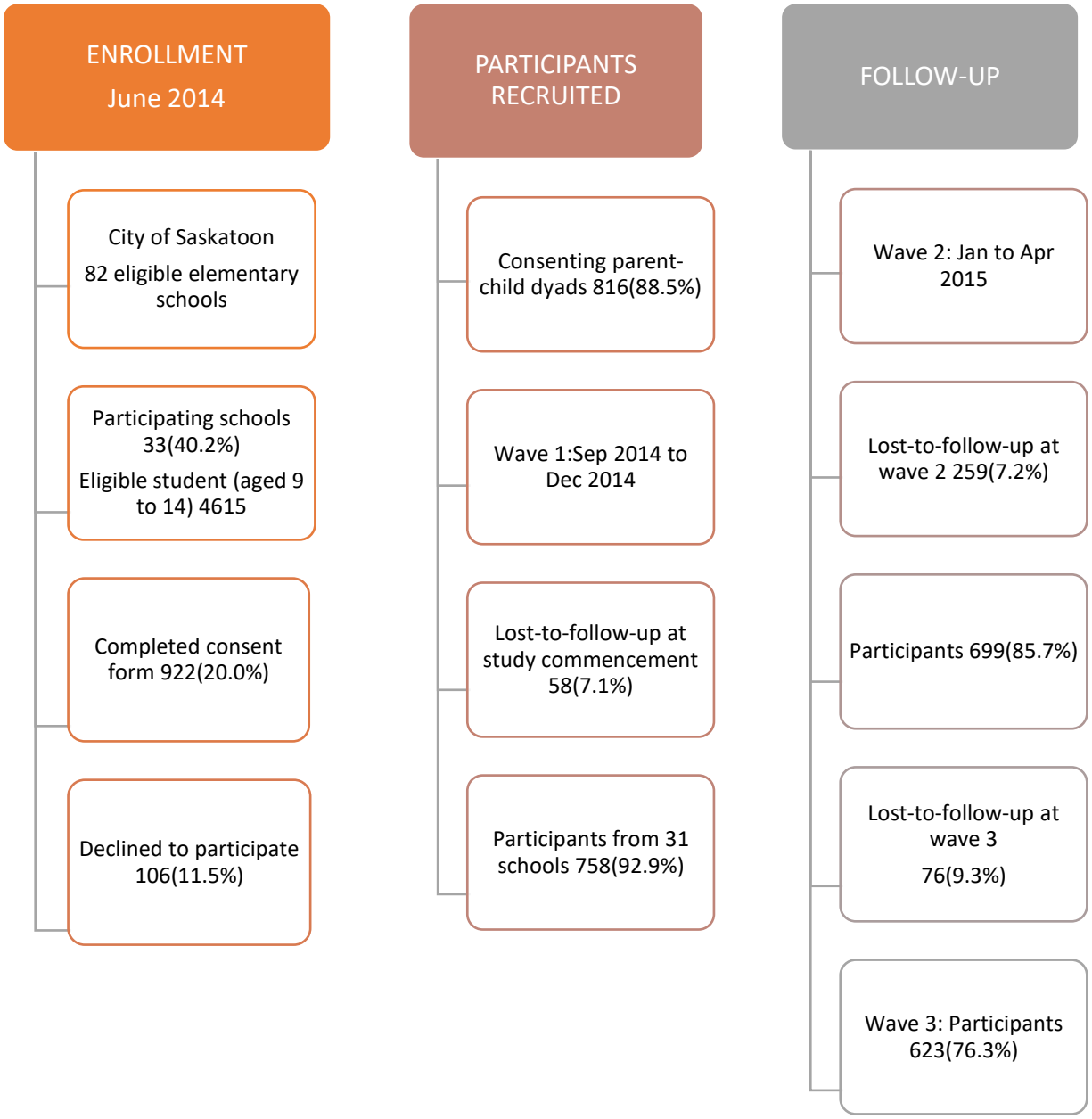

Figure 3 Participant flow of recruitment and retention

4.3.3.2 Children's Perceived Built Environment Measures

Items addressed various aspects of the child perceived built environments, such as accessibility and availability of recreation facilities such as parks, playgrounds and gyms, presence of suitable play areas, aesthetics, walkability, comfort (i.e. presence of sidewalks and less traffic volume), friendliness and safety from crime, traffic and scary dog/people. Perceived built and social environment data were dichotomized (presence/absence of certain environmental features).

4.3.3.3 Objective Physical Activity Behaviors: Accelerometry Measures

Accelerometry data collection occurred over a 1-week period during 3 time points from September 2014 – September 2015. At each time point 745, 706, and 592 participants provided accelerometry data. ActiGraph GT3X accelerometer devices (ActiGraph Corp., Pensacola, FL) were deployed (13) through schools to measure sedentary time (ST), Light (LPA), moderate (MPA) and vigorous physical activity (VPA). Accelerometers were delivered to study participants' schools. Children were visited at their respective schools and were asked to wear the devices on their right hip using an elastic belt, every day for 7 consecutive days (including sleeping hours), unless entering water. Children were asked to return the accelerometers at the end of the 7-day cycle. To improve compliance, they were offered a drop-in pass for a civic leisure centre upon return of their accelerometers. The devices began measuring data at 00:00 on the day following device deployment (i.e., almost a full day after the device was deployed) to minimize the potential for subject reactivity within the first day of wearing the accelerometer. Biologically implausible data (13) and non-wear time were defined as >15,000 cpm and 60 minute epochs with <2 minute interruptions of continuous 0s, respectively, and were excluded from analysis. Accelerometry data cut-off points used in the literature are often derived from calibration studies providing counts per minute (cpm) equivalents to METs and have ranged from <100 to <1100 cpm depending on the device used (163). Activity level cut points were defined as follows: ST ≤150 counts per minute (cpm), and light (LPA, 150-1951 cpm), moderate (MPA, 1952-5723 cpm) and vigorous PA (VPA, ≥5724 cpm) determined by evolving evidence-base on cut points (163). Daily MVPA (≥1952 cpm) was calculated as the total minutes of MVPA divided by the number of days of valid wear.

A valid day was defined as a day of accelerometry with 10 or more hours of wear-time (164,165). Daily wear-time was estimated by subtracting non-wear-time from 24 hours of that particular day. It was determined that non-wear-time would be a period of at least 60 consecutive

minutes of zero counts, including up to 2 minutes of counts between 0 and 100 (166). The final sample consisted of data from children with at least four valid days including at least one valid weekend day, i.e., the valid sample.

4.4. Arrangements for Conducting the Current Study

A number of graduate theses have been undertaken using SCHK and subsequent SASK data to lay the foundation for more rigorous active living research and answer questions about how the built environment influences children's physical activity behaviours, including neighbourhood mobility and activities (167) and sedentary behaviors. This thesis complements these previous theses, but with research and methodological contributions unique to the physical activity literature. Katapally (167) examined the interrelationship between objectively measured physical activity and sedentary behaviour in children in the context of diverse environmental exposures, while Lotoski investigated how season, demographics and built environment features predicts children's location-specific sedentary behaviour. While other theses tackled related issues of seasonality, environment, and PA/ST, this thesis complements the aforementioned theses by focusing narrowly on how the perceptions of neighbourhood BE, coupled with the objective measures influence children's physical activity and sedentary behaviors. To the best of my knowledge, no other thesis using SCHK and subsequent SASK data has combined children's perception and objective measures of BE in a similar way. Though the SASK study had longitudinal data, this thesis used these data cumulatively and not as repeated data.

4.5 Variable Selection Processes

Previous literature gives a base for variables. Each variable was chosen because it was a repetitive factor in the literature concerning BE influences of children's PA behavior.

4.6 Outcome Variables

Intensity of physical activity is usually expressed in terms of three specific thresholds: light , moderate, or vigorous, contrasted with sedentary activities (168). Specific activities performed at different levels of intensity are considered as the outcome variables in the studies of environmental correlates of physical activity. Current PA guidelines for children aged 5-11 years and youth aged 12-17 years recommend at least 60 minutes of moderate-to-vigorous PA (MVPA) every day (169). However, on any given day, individuals can accumulate this recommended quantity of MVPA,

and still remain sedentary for most of the day (167). In addition, light physical activity, along with MVPA and sedentary time may constitute the full spectrum of daily activity (157,158). While this data is not compositional in nature (given as a proportion of a child's other waking activity behaviours), ST is intrinsically tied to all waking (LPA, MPA and VPA) and sleeping behaviours accumulated by the individual. If one behaviour is altered, other activity behaviour must be altered in concert to replace the loss or gain in one physical action/inaction. The primary focus of this thesis is to understand BE determinants of a continuum of activity and sedentary behaviour in children. Consequently, ST, LPA and MVPA are considered as the outcome variables in this study.

4.7 Predictors

The predictor variables were segregated into two levels: neighbourhood level variables (objective and children perceived BE measures) and individual level variables. **Table 3** depicts the set of variables which were identified as either outcomes or predictors in this thesis.

Table 3 Overview of the Study Variables Developed for This Thesis

Data collection cycle	Measured variables	Collection modes/measurement tools
2014-2015 Autumn Sep to Dec 2014	**Outcome measures** (Physical activity- LPA, MVPA, and ST)	Accelerometry
Winter Jan to Apr 2015	**Exposure measures (BE characteristics)**	
Spring Apr to Sep 2015	**Perceived measures**- children's perceptions of neighborhood BE	
Participating children **Sample frame- 4619 (43 approached schools)** Consenting- 816 Time pint 1: 758 Time point 2: 699 Time point 3: 623	Parks and Recreational facilities Density of destinations Accessibility Perceived safety (scary pets or people) Safety from crime and traffic Pedestrian Infrastructure- Sidewalks, traffic Aesthetics Active role models	SASK survey questionnaire
	Individual and family characteristics	Children's age, gender, annual household income
2009-2010	**Objective measures** Density and diversity of destinations Safety from traffic Safety from crime Activity friendliness Pedestrian access Universal accessibility Attractiveness	Neighborhood Active Living Potential (NALP) and Irvine Minnesota Inventory (IMI)

4.8 Statistical Analysis: An Analysis of Secondary Data

Data cleaning, manipulation, analysis and visualization was performed using the Statistical Package for the Social Sciences (SPSS 25). All analyses in the study were conducted using the valid sample. The statistical significance for all analyses was set at $p<0.05$. MVPA, LPA, and ST were the outcome variables of interest (measured as continuous) and used as the dependant variable in all univariate and linear mixed effect models presented. Linear mixed-effects models were used to estimate the association between attributes of the neighbourhood BE and changes in average daily LPA, MVPA, and ST over time (clustered by child). This model employed a robust variance estimation method to adjust the standard errors for the clustering of observations within each child. Each participant contributing valid accelerometry data had a minimum of 4 days (or data points) of accelerometry data, resulting in repeated measures nested within the individual. Additionally, participants shared common home or school neighbourhoods. For these reasons, a multilevel modeling approach was used.

It is important to note that even though the assumptions of linearity and normality are satisfied by multilevel models fitted in this thesis, the assumption of independence of observations is violated due to the nested nature of the data ─ children are nested within the neighbourhoods they reside in i.e., the observations of a group of children within the same neighbourhood are not independent of each other. Multivariable mixed effect models were built using a backwards stepwise approach (models with single neighbourhood environment characteristics entered at a time, selected based on bivariable analysis to be included as candidate variables ($p<0.20$) in multilevel model, followed by a single model incorporating multiple neighbourhood environment covariates). BE attributes (children's perception of the neighbourhood built environment features, i.e. safety, recreational facilities, and comfort, NALP dimension scores: aesthetic factors, density of destination, safety, and universal accessibility; IMI dimension scores: density of destination, pedestrian accessibility, safety from crime, safety from traffic) demonstrating significant prediction ($p < 0.05$) of MVPA, LPA, and ST and improved model fit were included. Based on existing knowledge of confounders, model was adjusting for children's age, gender, and household income (time-varying). All models included a random intercept and a random time slope for each participant to allow the baseline responses, as well as the time slope, to vary between individuals. Coefficients from the final model were used to compare the physical activity trajectories over time for different components of neighbourhood environment.

CHAPTER 5

RESULTS

5.1 Population Demographic Characteristics

In the analyses, the entire valid accelerometry dataset was used to examine predictors of time-dependent total daily LPA, MVPA, and ST (n=619). Descriptive statistics about the sample who contributed to valid accelerometer data can be found in **Table 4**. At the first collection time point in the study, 758 child-parent dyads participated in the study. 45.5% (n=345) and 54.5% (n=413) participation identified as male and female, respectively. Under valid wear time criteria, 619 participants provided at least one time point of valid accelerometry data. Of these study participants, 58.6 % were female. The majority of participants were between 10 and 11 years old (71.2%).

Table 4 Study population characteristics of those contributing valid accelerometer data (n=619).

Study Population Characteristics		n (%)	Mean daily LPA (min/day)	ANOVA p value	Mean daily MVPA (min/day)	ANOVA p value	Mean daily ST (min/day)	ANOVA p value
Gender	Male	256(41.3)	324		42.3		274	
	Female	363(58.6)	350	<0.001	38	<0.001	273	P=0.97
Age (years)	9	29(4.7)	369		43		242	
	10	214(34.6)	351		42		247	
	11	195(32.2)	339	<0.001	39	<0.001	275	<0.001
	12	105(17.1)	320		38		301	
	13-14	76(11.4)	313		35		316	
Annual Household Income	Less than $20,000	12(1.9)	311		39		293	
	$20,000 to $60,000	86(13.9)	341		38		270	
	$60,000 to $100,000	104(16.9)	346	0.05	39	0.85	261	0.35
	$100,000 or more	258(41.8)	332		40		275	
	Unknown	157(25.4)	333		41		271	

Within the study population, the category "Unknown" for annual household income includes those who actively chose not to answer, didn't know their annual household income, or did not provide an answer.

Over the one-year collection period, participants accumulated a daily mean of 271.4 ST, 335.4 LPA, and 39.4 MVPA minutes/day. Males accumulated significantly less LPA, but significantly more MVPA in comparison to females. Older children accumulated significantly less LPA and MVPA, but significantly more ST. ST did not differ by gender when a child's entire day was considered.

5.2 Model Specification

A series of models using stepwise linear regression analyses with backward elimination were specified to assess associations between the dependent variables (min/day MVPA, LPA, and ST)

and the explanatory variables (e.g. the children's perceived and objective BE attributes), while accounting for a set of demographic factors (child's age, gender, and annual household income), regardless of their relationship with PA and ST. To investigate the association between physical activity outcomes and the objective and perceived measures of the neighborhood BE attributes, the BE attributes were entered using the two stage process (with single BE attribute entered at a time with the dependent variable, removed sequentially that met the criterion for elimination ($p \geq 0.20$), followed by a single model incorporating multiple BE covariates). This procedure was repeated until the neighborhood environmental attributes with a $p < 0.20$ remained in bivariable analysis to become candidates for the multivariable model. Significant variables were subsequently assessed for multicollinearity using Variance Inflation Factors (VIFs) prior to development of a final model. Next, a multilevel model was fitted with all the variables that were selected based on bivariable analysis to be included as candidate variables in the subsequent multivariable model. Assessment of VIFs indicated that collinearity was not problematic (all VIFs < 2), so all candidate variables from bivariable analysis were entered into the final model. A final model was developed with the neighbourhood BE characteristics that demonstrated significant association with physical activity outcomes (LPA, MVPA, and ST) in the multilevel models with a $p<0.05$, controlling for child's age, gender, and annual household income.

5.3 Associations of Children's Perceived and Objective BE Attributes with Objectively Measured MVPA

Models assessing the association between individual neighbourhoods BE characteristics and MVPA indicate some associations between average daily minutes of MVPA and objective and child-perceived neighbourhood environmental attributes. Most perceived BE characteristics are significant and usually in the expected direction. In the fully adjusted model, we observed a positive, statistically significant association between perceived availability and accessibility of recreational facilities (e.g. parks, playgrounds, and gym) and MVPA. Children from neighbourhoods with high perceived availability of parks and other recreational facilities were engaged in 2.73 more min of MVPA over the course of the year. Children's report of sidewalks with poor condition/ the absence of sidewalks in the neighbourhood was associated with 2.59 fewer min of MVPA. Children reporting concerns for crime in their neighbourhood were engaged in 1.82 fewer min of MVPA. We observed some mixed evidence for the association between objective

neighbourhood environment and MVPA, and some of these associations were in an unexpected direction. As hypothesized, objectively measured general neighbourhood safety (NALP) was associated with higher levels of MVPA in children (β=3.93, $p<0.001$). Surprisingly, objective safety from crime (IMI) was associated with lower levels of MVPA (β=-1.08, $p<0.001$). Even though no significant association was found between children's perceived neighbourhood aesthetics and MVPA, objectively measured attraction (IMI) was associated with lower levels of MVPA (β= -2.21, $p<0.01$). Model result estimating the association between neighbourhood environment and change in MVPA can be found in **Table 5**.

Table 5 Results of full model assessing associations between BE and average daily minutes of MVPA (n=619): univariate, main effect model, and model controlling for demographic variables (child's age, gender and annual household income)

BE Characteristics	MVPA					
	Univariate models		Main effects models unadjusted		Adjusted models	
Perceived neighbourhood-built environment attributes						
	β(SE)	**95% CI**	**β(SE)**	**95% CI**	**β(SE)**	**95% CI**
Absence of sidewalk	-1.78 (.42)	-2.6, -.96	-2.83 (.69)**	-4.19, -1.47	-2.59 (.65)**	-3.88, -1.30
Low traffic volume	1.92 (.57)	.79, 3.03	-	-	-	-
Absence of social/physical disorder (no unattended dogs/unsafe people)	-1.44 (.40)	-2.3, -.64	-	-	-	-
Availability of parks/facilities	2.45 (.64)	1.20, 3.71	2.18 (.71)**	.77, 3.58	2.73 (.702)***	1.35, 4.11
Presence of street lighting	3.59 (.88)	1.86, 5.32	-	-	-	-
Concerns for crime	-1.42 (.71)	-2.87, -.08	-1.58 (.72)*	-2.99, -.16	-1.82 (.71)*	-3.20, -.43
Presence of physical activity active role models	4.38 (1.1)	2.14, 6.63	-	-	-	-
Safety from traffic	-	-				
Proximity to destinations	-	-				
Aesthetics	-	-				
Objective neighbourhood-built environment attributes						
NALP activity friendliness	1.80 (.40)	1.0, 2.59	-	-		
NALP density of destinations	1.9 (.25)	.54, 1.53	-	-		
NALP safety	4.2 (.51)	3.04, 5.05	5.15 (.69)**	3.78, 6.52	3.93 (.52)***	2.91, 4.95
NALP universal accessibility	.59 (.31)	-.01, 1.20	-	-		
IMI attraction	-1.0 (.50)	-2.04, -.07	-3.17 (.61)*	-4.38, -1.96	-2.21 (.50)*	-3.19, -1.23
IMI density of destinations	.20 (.07)	.05, .35	-	-		
IMI safety from crime	-.53 (.21)	-.95, -.12	-1.11 (.28)***	-1.68, -.54	-1.08 (.21)***	-1.50, -.66
IMI safety from traffic	-	-				
IMI pedestrian access	-	-				
Demographics						
Age (in years)	-2.27 (.17)***	-2.61, -1.93				
Gender(Ref: Female)	4.85 (.38)**	4.08, 5.59				
Annual household income Ref: Less than $20,000						
$20,000 to less than $60,000	.66 (.60)	-.51, 1.8				
$60,000 to less than $100,000	.07 (.578)	-1.0, 1.20				
$100,000 or more	-.29 (.414)	-1.10, .51				
Unknown	-2.10 (.516)*	-3.11, -1.09				

Univariate models: Neighbourhood characteristics demonstrated some association with the average daily minutes of MVPA at $p<0.20$ were considered as potential candidates for multivariable model.
Main effect model (unadjusted): Neighbourhood characteristics that demonstrated statistically significant association with the average daily minutes of MVPA at $p<0.05$.
'-'= indicates neighbourhood characteristics that demonstrated no statistically significant association with the average daily minutes of MVPA at $p>0.05$
Fully adjusted model: Neighbourhood characteristics that demonstrated statistically significant association with the average daily minutes of MVPA at $p<0.05$, controlling for demographic variables (child's age, gender, and annual household income).
* $P < 0.05$; ** $P < 0.01$; ***$P < 0.0001$.

5.4 Associations of Children's Perceived and Objective BE Attributes with Objectively Measured LPA

Models assessing the association between individual neighbourhood characteristics and LPA indicate some associations between average daily minutes of LPA and objective and child-perceived neighbourhood environmental attributes. In the fully adjusted model, we observed a positive, statistically significant association between children's report of lack of social disorder (e.g. no unattended animals/unsafe people) and LPA. Children who reported good condition of neighbourhoods (e.g absence of social disorder such as no scary dog roaming around or unsafe people loitering in their neighbourhood) were engaged in 6.11 more min of LPA year-round. Children who reported the presence of role models who are active in the neighbourhood (e.g. seeing others do exercise) were engaged in 22.2 more min of LPA. No other significant perceived BE associates of LPA were found.

Contrary to our hypothesis, objectively measured general neighbourhood safety (NALP) and safety from crime (IMI) showed a negative, significant association with LPA (as scores of NALP safety and IMI safety from crime increase, children were engaged in 10.0 and 4.39 fewer min of LPA, respectively). No objective BE attributes were found to predict LPA in an expected direction (e.g. the highest score in the objective BE characteristics is related to higher levels of LPA). Model result estimating the association between neighbourhood environment and change in LPA can be found in **Table 6**.

Table 6 Results of full model assessing associations between BE characteristics and average daily minutes of LPA (n=619) containing: univariate model, main effect model and model controlling for demographic variables (child's age, gender and annual household income)

BE Characterises	LPA					
	Univariate models		Main effects models unadjusted		Adjusted models	
Perceived neighbourhood built environment attributes						
	β(SE)	**95% CI**	**β(SE)**	**95% CI**	**β(SE)**	**95% CI**
Absence of sidewalk	-	-				
Low traffic volume	-	-				
Absence of social/physical disorder	4.11 (1.9)	.23, 8.01	8.05 (3.1)*	2.02, 14.1	6.11 (2.76)*	.70, 11.5
Availability of parks/facilities	-	-				
Presence of street lighting	7.33 (4.3)	-1.14, 15.8	-	-		
Concerns for crime	-8.01 (3.5)	-14.8, -1.16	-	-		
Presence of physical activity active role models	18.3 (5.6)	7.31, 29.3	20.5 (6.0)**	8.67, 32.3	22.2 (5.66)**	11.3, 33.3
Safety from traffic	-	-				
Proximity to destinations	-	-				
Aesthetics	0.03 (.01)	.01, .03				
Objective neighbourhood built environment attributes						
NALP activity friendliness	-	-				
NALP density of destinations	-	-				
NALP safety	-13.8 (2.51)	-18.8, -8.90	-11.1 (3.21)***	-17.4 ,-4.81	-10.0 (2.49)***	-14.9, -5.13
NALP universal accessibility	-2.69 (1.51)	-5.61, .337	-	-		
IMI attraction	-3.42 (2.46)	-8.26, 1.40	-	-		
IMI density of destinations	-	-				
IMI safety from crime	-4.76 (1.04)	-6.79, -2.72	-2.65 (1.30)**	-5.21 ,-.10	-4.39 (1.05)**	-6.46, -2.33
IMI safety from traffic	-	-				
IMI pedestrian access	-	-				
Demographics						
Age(in years)	-13.9 (.85)**	-15.6, -12.2				
Gender (Ref: Female)	-26.7(1.89)**	-30.4, -23.0				
Annual household income Ref: Less than $20,000						
$20,000 to less than $60,000	-1.19 (2.94)	-6.96, 4.57				
$60,000 to less than $100,000	-5.34 (2.83)	-10.8, .21				
$100,000 or more	2.17 (2.02)	-1.8, 6.1				
Unknown	-.15 (2.53)	-5.11, 4.81				

Univariate models: Neighbourhood characteristics demonstrated some association with the average daily minutes of LPA at $p<0.20$ were considered as potential candidates for multivariable model.

Main effect model (unadjusted): Neighbourhood characteristics that demonstrated statistically significant association with the average daily minutes of LPA at $p<0.05$.

'-'= indicates neighbourhood characteristics that demonstrated no statistically significant association with the average daily minutes of LPA at $p>0.05$

Fully adjusted model: Neighbourhood characteristics that demonstrated statistically significant association with the average daily minutes of LPA at $p<0.05$, controlling for demographic variables (child's age, gender, and annual household income).

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.0001$.

5.5 Associations of Children's Perceived and Objective BE Attributes with Objectively Measured ST

In line with MVPA and LPA, models assessing the association between individual neighbourhood characteristics and ST indicate some associations between average daily minutes of ST and objective and child-perceived neighbourhood environmental attributes. In the fully adjusted model, we observed a negative, statistically significant association between children's perceived presence of parks and other recreation facilities and lower levels of ST. Children who reported availability of parks, play spaces, and gyms nearby were engaged in 16.9 fewer min of ST year-round. A positive, statistically significant association was observed between children's report of having absence of sidewalks and/or poor condition of sidewalk and ST. Children from neighbourhood with no sidewalks or low perception of sidewalks that limit their opportunities to walk/bike in the neighbourhood, were engaged in 10.4 more min of ST. Children who reported having active role models in the neighbourhood (e.g seeing others do exercise), were engaged in 25 fewer min of ST.

Some mixed results have been obtained in terms of the association between objective BE attributes and children's time spent in sedentary behaviors. As expected, objectively measured activity friendliness (NALP) was associated with decreased ST, so do objectively measured pedestrian accessibility (IMI). Contrary to our hypothesis, safety from crime (IMI) was associated with increased ST ($\beta=8.89$, $p<0.001$). Model result estimating the association between neighbourhood environment and change in ST can be found in **Table 7**.

Table 7 Results of full model assessing associations between BE characteristics and average daily minutes of ST (n=619) containing: univariate model, main effect model and model controlling for demographic variables (child's age, gender and annual household income)

Variables	ST					
	Univariate models		Main effects models unadjusted		Adjusted models	
Perceived neighbourhood built environment attributes						
	β(SE)	**95% CI**	**β(SE)**	**95% CI**	**β(SE)**	**95% CI**
Absence of sidewalk	6.33 (2.54)	1.35, 11.3	10.4 (4.23)*	2.07, 18.7	7.02 (3.9)*	-.80, 14.8
Low traffic volume	-5.13 (3.48)	-11.9, 1.69	-	-		
Absence of social/physical disorder	4.88 (2.45)	.07, 9.69	-	-		
Availability of parks/facilities	-13.8 (3.88)	-21.4, -6.20	-16.9 (4.36)**	-25.5, -8.41	-16.4 (4.29)**	-24.8, -8.0
Presence of street lighting	-12.2 (5.35)	-22.6, -1.68	-	-		
Concerns for crime	-	-				
Presence of physical activity active role models	-24.9 (6.96)	-38.5, -11.2	-19.8 (7.87)**	-35.2, -4.31	-25 (7.0)**	-38.7, -11.0
Safety from traffic	-	-				
Proximity to destinations	-	-				
Aesthetics	-.05 (0.01)	-.08, -.02				
Objective neighbourhood built environment attributes						
NALP activity friendliness	-10.2 (2.47)	-15.0, -5.30	-9.73 (2.65)*	-14.9, -4.52	-6.82 (2.45)*	-11.6, -2.01
NALP density of destinations	-6.64 (1.55)	-9.68, -3.60	-	-		
NALP safety	-	-				
NALP universal accessibility	-	-				
IMI attraction	4.09 (3.06)	-1.90, 10.0	-	-		
IMI density of destinations	-1.30 (.48)	-2.23, -.38	-	-		
IMI safety from crime	5.61 (1.29)	3.08, 8.15	9.27 (1.90)***	5.51, 13.0	8.89 (1.35)***	6.24, 11.54
IMI safety from traffic	-	-				
IMI pedestrian access	-5.26 (2.64)	-10.4, -.07	-6.23 (3.25)**	-12.61, .15	-7.92 (2.76)*	-13.4, -2.50
Demographics						
Age(in years)	22.8 (1.0)	20.7, 24.8				
Gender (Ref: Female)	.25 (2.37)	-4.4, 4.91				
Annual household income Ref: Less than $20,000						
$20,000 to less than $60,000	.65 (3.69)	-6.49, 7.80				
$60,000 to less than $100,000	1.6 (3.50)	-5.24, 8.51				
$100,000 or more	-2.3 (2.51)	-7.28, 2.56				
Unknown	11.4 (3.13)*	5.35, 17.6				

Univariate models: Neighbourhood characteristics demonstrated some association with the average daily minutes of ST at $p<0.20$ were considered as potential candidates for multivariable model.
Main effect model (unadjusted): Neighbourhood characteristics that demonstrated statistically significant association with the average daily minutes of ST at $p<0.05$.
'-'= indicates neighbourhood characteristics that demonstrated no statistically significant association with the average daily minutes of ST at $p>0.05$
Fully adjusted model: Neighbourhood characteristics that demonstrated statistically significant association with the average daily minutes of ST at $p<0.05$, controlling for demographic variables (child's age, gender, and annual household income).
* $P < 0.05$; ** $P < 0.01$; *** $P < 0.0001$.

5.6 Models Results Estimating the Association between Children's Overall Activity and BE

In contrast to the models predicting LPA, more of the built environment variables, measured objectively or perceived, are significant in predicting MVPA and ST. Some consistent patterns appeared within all models estimating the association between different levels of physical activity behaviors and neighbourhood BE attributes. Children's report of availability of parks and other recreation facilities, for instance, was associated with higher levels of MVPA, but not LPA, and lower levels of ST. Similarly, children's report of having active role models in the neighbourhood

was associated with higher levels of LPA, and lower levels of ST. In addition, children's report of negative pedestrian infrastructure/accessibility (e.g. no sidewalk) was associated with lower levels of MVPA and higher levels of ST.

Surprisingly, but consistently, objectively assessed safety from crime (IMI) was associated with lower levels of PA (both MVPA and LPA) and higher levels of ST. However, it is interesting to note that, the NALP safety and IMI safety from crime had converse associations with MVPA; children living in neighbourhoods measured as safe from crime using IMI audit tool were engaged in lower levels of MVPA, while children living in neighbourhoods measured as safe using NALP tool were engaged in higher levels of MVPA. There is one possible explanation for this result; the constitution of the NALP and IMI audit tools. The NALP tool which is more subjective in nature and takes into account the impression of the entire neighbourhood based on the systematic observations of the researchers. In contrast, the IMI is more objective in nature and is based on observations of each individual segment.

While IMI safety from crime dimension score was included to examine the role of social and physical disorder on physical activity behavior, area-level deprivation and actual crime statistics were not accounted for. Even though, quantifying the concordance between the objective and perceived measures was beyond the scope of this thesis, certain BE features (both perceived by children and independently assessed by either researchers or BE tools) showed some association with children's specific activity behavior in the same manner. For example, children's report of concerns of crime in the neighbourhood was associated with lower levels of MVPA, while higher scores in objectively assessed neighbourhood general safety (NALP) was associated with higher levels of MVPA. This finding, however, suggest that, neighbourhood general safety, either perceived or objectively measured, may, in part, explain children's higher levels of physical activity (but not lower levels of ST). Similarly, children's report of negative pedestrian infrastructure (e.g. no sidewalk/access) was associated with increased ST, while, objectively assessed highest level of pedestrian accessibility (IMI) and activity friendliness (NALP) were associated with decreased ST. This finding, therefore, demonstrate that, provision of pedestrian facilities (e.g. sidewalk, better pedestrian access), may influence children's decision to be physically active in the neighbourhood.

Table 8 presents results across all three physical activity outcomes—MVPA, LPA, and ST—identifying common, and singular, BE predictors.

Table 8 Results across all PA domains in relation to the neighbourhood BE characteristics

Predictors **(BE characteristics)**	**Physical Activity Outcomes(min/day)**		
	MVPA	**LPA**	**ST**
Children's perceived BE			
Availability of parks	Increased MVPA, 2.73 more min/day	-	Decreased ST, 16.43 less min/day
Absence of sidewalks	Decreased MVPA, 2.5 less min/day	-	Increased ST, 7.02 more min/day
Presence of physical activity active role models (see others do exercise)	-	Increased LPA, 22.24 more min/day	Decreased ST, 25 less min/day
Concerns for crime	Decreased MVPA, 1.82 fewer min/day	-	-
Absence of social/physical disorder	-	Increased LPA, 6.11 more mi/day	-
Objectively measured BE			
IMI Safety from Crime	Decreased MVPA, 1.08 less min/day	Decreased LPA, 4.39 less min/day	Increased ST, 8.89 more min/day
NALP Safety	Increased MVPA, 3.93 more min/day	Decreased LPA, 10.02 less min/day	-
IMI Attraction	Decreased MVPA, 2.21 fewer min/day	-	-
NALP activity friendliness	-	-	Decreased ST, 6.82 fewer min/day
IMI pedestrian access	-	-	Decreased ST, 7.92 fewer min/day

'-' denotes- no significant impact on the PA outcome

CHAPTER 6

DISCUSSION

6.1 The Relationship between Perceived and Objective Neighbourhood Built Environment on Physical Activity Behavior Outcomes

This thesis was aimed at forming a better understanding of the determinants of childhood physical activity behaviors in the context of neighbourhood level BE characteristics over an entire year. Exploring the relative effect of the objective and perceived BE on children's PA and ST is an important research question in developing theories linking the built environment and activity behavior. However, very few empirical studies have examined this research question. In addition, longitudinal studies are necessary to make rigorous causal inferences among such factors as the built environment, perceptions, and behavior. To partially fill in the gap in the literature, this study explored whether children's perceptions and objective measures of BE characteristics were associated with children's activity, specifically: MVPA, LPA, and ST in a large sample of children in Saskatoon, Canada.

6.2 Physical Activity and Sedentary Time and Perceived Neighbourhood Built Environment

Several selected perceived features of the BE consistently predicted PA and ST across all time examined. As hypothesized, children accumulated significantly higher levels of PA and lower levels of ST if they perceived their neighbourhoods are good with parks and recreation facilities and pedestrian amenities (e/g. presence of sidewalk), the presence of active PA role models and an absence of neighbourhood social disorder (e.g. absence of scary dogs/ people). Additionally, more of the perceived BE variables were significant in predicting MVPA and ST, in contrast to the models predicting LPA. Overall, the perceived BE features that showed associations with MVPA, LPA and ST were of the expected direction.

The results of this study indicate that, children living in neighbourhoods with higher perceived availability and accessibility of parks and other recreational facilities accumulated higher levels of PA (but only in models predicting MVPA) and lower levels of ST. In line with our findings, a recent cross-sectional study among four hundred children aged 9-14 year demonstrated that children from neighbourhoods with greater access to parks with sports fields and multi-use path space accumulated significantly higher levels of objectively measured MVPA when controlling

for individual and neighbourhood socio-demographic factors (80). Similarly, Davison and colleagues (170), in their extensive review on the influence of built environments on children's physical activity behaviour found a positive association between children's physical activity and each of access and availability of parks and other recreation facilities, spending on public recreational infrastructure, and pedestrian infrastructure. Conversely, Timperio et al. (171) found an association of children's lower perception of parks (e.g. lack of or no suitable parks or sports grounds near home) with a lower likelihood of walking or cycling in the neighbourhood.

Additionally, children living in neighbourhoods with poor perception of pedestrian infrastructures such as the absence of sidewalks accumulated lower levels of MVPA. Conversely, children living in neighbourhoods with poor perception of sidewalks, trails, and paths (e.g. absence of sidewalks / poor condition of sidewalks), where they found difficulties to walk and/or bike, accumulated higher levels of ST. These observations are consistent with the literature. For example, Jago et al. (90) in one of the few studies to examine both physical activity and sedentary behaviour, found that perceptions of good sidewalk characteristics were negatively associated with minutes of sedentary behaviour and positively associated with minutes of light-intensity physical activity. Ewing et al. (88) reported that the proportion of street segments (miles) with streetlights, sidewalks, and bike lanes was positively associated with adolescent's rates of walking and biking to school. Similarly, Evenson et al. (97) found an association between adolescent's girl's reports of a presence of sidewalks on most streets with higher levels of self reported physical activity.

Children's levels of light physical activity (LPA) were higher if they perceived their neighbourhoods with a lack of social disorder (absence of any scary/unattended pets, unsafe people, and/or strangers), compared to those who perceived a higher social disorder present in the neighbourhood. This finding supports previous findings on the association between neighbourhood disorder and children's PA. Molnar et al. (109) for instance, reported that, children's perception of both physical (e.g., graffiti, empty beer bottles) and social (e.g., unattended dogs/unsafe people) disorder were associated with parent's reported lower levels of recreational activity (e.g. light walking, walking to parks). Similarly, Alton et al. (82) found that, child's concerns regarding the social disorder (e.g. "stranger danger") was inversely associated with their participation in active play.

Another important finding was that, children living in neighbourhoods with lower perceived safety (e.g. concerns for crime in the neighbourhoods) accumulated lower levels of MVPA. These results are consistent with those of other studies (124,172–176) and suggests that, perceived safety is associated with increased PA in children. For example, Carolyn and colleagues reported that, girl's report of neighbourhood safety (from crime) was positively associated with active travel to/from school (111). As well, Camillie et al. (177) found that, adolescent's girl's report of the safety (from crime) was positively associated with higher levels of their reported vigorous physical activity. Similarly, Perez et al. (178) demonstrated that, parent's report of safety from crime was associated with adolescent's reported higher levels of non-school MVPA.

As expected, children living in neighbourhoods with a perception of having active role models in the neighbourhood (seeing others do exercise in the neighbourhood) were engaged in more minutes of LPA and fewer minutes of ST. This study confirms previous findings regarding social support/ active role models of PA and their relation to participation in PA. For example, Maria et al. showed a significant association between adolescent's boy's physical activity and report on the presence of people being active in the neighbourhood (129). Similarly, Samantha et al. (179) found that, children's report of seeing others do physical activity in the neighbourhood was significantly associated with accelerometer assessed higher levels of MVPA.

Surprisingly, this study found no substantial associations between children's report of neighbourhood aesthetics/pleasantness and physical activity behaviors. These findings, however, are also consistent with the literature. For example, de Brujin et al. (103) found no direct association between children's reports of neighbourhood conditions including general aesthetics, attraction, and overall pleasantness with objectively measured PA. Similarly, Jago et al. (68) and Grow et al. (106) found no association between adolescent's perceived neighborhoods aesthetics with objectively measured physical activity. However, Tappe KA et al. (180) reported that, parent's report of higher neighborhood aesthetics was correlated with higher reported child activity in the neighborhood. As views of beauty or pleasantness are relative to differences in perception and consideration (181), more research is needed on the topic of neighbourhood aesthetics, specifically the impact on children's activity behaviours.

6.3 Physical Activity and Sedentary Time and Objectively Measured Neighbourhood Built Environment

Overall, most of the objectively measured individual built environment features showed no significant association with PA outcomes, and among those that did, no single feature of the BE, except for the objectively assessed safety from crime (IMI), which was of an unexpected direction, consistently predicted PA outcomes.

As hypothesized, children living in neighbourhoods with the highest level of neighbourhood general safety (NALP) accumulated significantly higher levels of MVPA; however, they accumulated significantly lower levels of LPA. This is likely because children living in neighbourhoods observed as safe accumulated more minutes of MVPA, this comes at the expenses of lower LPA (i.e. displacing LPA).

It is somewhat surprising that, children living in neighbourhoods with the highest level of safety from crime (IMI) significantly accumulated lower levels of PA (both LPA and MVPA) and higher levels of ST. Even though, NALP general neighbourhood safety was positively associated with MVPA, the specific measure in IMI safety from crime was surprisingly, but consistently, associated with increased ST and decreased MVPA. One possible explanation of this unexpected findings is the constitution of the NALP and IMI audit tools. While the NALP tool is more subjective and takes into account the impression of the entire neighbourhood based on the systematic observations of the researchers, IMI, on the other hand, is an audit tools and is based on observations of each individual segment in detail. Thus, NALP safety, more of an individual's perception, relates better with the findings obtained from children's perception of general safety and the levels of MVPA.

Even though this study produced some mixed evidence in terms of the influence of objectively measured safety related features in the neighbourhood on children's PA and ST, these are consistent with studies found in the literature. Monika et al. (119) reported, as we do here, an inverse association between objectively-assessed safety (from crime) and adolescent's after school MVPA. However, in contrast to our findings, Penny et al. (117) found a positive association between objectively measured safety from crime with the higher levels of MVPA among adolescents.

The current study found that, children living in neighbourhoods with the highest level of pedestrian accessibility (IMI) and greater (IMI) activity friendliness spent significantly less ST in comparison to children living in low walkable neighbourhoods. The present findings seem to be consistent with other research which found the association between accessibility and activity friendliness and PA outcomes in children. In their extensive review, McGrath et al. (182) examined the associations between objectively measured BE attributes with youth PA and reported that, increased pedestrian accessibility was positively associated with adolescent's objectively measured MVPA. Similarly, Oliver et al. (183) reported that, neighbourhoods independently assesses as activity friendly (e.g. better walking and cycling infrastructure), and the ratio of traffic speed in the road were positively related to MVPA among children aged 9 to 13 years old (the same age group as our study).

One unanticipated finding was that, children living in the highest attractive neighbourhoods (IMI), accumulated significantly lower levels of MVPA. In contrast to our findings, Diana et al. found that, higher levels of observed neighbourhood greenness was associated with higher levels of objectively measured children's physical activity (105). Nevertheless, most studies to date examining the role of neighbourhood aesthetics on PA behavior have been focused on individual's perception (rather than objective measures), and results remain inconsistent. This study has been unable to demonstrate that neighbourhood aesthetics, either perceived by children or objectively measured, predict more PA and less ST. This unexpected result may be due to the fact that there may exist a difference between residents' notions of neighbourhood attractiveness and the way aesthetics is defined by researchers. Further investigation is warranted to explore how neighbourhood aesthetics play a role in predicting children's PA outcomes.

The findings suggest that, levels of physical activity are associated with different perceived and objectively measured built environmental measures after controlling for age, gender, and annual household income. Further, it is interesting to note that, controlling for demographics did not substantially change the magnitude and significance level of the coefficients of the built environment variables. For example, the perceived measure of parks and recreational facilities in relation to an average daily minutes of MVPA has been changed from 2.18 (min/day) in an unadjusted model to 2.73 (min/day) in the adjusted, however, no substantial changes in the

significance level has been observed (these associations remained significant after adjustment for demographics, however, significant level differs slightly).

In most cases, children living in neighbourhoods with specific perceived BE characteristics, such as higher levels of safety from crime, overall activity friendliness (e.g. presence of sidewalks), availability and accessibility of parks and recreational facilities, demonstrated significant differences in physical activity behaviors (e.g. increased MVPA accumulation vs. decreased ST) in comparison to children living in opposing neighbourhoods. Based on the model results of this study, we found that the perceived and objective BE characteristics have different associations with physical activity behaviors when both are presented in the same model. By comparing model results, we found that, perceived measures of the BE had a stronger association with PA and ST than objective measures and all are of an expected direction.

6.4 Revisiting the Proposed Theoretical Framework and Models

In Chapter 3, a conceptual model exploring the BE factors that influence a child's physical activity behaviours was proposed (Figure 2). The neighbourhood-scale built environment, either perceived or objectively measured, were significant predictors of children's PA and ST outcomes reported in this study; most were in expected directions. As PA was hypothesized to be the highest and ST to be the lowest if neighbourhoods are perceived as safe, with good services/facilities, and activity friendly, most BE features such as the presence of parks and other recreational facilities, sidewalks, and active role models were associated with increased PA and reduced ST outcomes in children. While PA was hypothesized to be the highest and ST to be the lowest if neighbourhoods are objectively measured as safe, walkable, and activity friendly, only neighbourhood general safety (NALP) was associated with increased PA, whilst both observed activity friendliness and pedestrian accessibility were associated with reduced ST. Surprisingly, in almost all PA-domains examined, objectively measured safety from crime (IMI) was associated with reduced PA and increased ST. As proposed in the model outlining the role of the built environment in shaping physical activity outcomes of children (Figure 2), perceived BE features had a stronger effect in predicting children's PA outcomes and all are of the expected directions.

6.5 Strength and Limitation

This study is unique as it includes device-based measures of children's physical activity behaviour, survey data exploring children's perception of the BE characteristics, and objectively measured neighbourhood level BE characteristic data. This study contributes to existing knowledge on how the perceptions of children and the actual built environment affect their PA behaviors. Although objective measures provide the necessary rigour to built environment measurement, there is evidence to suggest that environmental perceptions may be equally predictive of physical activity. To date, as relatively little research linking the built environment and physical activity behavior has been done by taking both objective and perceived measures of BE into account, this study, thus, provides the evidence to include both objective and perceptual measures of BE in future activity behavior research in children.

Children's perception of the BE characteristics, which is subjective and prone to error and not always able to capture children's direct and true exposure to their neighbourhood environments, may be an important predictor of their physical activity behaviors while combined with objective measures. Furthermore, subjective measures (e.g. self- and proxy-report) are more convenient and cost efficient for large population-based surveys. Thus, the approach taken in this study to combine perceptions and objective measures of BE, and their relative effects on children's physical activity behavior, is a key strength of the study that addresses an important research gap in the current literature linking the built environment and physical activity.

Although only a few studies have quantified the agreement between perceived and objective environmental measures(mostly in adult population), future studies should investigate whether the agreement between the measures differs across neighbourhood and individual characteristics to help further define the relationship between the two and potentially lead to PA promotion strategies that target such groups. Differences in the way children and parents perceive the safety and other environmental features in their physical and social neighbourhood environment which in turn can impact their health behaviors (e.g. physical activity). Further research should also identify, however, any differences that may exist between levels of children's PA, from the mismatch between young children's and parents' perceptions of the neighborhood BE.

Another major strength of this study is a longitudinal/prospective design to study these relationships, among such factors as the built environment, perceptions, and physical activity

behavior, with three collection time points occurring over four seasons. Although the evidence based on the associations between built environment and children's physical activity behavior exist, few studies have assessed this relationship longitudinally (To date, most studies have been cross-sectional, comparing physical activity behavior in relationship with BE at a specific point in time). It is however difficult to draw firm conclusions about causality from cross-sectional studies. Thus, the present study provides longitudinal evidence for children's physical activity behavior with respect to the BE characteristics.

While the necessity of studying the influence of environment on PA seems apparent, given that ST is independently associated with long term health outcomes, it is imperative to study ST when conducting physical health behavior research. To data, most observational or intervention studies have been focused on either PA or ST in regard to their relationship with BE. The approach taken in this study to investigate the influence of built environmental characteristic on both physical activity and sedentary behavior, contributes to the body of existing knowledge.

While subjective measures present limitations in capturing physical activity due to poor reliability and validity, participant recall bias, and interpretation of questions, this study is strengthened by its employment of accelerometer-based measures in capturing physical activity behaviors, thus avoiding self-report bias. Even though objective measures (e.g. accelerometer) have some component of measurement error, however, there is no evidence supporting the effect of any systematic bias (68) (e.g. under estimation or over estimation) on introducing bias in the association between the environment and the behavior.

In terms of statistical analysis, this study utilized linear mixed effect models that employs a robust variance estimation method to adjust the standard errors for the clustering of observations within each child. The development of mixed effects models to capture the influence of a diverse set of built environmental variables not only ensured statistical rigour, but also included the determination of variation in PA and SED at both neighbourhood and individual of multilevel models. Nevertheless, this approach supports the conceptual background presented in this study and highlights a statistically rigorous analytical method to conduct active living research in children. In using mixed models, the possibility of bias due to any unmeasured characterises including residential self-selection resulting from neighbourhood preferences, however, can not be ruled out (184). In addition, longitudinal analysis may be hampered by the possibility that

individuals with certain activity preferences choose neighborhoods with better resources (185). There is alternative way (e.g. buffers around children, activity space) to define child-centered neighbourhoods. Nevertheless, this study focused on neighbourhoods defined by the city (i.e. municipal boundaries, development era, and associated urban design), since the goal was to match objectively defined neighbourhood BE characteristics with the perceived BE characteristics (i.e. that in both types of measures refer to the same neighbourhood).

Another strength of this study includes the large representative sample of children aged 9 to 14 years representing all socioeconomic categories within all types of neighbourhoods in Saskatoon, built in a range of urban designs. This study is further strengthened by the inclusion of IMI and NALP measures in all models presented in an effort to capture neighbourhood-scale BE features children are exposed to on a daily basis. Although associations between activity accumulation and neighbourhood BE have been established, this study, however, have not attempted to relate environmental attributes to children's activity in specific locations. Neighborhood attributes may be more related to physical activity in specific locations in the neighborhood. Further detailed studies of environmental correlates of children's physical activity in specific locations may be informative, particularly for public policy and urban planning projects that target specific transit and recreation-related infrastructure.

6.6 Policy Implications and Future Directions

Creating opportunities for children to participate in physical activity and engage in lower levels of sedentary time is a potentially important public health intervention. In order to design effective interventions to promote physical activity in children, there is a need for studies identifying its influencing factors (186). In working towards developing interventions aiming to effect positive activity behavior changes in children, understanding the complexity of the link between the built environment and these behaviors, this study has the potential to make a contribution to public health approaches through the integration of the knowledge into health intervention research and incorporation of evidence-based strategies into community planning.

There is currently little clear public health evidence about the impacts of the built environment, to guide policy and planning (187). This work has direct relevance for improvement of child health and the prevention of childhood obesity as this study collects new and actionable evidence about aspects of neighborhood built environment correlates of physical activity and

sedentary behaviors. This study makes a valuable contribution to the existing literature, indicates the importance of children's perception and objective measures of built environment in shaping children's physical activity behaviors, and environment-physical activity research extending beyond cross-sectional examinations. This study help inform policymakers and decision-makers for initiating more sustainable and broader reaching environmental and policy changes and allows for designing neighborhood in context of promoting children's activity. However, further context-specific and hypothesis-driven built environment research and comprehensive understanding of the policy processes to influence changes are needed.

Findings from this study underscore that future research is needed to clarify how contextual exposure to diverse environments outside the home and school differs according to activity intensity (i.e. what environments exert a contextual influence on children for MVPA versus sedentary activity versus light physical activity). In addition, future research should investigate the specific features of what children are being exposed to for physical activity (e.g. instead of stating a child was exposed to a park, future research could identify whether this park was with a specific sport field, such as a football field, tennis court, or baseball diamond). Moreover, future research should identify the intensities of the activities taken place in the context of what children are being exposed to for PA (e.g. instead of stating a child was exposed to a play area, future research could identify whether children are engaged in any kind of activity while visiting the area, or sitting, having snacks, and/or chatting with friends).

CHAPTER 7

CONCLUSIONS

A number of recent studies have suggested that physical activity in children is influenced in part by an individual's exposure to and engagement with their built environment. Results from these studies, however, have been inconsistent, perhaps in part because most of the previous research has focused on either perceptions or objective measures of the neighborhood environment, but not capturing both measures of BE. Additionally, the few studies that have assessed perceptions of the neighbourhood BE focused on parental perceptions, but not child's perception. While research indicates that SED is independently associated with a wide range of health outcomes, active living research has predominantly focused on only physical activity, but not both. Moreover, past studies of the neighborhood environment and children's PA have been cross-sectional, however, it is also important to understand the potential effects of this environment on PA throughout the course of the year and more studies with a longitudinal design are needed. The present study addresses several of these research gaps. The purpose of this study was to explore how the BE, either child's perceived or objectively measured, influences children's physical activity and time spent in sedentary activities across the four seasons in a given year. This thesis aimed to clarify whether both perceptual and objective measures of neighbourhood BE are associated with children's PA behavior. Overall safe, walkable, and activity friendly neighbourhoods were found to influence children's activity behaviors. Even so, perceptions of the BE were more strongly associated with children's PA outcomes than with objectively measured BE.

Findings from this research provide supporting evidence that exposure to BE contexts influences children's PA and ST. However, there is no simple answer to improving children's physical activity and reducing sedentary time. Many results are consistent with findings of previous studies, providing further support for policies that promote child-friendly neighbourhoods to support physical activity. However, the generalizability of specific results is limited because of unique characteristics of the Saskatoon city and BE factors impacting PA need to be considered the context of the country in which the study has been undertaken and the ethnic groups involved. Further context-specific studies and understanding of the policy process that influence changes are required.

REFERENCES

1. Janssen I, LeBlanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act [Internet]. 2010 May 11 [cited 2019 Apr 5];7(1):40. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20459784
2. Strong WB, Malina RM, Blimkie CJR, Daniels SR, Dishman RK, Gutin B, et al. Evidence Based Physical Activity for School-age Youth. J Pediatr [Internet]. 2005 Jun [cited 2019 Apr 5];146(6):732–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15973308
3. Biddle SJ, Gorely T, Stensel DJ. Health-enhancing physical activity and sedentary behaviour in children and adolescents. J Sports Sci [Internet]. 2004 Aug [cited 2019 Apr 5];22(8):679–701. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15370482
4. Shaibi GQ, Faulkner MS, Weigensberg MJ, Fritschi C, Goran MI. Cardiorespiratory fitness and physical activity in youth with type 2 diabetes. Pediatr Diabetes [Internet]. 2008 Oct [cited 2019 Apr 5];9(5):460–3. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18503498
5. Pietiläinen KH, Kaprio J, Borg P, Plasqui G, Yki-Järvinen H, Kujala UM, et al. Physical Inactivity and Obesity: A Vicious Circle. Obesity [Internet]. 2008 Feb [cited 2019 Apr 5];16(2):409–14. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18239652
6. González K, Fuentes J, Márquez JL. Physical inactivity, sedentary behavior and chronic diseases [Internet]. Vol. 38, Korean Journal of Family Medicine. Korean Academy of Family Medicine; 2017 [cited 2019 Apr 5]. p. 111–5. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28572885
7. Hallal PC, Victora CG, Azevedo MR, Wells JCK. Adolescent Physical Activity and Health. Sport Med [Internet]. 2006 [cited 2019 Apr 5];36(12):1019–30. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17123326
8. Hardy LL, Dobbins TA, Denney-Wilson EA, Okely AD, Booth ML. Descriptive epidemiology of small screen recreation among Australian adolescents. J Paediatr Child Health [Internet]. 2006 Nov [cited 2019 Apr 5];42(11):709–14. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17044899
9. Matthews CE, Chen KY, Freedson PS, Buchowski MS, Beech BM, Pate RR, et al. Amount of Time Spent in Sedentary Behaviors in the United States, 2003-2004. Am J

Epidemiol [Internet]. 2008 Mar 14 [cited 2019 Apr 5];167(7):875–81. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18303006

10. Van Der Horst K, Paw MJCA, Twisk JWR, Van Mechelen W. A brief review on correlates of physical activity and sedentariness in youth [Internet]. Vol. 39, Medicine and Science in Sports and Exercise. 2007 [cited 2019 Apr 5]. p. 1241–50. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17762356
11. Gray CE, Larouche R, Barnes JD, Colley RC, Bonne JC, Arthur M, et al. Are we driving our kids to unhealthy habits? Results of the active healthy kids Canada 2013 report card on physical activity for children and youth. Int J Environ Res Public Health [Internet]. 2014 Jun 5 [cited 2019 Apr 5];11(6):6009–20. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24905246
12. Colley RC, Garriguet D, Janssen I, Craig CL, Clarke J, Tremblay MS. Physical activity of Canadian children and youth: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. Heal reports [Internet]. 2011 Mar [cited 2019 Apr 5];22(1):15–23. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21510586
13. Esliger DW, Sherar LB, Muhajarine N. Smart cities, healthy kids: the association between neighbourhood design and children's physical activity and time spent sedentary. Can J Public Health [Internet]. 2012 Jul 26 [cited 2019 Apr 5];103(9 Suppl 3):eS22-8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23618084
14. Katapally TR, Muhajarine N. Towards uniform accelerometry analysis: a standardization methodology to minimize measurement bias due to systematic accelerometer wear-time variation. J Sports Sci Med [Internet]. 2014 May [cited 2019 Apr 5];13(2):379–86. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24790493
15. ParticipACTION. Canadian 24-Hour Movement Guidelines for Children and Youth : 2016 [cited 2019 Apr 6];(January 2015):1–2. Available from: https://indd.adobe.com/view/b82b4a90-6e46-4b1a-b628-d53805688baf
16. Warburton DER, Nicol CW, Bredin SSD. Health benefits of physical activity: The evidence [Internet]. Vol. 174, CMAJ. Canadian Medical Association; 2006 [cited 2019 Apr 5]. p. 801–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16534088
17. Muhajarine N, Katapally TR, Fuller D, Stanley KG, Rainham D. Longitudinal active living research to address physical inactivity and sedentary behaviour in children in

transition from preadolescence to adolescence. BMC Public Health [Internet]. 2015 Dec 17 [cited 2019 Apr 5];15(1):495. Available from: http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-1822-2

18. Prochaska JJ, Prochaska JO. A Review of Multiple Health Behavior Change Interventions for Primary Prevention. Am J Lifestyle Med [Internet]. 2011 May [cited 2019 Apr 5];5(3). Available from: http://www.ncbi.nlm.nih.gov/pubmed/24358034
19. Hills AP, Byrne NM, Lindstrom R, Hill JO. 'Small Changes' to Diet and Physical Activity Behaviors for Weight Management. Obes Facts [Internet]. 2013 [cited 2019 Apr 5];6(3):228. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23711772
20. Uijtdewilligen L, Nauta J, Singh AS, van Mechelen W, Twisk JWR, van der Horst K, et al. Determinants of physical activity and sedentary behaviour in young people: a review and quality synthesis of prospective studies. Br J Sports Med [Internet]. 2011 Sep 1 [cited 2019 Apr 5];45(11):896–905. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21836173
21. Timperio A, Reid J, Veitch J. Playability: Built and Social Environment Features That Promote Physical Activity Within Children. Curr Obes Rep [Internet]. 2015 Dec 23 [cited 2019 Apr 5];4(4):460–76. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26399255
22. King AC, Parkinson KN, Adamson AJ, Murray L, Besson H, Reilly JJ, et al. Correlates of objectively measured physical activity and sedentary behaviour in English children. Eur J Public Health [Internet]. 2011 Aug 1 [cited 2019 Apr 5];21(4):424–31. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20650946
23. Handy SL, Boarnet MG, Ewing R, Killingsworth RE. How the built environment affects physical activity: views from urban planning. Am J Prev Med [Internet]. 2002 Aug [cited 2019 Apr 5];23(2 Suppl):64–73. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12133739
24. Ding D, Sallis JF, Kerr J, Lee S, Rosenberg DE. Neighborhood Environment and Physical Activity Among Youth. Am J Prev Med [Internet]. 2011 Oct [cited 2019 Apr 5];41(4):442–55. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21961474
25. Molnar BE, Gortmaker SL, Bull FC, Buka SL. Unsafe to Play? Neighborhood Disorder and Lack of Safety Predict Reduced Physical Activity among Urban Children and

Adolescents. Am J Heal Promot [Internet]. 2004 May 25 [cited 2019 Apr 5];18(5):378–86. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15163139

26. Reimers AK, Wagner M, Alvanides S, Steinmayr A, Reiner M, Schmidt S, et al. Proximity to Sports Facilities and Sports Participation for Adolescents in Germany. Bacurau RFP, editor. PLoS One [Internet]. 2014 Mar 27 [cited 2019 Apr 5];9(3):e93059. Available from: https://dx.plos.org/10.1371/journal.pone.0093059
27. Nutbeam D, Aar L, Catford J. Understanding childrens' health behaviour: the implications for health promotion for young people. Soc Sci Med [Internet]. 1989 [cited 2019 Apr 5];29(3):317–25. Available from: http://www.ncbi.nlm.nih.gov/pubmed/2762860
28. Loebach JE, Gilliland JA. Free Range Kids? Using GPS-Derived Activity Spaces to Examine Children's Neighborhood Activity and Mobility. Environ Behav [Internet]. 2016 Apr 28 [cited 2019 Apr 5];48(3):421–53. Available from: http://journals.sagepub.com/doi/10.1177/0013916514543177
29. Clark C, Uzzell DL. The affordances of the home, neighbourhood, school and town centre for adolescents. J Environ Psychol [Internet]. 2002 Mar 1 [cited 2019 Apr 5];22(1–2):95–108. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0272494401902427
30. McMillan TE. Urban Form and a Child's Trip to School: The Current Literature and a Framework for Future Research. J Plan Lit [Internet]. 2005 May 18 [cited 2019 Apr 5];19(4):440–56. Available from: http://journals.sagepub.com/doi/10.1177/0885412204274173
31. Tappe KA, Glanz K, Sallis JF, Zhou C, Saelens BE. Children's physical activity and parents' perception of the neighborhood environment: neighborhood impact on kids study. Int J Behav Nutr Phys Act [Internet]. 2013 Mar 27 [cited 2019 Apr 5];10(1):39. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23531282
32. Huertas-Delgado FJ, Herrador-Colmenero M, Villa-González E, Aranda-Balboa MJ, Cáceres MV, Mandic S, et al. Parental perceptions of barriers to active commuting to school in Spanish children and adolescents. Eur J Public Health [Internet]. 2017 Jan 19 [cited 2018 Aug 16];27(3):ckw249. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28108594
33. Rainham D, Krewski D, McDowell I, Sawada M, Liekens B. Development of a wearable

global positioning system for place and health research. Int J Health Geogr [Internet]. 2008 Nov 25 [cited 2019 Apr 5];7(1):59. Available from: http://ij-healthgeographics.biomedcentral.com/articles/10.1186/1476-072X-7-59

34. Maddison R, Jiang Y, Vander Hoorn S, Ni Mhurchu C, Exeter D, Utter J. Perceived versus actual distance to local physical-activity facilities: does it really matter? J Phys Act Health [Internet]. 2010 May [cited 2019 Apr 5];7(3):323–32. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20551488
35. Giles-Corti B, Wood G, Pikora T, Learnihan V, Bulsara M, Van Niel K, et al. School site and the potential to walk to school: The impact of street connectivity and traffic exposure in school neighborhoods. Health Place [Internet]. 2011 Mar [cited 2019 Apr 5];17(2):545–50. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21237697
36. Rosenberger ME, Haskell WL, Albinali F, Mota S, Nawyn J, Intille S. Estimating activity and sedentary behavior from an accelerometer on the hip or wrist. Med Sci Sports Exerc [Internet]. 2013 May [cited 2019 Apr 5];45(5):964–75. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23247702
37. Bejarano CM, Carlson JA, Cushing CC, Kerr J, Saelens BE, Frank LD, et al. Neighborhood built environment associations with adolescents' location-specific sedentary and screen time. Health Place [Internet]. 2019 Mar 1 [cited 2019 Apr 5];56:147–54. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1353829218306877
38. Crawford D, Cleland V, Timperio A, Salmon J, Andrianopoulos N, Roberts R, et al. The longitudinal influence of home and neighbourhood environments on children's body mass index and physical activity over 5 years: the CLAN study. Int J Obes [Internet]. 2010 Jul 30 [cited 2019 Apr 5];34(7):1177–87. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20351728
39. Barnes JD, Cameron C, Carson V, Chaput J-P, Faulkner GEJ, Janson K, et al. Results From Canada's 2016 ParticipACTION Report Card on Physical Activity for Children and Youth. J Phys Act Heal [Internet]. 2016 Nov [cited 2019 Apr 5];13(11 Suppl 2):S110–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/27848727
40. Poitras VJ, Gray CE, Borghese MM, Carson V, Chaput J-P, Janssen I, et al. Systematic review of the relationships between objectively measured physical activity and health

indicators in school-aged children and youth. Appl Physiol Nutr Metab [Internet]. 2016 Jun [cited 2019 Apr 5];41(6 (Suppl. 3)):S197–239. Available from: http://www.ncbi.nlm.nih.gov/pubmed/27306431

41. Tremblay MS, LeBlanc AG, Kho ME, Saunders TJ, Larouche R, Colley RC, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth [Internet]. Vol. 8, International Journal of Behavioral Nutrition and Physical Activity. BioMed Central; 2011 [cited 2019 Apr 5]. p. 98. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21936895
42. Cummins S, Curtis S, Diez-Roux A V., Macintyre S. Understanding and representing "place" in health research: A relational approach. Soc Sci Med [Internet]. 2007 Nov [cited 2019 Apr 5];65(9):1825–38. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17706331
43. Active Healthy Living: Prevention of Childhood Obesity Through Increased Physical Activity. Pediatrics [Internet]. 2006 [cited 2019 Apr 5];117(5):1834–42. Available from: www.pediatrics.org/cgi/doi/10.1542/
44. Hinckson EA, Duncan S, Oliver M, Mavoa S, Cerin E, Badland H, et al. Built environment and physical activity in New Zealand adolescents: A protocol for a cross-sectional study. BMJ Open [Internet]. 2014 Apr 1 [cited 2019 Apr 5];4(4):e004475. Available from: https://bmjopen.bmj.com/content/4/4/e004475
45. Council on Sports Medicine and Fitness, Council on School Health. Active Healthy Living: Prevention of Childhood Obesity Through Increased Physical Activity. Pediatrics [Internet]. 2006 May 1 [cited 2019 Apr 5];117(5):1834–42. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16651347
46. Sallis JF, Owen N. Physical activity & behavioral medicine. Sage Publications; 1999. 210 p.
47. Smith BJ, Grunseit A, Hardy LL, King L, Wolfenden L, Milat A. Parental influences on child physical activity and screen viewing time: a population based study. BMC Public Health [Internet]. 2010 Oct 8 [cited 2019 Apr 5];10:593. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20929587
48. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. Med Sci Sports Exerc [Internet]. 2000 May [cited 2018 May

23];32(5):963–75. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10795788

49. Sallis JF, Fisher EB, Owen N. Ecological models of health behavior. In: Glanz, Karen, Rimer, Barbara K., Viswanath K, editor. Health Behavior and Health Education [Internet]. 4th ed. San Francisco: Jossey-Bass; 1990 [cited 2019 Apr 3]. p. 465–85. Available from: https://uq.rl.talis.com/items/26D59337-58CE-30E9-DCB5-E1508FB0138F.html
50. Bornstein MH, Gibson JJ. The Ecological Approach to Visual Perception. J Aesthet Art Crit [Internet]. 1980 [cited 2019 Apr 4];39(2):203. Available from: https://www.jstor.org/stable/10.2307/429816?origin=crossref
51. Ergler CR, Kearns RA, Witten K. Seasonal and locational variations in children's play: Implications for wellbeing. Soc Sci Med [Internet]. 2013 Aug [cited 2019 Apr 3];91:178–85. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0277953612007964
52. Bronfenbrenner U. The ecology of human development : experiments by nature and design [Internet]. Harvard University Press; 1979 [cited 2019 Apr 3]. 330 p. Available from: http://www.hup.harvard.edu/catalog.php?isbn=9780674224575&content=reviews
53. Davison KK, Birch LL. Childhood overweight: a contextual model and recommendations for future research. Obes Rev [Internet]. 2001 Aug [cited 2019 Apr 3];2(3):159–71. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12120101
54. Sallis JF, Glanz K. The role of built environments in physical activity, eating, and obesity in childhood. Futur Child [Internet]. 2006 [cited 2019 Apr 4];16(1):89–108. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16532660
55. Miyake KK, Maroko AR, Grady KL, Maantay JA, Arno PS. Not Just a Walk in the Park: Methodological Improvements for Determining Environmental Justice Implications of Park Access in New York City for the Promotion of Physical Activity. Cities Environ [Internet]. 2010 Jan 1 [cited 2019 Apr 4];3(1):1–17. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21874148
56. Sallis JF, Taylor WC, Dowda M, Freeson PS, Pate RR. Correlates of Vigorous Physical Activity for Children in Grades 1 Through 12: Comparing Parent-Reported and Objectively Measured Physical Activity [Internet]. Vol. 14, Pediatric Exercise Science. 2002 [cited 2019 Apr 4]. Available from: http://scholarcommons.sc.edu/
57. Roemmich JN, Epstein LH, Raja S, Yin L. The neighborhood and home environments: Disparate relationships with physical activity and sedentary behaviors in youth. Ann

Behav Med [Internet]. 2007 Feb [cited 2019 Apr 4];33(1):29–38. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17291168

58. De Vet E, de Ridder DTD, de Wit JBF. Environmental correlates of physical activity and dietary behaviours among young people: A systematic review of reviews. Obes Rev [Internet]. 2011 May 1 [cited 2019 Apr 4];12(501):e130–42. Available from: http://doi.wiley.com/10.1111/j.1467-789X.2010.00784.x
59. Norman GJ, Adams MA, Kerr J, Ryan S, Frank LD, Roesch SC. A Latent Profile Analysis of Neighborhood Recreation Environments in Relation to Adolescent Physical Activity, Sedentary Time, and Obesity. J Public Heal Manag Pract [Internet]. 2010 [cited 2019 Apr 4];16(5):411–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20689390
60. Broberg A, Salminen S, Kyttä M. Physical environmental characteristics promoting independent and active transport to children's meaningful places. Appl Geogr [Internet]. 2013 Mar 1 [cited 2019 Apr 4];38:43–52. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0143622812001579
61. Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. Understanding environmental influences on walking. Am J Prev Med [Internet]. 2004 Jul [cited 2019 Apr 4];27(1):67–76. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15212778
62. Van Der Horst K, Paw MJ, Twisk JW VMW. A Brief Review on Correlates of Physical Activity and Sedentariness in Youth. Med Sci Sport Exerc [Internet]. 2007 Aug [cited 2019 Apr 4];39(8):1241–50. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17762356
63. Heath GW, Brownson RC, Kruger J, Miles R, Powell KE, Ramsey LT, et al. The Effectiveness of Urban Design and Land Use and Transport Policies and Practices to Increase Physical Activity: A Systematic Review. J Phys Act Heal [Internet]. 2006 Feb [cited 2019 Apr 4];3(s1):S55–76. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28834525
64. Gebel K, Bauman AE, Petticrew M. The Physical Environment and Physical Activity. Am J Prev Med [Internet]. 2007 May [cited 2019 Apr 4];32(5):361–369.e3. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0749379707000499
65. Rodríguez DA, Cho G-H, Evenson KR, Conway TL, Cohen D, Ghosh-Dastidar B, et al. Out and about: Association of the built environment with physical activity behaviors of

adolescent females. Health Place [Internet]. 2012 Jan [cited 2019 Apr 4];18(1):55–62. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21945085

66. Veugelers P, Sithole F, Zhang S, Muhajarine N. Neighborhood characteristics in relation to diet, physical activity and overweight of Canadian children. Int J Pediatr Obes [Internet]. 2008 Jan [cited 2019 Apr 4];3(3):152–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19086297
67. Cohen DA, Ashwood JS, Scott MM, Overton A, Evenson KR, Staten LK, et al. Public Parks and Physical Activity Among Adolescent Girls. Pediatrics [Internet]. 2006 Nov 1 [cited 2019 Apr 4];118(5):e1381–9. Available from: http://pediatrics.aappublications.org/cgi/doi/10.1542/peds.2006-1226
68. Jago R, Baranowski T, Baranowski JC. Observed, GIS, and Self-Reported Environmental Features and Adolescent Physical Activity. Am J Heal Promot [Internet]. 2006 Jul 26 [cited 2019 Apr 4];20(6):422–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16871822
69. Kligerman M, Sallis JF, Ryan S, Frank LD, Nader PR. Association of Neighborhood Design and Recreation Environment Variables with Physical Activity and Body Mass Index in Adolescents. Am J Heal Promot [Internet]. 2007 Mar 28 [cited 2019 Apr 4];21(4):274–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17375494
70. Adkins S, Sherwood NE, Story M, Davis M. Physical Activity among African-American Girls: The Role of Parents and the Home Environment. Obes Res [Internet]. 2008 Sep [cited 2019 Apr 4];12(S9):38S–45S. Available from: http://doi.wiley.com/10.1038/oby.2004.267
71. Salmon J, Timperio A. Prevalence, Trends and Environmental Influences on Child and Youth Physical Activity. In: Pediatric Fitness [Internet]. Basel: KARGER; 2007 [cited 2019 Apr 4]. p. 183–99. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17387258
72. Pont K, Ziviani J, Wadley D, Bennett S, Abbott R. Environmental correlates of children's active transportation: A systematic literature review. Heal Place [Internet]. 2009 Sep 1 [cited 2019 Apr 4];15(3):849–62. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1353829209000136?via%3Dihub
73. Panter JR, Jones AP, van Sluijs EM. Environmental determinants of active travel in youth: A review and framework for future research. Int J Behav Nutr Phys Act [Internet]. 2008

Jun 23 [cited 2019 Apr 3];5(1):34. Available from: http://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-34

74. Davison KK, Lawson CT. Do attributes in the physical environment influence children's physical activity? A review of the literature. Int J Behav Nutr Phys Act [Internet]. 2006 Jul 27 [cited 2019 Apr 5];3:19. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16872543
75. Armstrong N, Welsman JR, Beunen G, Kemper HCG, Van Praagh E. Young people and physical activity. Med Sci Sport Exerc [Internet]. 2003 [cited 2019 Apr 5];31(Supplement):S293. Available from: https://books.google.ca/books/about/Young_People_and_Physical_Activity.html?id=xdFsAAAAMAAJ&redir_esc=y
76. Holt NL, Spence JC, Sehn ZL, Cutumisu N. Neighborhood and developmental differences in children's perceptions of opportunities for play and physical activity. Health Place [Internet]. 2008 Mar 1 [cited 2019 Apr 5];14(1):2–14. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1353829207000299
77. Hume C, Salmon J, Ball K. Children's perceptions of their home and neighborhood environments, and their association with objectively measured physical activity: a qualitative and quantitative study. Health Educ Res [Internet]. 2004 Jul 14 [cited 2019 Apr 5];20(1):1–13. Available from: https://academic.oup.com/her/article-lookup/doi/10.1093/her/cyg095
78. Mota J, Almeida M, Santos P, Ribeiro JC. Perceived Neighborhood Environments and physical activity in adolescents. Prev Med (Baltim) [Internet]. 2005 Nov 1 [cited 2019 Apr 5];41(5–6):834–6. Available from: https://www.sciencedirect.com/science/article/pii/S009174350500112X?via%3Dihub
79. Timperio A, Crawford D, Telford A, Salmon J. Perceptions about the local neighborhood and walking and cycling among children. Prev Med (Baltim) [Internet]. 2004 Jan [cited 2019 Apr 5];38(1):39–47. Available from: http://www.ncbi.nlm.nih.gov/pubmed/14672640
80. Mitchell C, Clark A, Gilliland J. Built Environment Influences of Children's Physical Activity: Examining Differences by Neighbourhood Size and Sex. Int J Environ Res Public Health [Internet]. 2016 Jan 15 [cited 2019 Apr 5];13(1):130. Available from:

http://www.mdpi.com/1660-4601/13/1/130

81. Veitch J, Timperio A, Crawford D, Abbott G, Giles-Corti B, Salmon J. Is the Neighbourhood Environment Associated with Sedentary Behaviour Outside of School Hours Among Children? Ann Behav Med [Internet]. 2011 Jun 19 [cited 2019 May 25];41(3):333–41. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21336879
82. Alton D, Adab P, Roberts L, Barrett T. Relationship between walking levels and perceptions of the local neighbourhood environment. Arch Dis Child [Internet]. 2007 Jan [cited 2019 Apr 5];92(1):29–33. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17158145
83. Wong BY-M, Cerin E, Ho S-Y, Mak K-K, Lo W-S, Lam T-H. Adolescents' physical activity: Competition between perceived neighborhood sport facilities and home media resources. Int J Pediatr Obes [Internet]. 2010 Apr [cited 2019 Apr 5];5(2):169–76. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19657859
84. Dunton GF, Jamner MS, Cooper DM. Assessing the perceived environment among minimally active adolescent girls: Validity and relations to physical activity outcomes. Am J Heal Promot [Internet]. 2003 Sep 25 [cited 2019 Apr 5];18(1):70–3. Available from: http://journals.sagepub.com/doi/10.4278/0890-1171-18.1.70
85. Ries A V., Yan AF, Voorhees CC. The Neighborhood Recreational Environment and Physical Activity Among Urban Youth: An Examination of Public and Private Recreational Facilities. J Community Health [Internet]. 2011 Aug 12 [cited 2019 Apr 5];36(4):640–9. Available from: http://link.springer.com/10.1007/s10900-010-9355-1
86. Scott MM, Evenson KR, Cohen DA, Cox CE. Comparing Perceived and Objectively Measured Access to Recreational Facilities as Predictors of Physical Activity in Adolescent Girls. J Urban Heal [Internet]. 2007 May 10 [cited 2019 Apr 5];84(3):346–59. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17401691
87. Wilson DK, Lawman HG, Segal M, Chappell S. Neighborhood and Parental Supports for Physical Activity in Minority Adolescents. Am J Prev Med [Internet]. 2011 Oct [cited 2019 Apr 5];41(4):399–406. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21961467
88. Ewing R, Schroeer W, Greene W. School Location and Student Travel Analysis of Factors Affecting Mode Choice. Transp Res Rec J Transp Res Board [Internet]. 2004 Jan 1 [cited

2019 Apr 5];1895(1):55–63. Available from: http://journals.sagepub.com/doi/10.3141/1895-08

89. De Meester F, Van Dyck D, De Bourdeaudhuij I, Cardon G. Parental perceived neighborhood attributes: associations with active transport and physical activity among 10–12 year old children and the mediating role of independent mobility. BMC Public Health [Internet]. 2014 Dec 20 [cited 2019 Apr 5];14(1):631. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24950713
90. Jago R, Baranowski T, Zakeri I, Harris M. Observed Environmental Features and the Physical Activity of Adolescent Males. Am J Prev Med [Internet]. 2005 Aug [cited 2019 Apr 5];29(2):98–104. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16005805
91. Boarnet MG, Anderson CL, Day K, McMillan T, Alfonzo M. Evaluation of the California Safe Routes to School legislation. Am J Prev Med [Internet]. 2005 Feb [cited 2019 Apr 5];28(2):134–40. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15694521
92. Fulton JE, Shisler JL, Yore MM, Caspersen CJ. Active Transportation to School. Res Q Exerc Sport [Internet]. 2005 Sep [cited 2019 Apr 5];76(3):352–7. Available from: http://www.tandfonline.com/doi/abs/10.1080/02701367.2005.10599306
93. Huertas-Delgado FJ, Herrador-Colmenero M, Villa-González E, Aranda-Balboa MJ, Cáceres MV, Mandic S, et al. Parental perceptions of barriers to active commuting to school in Spanish children and adolescents. Eur J Public Health [Internet]. 2017 Jan 19 [cited 2019 Apr 5];ckw249. Available from: https://academic.oup.com/eurpub/article-lookup/doi/10.1093/eurpub/ckw249
94. Larsen K, Gilliland J, Hess PM. Route-Based Analysis to Capture the Environmental Influences on a Child's Mode of Travel between Home and School. Ann Assoc Am Geogr [Internet]. 2012 Nov [cited 2019 Apr 5];102(6):1348–65. Available from: http://www.tandfonline.com/doi/abs/10.1080/00045608.2011.627059
95. Carver A, Timperio AF, Crawford DA. Neighborhood road environments and physical activity among youth: the CLAN study. J Urban Health [Internet]. 2008 Jul [cited 2019 Apr 5];85(4):532–44. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18437579
96. Carson V, Kuhle S, Spence JC, Veugelers PJ. Parents' perception of neighbourhood environment as a determinant of screen time, physical activity and active transport. Can J Public Health [Internet]. [cited 2019 Apr 5];101(2):124–7. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/20524376

97. Evenson KR, Scott MM, Cohen DA, Voorhees CC. Girls' Perception of Neighborhood Factors on Physical Activity, Sedentary Behavior, and BMI*. Obesity [Internet]. 2007 Feb [cited 2019 Apr 5];15(2):430–45. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17299117

98. Deforche B, Van Dyck D, Verloigne M, De Bourdeaudhuij I. Perceived social and physical environmental correlates of physical activity in older adolescents and the moderating effect of self-efficacy. Prev Med (Baltim) [Internet]. 2010 Jan [cited 2019 Apr 5];50:S24–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19818363

99. McMillan TE. The relative influence of urban form on a child's travel mode to school. Transp Res Part A Policy Pract [Internet]. 2007 Jan 1 [cited 2019 Apr 5];41(1):69–79. Available from: https://www.sciencedirect.com/science/article/pii/S0965856406000620

100. Kerr J1, Rosenberg D, Sallis JF, Saelens BE, Frank LD CT. Active Commuting to School. Med Sci Sport Exerc [Internet]. 2006 Apr [cited 2019 Apr 5];38(4):787–93. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16679998

101. DeWeese RS, Yedidia MJ, Tulloch DL, Ohri-Vachaspati P. Neighborhood perceptions and active school commuting in low-income cities. Am J Prev Med [Internet]. 2013 Oct [cited 2019 Apr 5];45(4):393–400. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24050414

102. McGrath LJ, Hinckson EA, Hopkins WG, Mavoa S, Witten K, Schofield G. Associations Between the Neighborhood Environment and Moderate-to-Vigorous Walking in New Zealand Children: Findings from the URBAN Study. Sport Med [Internet]. 2016 Jul 18 [cited 2019 Apr 5];46(7):1003–17. Available from: http://link.springer.com/10.1007/s40279-016-0533-x

103. de Bruijn G-J, Kremers SPJ, Lensvelt-Mulders G, de Vries H, van Mechelen W, Brug J. Modeling Individual and Physical Environmental Factors with Adolescent Physical Activity. Am J Prev Med [Internet]. 2006 Jun [cited 2019 Apr 5];30(6):507–12. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16704945

104. Evenson KR, Birnbaum AS, Bedimo-Rung AL, Sallis JF, Voorhees CC, Ring K, et al. Girls' perception of physical environmental factors and transportation: Reliability and association with physical activity and active transport to school. Int J Behav Nutr Phys

Act [Internet]. 2006 Sep 14 [cited 2019 Apr 5];3:28. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16972999

105. Grigsby-Toussaint DS, Chi SH, Fiese BH. Where they live, how they play: Neighborhood greenness and outdoor physical activity among preschoolers. Int J Health Geogr [Internet]. 2011 Dec 14 [cited 2019 Apr 5];10:66. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22165919
106. Grow HM, Saelens BE, Kerr J, Durant NH, Norman GJ SJ. Where Are Youth Active? Roles of Proximity, Active Transport, and Built Environment. Med Sci Sport Exerc [Internet]. 2008 Dec [cited 2019 Apr 5];40(12):2071–9. Available from: https://insights.ovid.com/crossref?an=00005768-200812000-00009
107. Tudor-Locke C, Ainsworth BE, Popkin BM. Active commuting to school: An overlooked source of childrens' physical activity? [Internet]. Vol. 31, Sports Medicine. 2001 [cited 2019 Apr 5]. p. 309–13. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11347681
108. Sampson RJ, Raudenbush SW. Systematic Social Observation of Public Spaces: A New Look at Disorder in Urban Neighborhoods. Am J Sociol [Internet]. 1999 Nov [cited 2019 Apr 5];105(3):603–51. Available from: https://www.journals.uchicago.edu/doi/10.1086/210356
109. Molnar BE, Gortmaker SL, Bull FC, Buka SL. Unsafe to Play? Neighborhood Disorder and Lack of Safety Predict Reduced Physical Activity among Urban Children and Adolescents. Am J Heal Promot [Internet]. 2004 May 25 [cited 2019 Apr 5];18(5):378–86. Available from: http://journals.sagepub.com/doi/10.4278/0890-1171-18.5.378
110. Valentine G, McKendrck J. Children's outdoor play: Exploring parental concerns about children's safety and the changing nature of childhood. Geoforum [Internet]. 2003 [cited 2019 Apr 5];28(2):219–35. Available from: https://pdfs.semanticscholar.org/fa98/ccca8b7a123e50412166ab0c2bd2e98c1588.pdf
111. Holt NL, Lee H, Millar CA, Spence JC. 'Eyes on where children play': a retrospective study of active free play. Child Geogr [Internet]. 2015 Jan 2 [cited 2019 Apr 5];13(1):73–88. Available from: http://www.tandfonline.com/doi/abs/10.1080/14733285.2013.828449
112. Motl RW, Dishman RK, Ward DS, Saunders RP, Dowda M, Felton G, et al. Perceived physical environment and physical activity across one year among adolescent girls: Self-efficacy as a possible mediator? J Adolesc Heal [Internet]. 2005 Nov [cited 2019 Apr

5];37(5):403–8. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1054139X0400268X

113. Millstein RA, Strobel J, Kerr J, Sallis JF, Norman GJ, Durant N, et al. Home, school, and neighborhood environment factors and youth physical activity. Pediatr Exerc Sci [Internet]. 2011 Nov [cited 2019 Apr 5];23(4):487–503. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22109776

114. Kawachi I, Berkman LF, editors. Neighborhoods and Health [Internet]. Oxford University Press; 2003 [cited 2019 Apr 5]. Available from: http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780195138382.001.0001/acprof-9780195138382

115. Voorhees CC1, Ashwood S, Evenson KR, Sirard JR, Rung AL, Dowda M MT. Neighborhood Design and Perceptions. Med Sci Sport Exerc [Internet]. 2010 Jul [cited 2018 Aug 16];42(7):1253–60. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20019628

116. Wilson K, Coen SE, Piaskoski A, Gilliland JA. Children's perspectives on neighbourhood barriers and enablers to active school travel: A participatory mapping study. Can Geogr / Le Géographe Can [Internet]. 2019 Mar 1 [cited 2019 Apr 5];63(1):112–28. Available from: http://doi.wiley.com/10.1111/cag.12488

117. Boone-Heinonen J, Casanova K, Richardson AS, Gordon-Larsen P. Where can they play? Outdoor spaces and physical activity among adolescents in U.S. urbanized areas. Prev Med (Baltim) [Internet]. 2010 [cited 2018 Oct 11];51(3–4):295–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20655948

118. Eichinger M, Schneider S, De Bock F. Subjectively and objectively assessed social and physical environmental correlates of preschoolers' accelerometer-based physical activity. Int J Behav Nutr Phys Act [Internet]. 2017 Dec 6 [cited 2019 Apr 5];14(1):153. Available from: http://ijbnpa.biomedcentral.com/articles/10.1186/s12966-017-0577-9

119. Uys M, Broyles ST, Draper CE, Hendricks S, Rae D, Naidoo N, et al. Perceived and objective neighborhood support for outside of school physical activity in South African children. BMC Public Health [Internet]. 2016 Dec 1 [cited 2019 Apr 5];16(1):462. Available from: http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-2860-0

120. Brownson RC, Hoehner CM, Day K, Forsyth A, Sallis JF. Measuring the Built Environment for Physical Activity. State of the Science [Internet]. Vol. 36, American Journal of Preventive Medicine. NIH Public Access; 2009 [cited 2018 Aug 16]. p. S99–123.e12. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19285216
121. Budd EL, Aaron Hipp J, Geary N, Dodson EA. Racial differences in parental perceptions of the neighborhood as predictors of children's physical activity and sedentary behavior. Prev Med reports [Internet]. 2015 [cited 2019 Apr 5];2:397–402. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26844096
122. Carver A, Timperio A, Hesketh K, Crawford D. Are Safety-Related Features of the Road Environment Associated with Smaller Declines in Physical Activity among Youth? J Urban Heal [Internet]. 2010 Jan 1 [cited 2019 Apr 5];87(1):29–43. Available from: http://link.springer.com/10.1007/s11524-009-9402-3
123. Hillman M, Adams J, Whitelegg J. ONE FALSE MOVE... A Study of Children's Independent Mobility [Internet]. 1990 [cited 2019 Apr 5]. Available from: http://john-adams.co.uk/wp-content/uploads/2007/11/one false move.pdf
124. Veitch J, Salmon J, Ball K. Individual, social and physical environmental correlates of children's active free-play: a cross-sectional study. Int J Behav Nutr Phys Act [Internet]. 2010 Feb 2 [cited 2019 Apr 5];7(1):11. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20181061
125. De Vries SI, Bakker I, Van Mechelen W, Hopman-Rock M. Determinants of activity-friendly neighborhoods for children: Results from the SPACE study. Am J Heal Promot [Internet]. 2007 Mar 28 [cited 2019 Apr 5];21(4 SUPPL.):312–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17465176
126. Wilk P, Clark AF, Maltby A, Smith C, Tucker P, Gilliland JA. Examining individual, interpersonal, and environmental influences on children's physical activity levels. SSM - Popul Heal [Internet]. 2018 [cited 2019 Apr 5];4:76–85. Available from: https://doi.org/10.1016/j.ssmph.2017.11.004
127. Mendonça G, Cheng LA, Mélo EN, De Farias Júnior JC. Physical activity and social support in adolescents: A systematic review [Internet]. Vol. 29, Health Education Research. Narnia; 2014 [cited 2019 Apr 5]. p. 822–39. Available from: https://academic.oup.com/her/article-lookup/doi/10.1093/her/cyu017

128. Carver A, Salmon J, Campbell K, Baur L, Garnett S, Crawford D. How Do Perceptions of Local Neighborhood Relate to Adolescents' Walking and Cycling? Am J Heal Promot [Internet]. 2005 Nov 25 [cited 2019 Apr 5];20(2):139–47. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16295706
129. Santos MP, Page AS, Cooper AR, Ribeiro JC, Mota J. Perceptions of the built environment in relation to physical activity in Portuguese adolescents. Health Place [Internet]. 2009 Jun 1 [cited 2019 Apr 5];15(2):548–52. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1353829208001056
130. Franzini L, Elliott MN, Cuccaro P, Schuster M, Gilliland MJ, Grunbaum JA, et al. Influences of physical and social neighborhood environments on children's physical activity and obesity. Am J Public Health [Internet]. 2009 Feb [cited 2019 Apr 5];99(2):271–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19059864
131. Katzmarzyk PT, Tremblay MS. Limitations of Canada's physical activity data: implications for monitoring trends. Can J Public Health [Internet]. 2007 [cited 2019 Apr 5];98 Suppl 2:S185-94. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18213948
132. Smith AL, Biddle S. Youth physical activity and sedentary behavior : challenges and solutions. Human Kinetics; 2008. 491 p.
133. Trost SG. State of the Art Reviews: Measurement of Physical Activity in Children and Adolescents. Am J Lifestyle Med [Internet]. 2007 Jul 12 [cited 2019 Apr 5];1(4):299–314. Available from: http://journals.sagepub.com/doi/10.1177/1559827607301686
134. Ainsworth BE, Haskell WL, Leon AS, Jacobs DR, Montoye HJ, Sallis JF, et al. Compendium of physical activities: classification of energy costs of human physical activities. Med Sci Sports Exerc [Internet]. 1993 Jan [cited 2019 Apr 7];25(1):71–80. Available from: http://www.ncbi.nlm.nih.gov/pubmed/8292105
135. CDC. General Physical Activities Defined by Level of Intensity. CDC ACSM Guidel [Internet]. 2000 [cited 2019 Apr 7];71–80. Available from: https://www.cdc.gov/nccdphp/dnpa/physical/pdf/PA_Intensity_table_2_1.pdf
136. Morris C, Boulding KE. The Image: Knowledge in Life and Society. Am Sociol Rev. 2006;22(1):112.
137. Ma L, Cao J. How perceptions mediate the effects of the built environment on travel behavior? Transportation (Amst) [Internet]. 2019 Feb 19 [cited 2019 Apr 5];46(1):175–97.

Available from: http://link.springer.com/10.1007/s11116-017-9800-4

138. Orstad SL, McDonough MH, Stapleton S, Altincekic C, Troped PJ. A Systematic Review of Agreement Between Perceived and Objective Neighborhood Environment Measures and Associations With Physical Activity Outcomes. Environ Behav [Internet]. 2017 Oct 29 [cited 2019 Apr 5];49(8):904–32. Available from: http://journals.sagepub.com/doi/10.1177/0013916516670982

139. Gebel K, Bauman AE, Sugiyama T, Owen N. Mismatch between perceived and objectively assessed neighborhood walkability attributes: Prospective relationships with walking and weight gain. Heal Place [Internet]. 2011 Mar 1 [cited 2019 Apr 5];17(2):519–24. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1353829210001863?via%3Dihub

140. Boehmer TK, Hoehner CM, Wyrwich KW, Ramirez LKB, Brownson RC. Correspondence between Perceived and Observed Measures of Neighborhood Environmental Supports for Physical Activity. J Phys Act Heal [Internet]. 2006 Jan 1 [cited 2019 Apr 5];3(1):22–36. Available from: http://journals.humankinetics.com/doi/10.1123/jpah.3.1.22

141. Ball K, Jeffery RW, Crawford DA, Roberts RJ, Salmon J, Timperio AF. Mismatch between perceived and objective measures of physical activity environments. Prev Med (Baltim) [Internet]. 2008 Sep [cited 2019 Apr 5];47(3):294–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18544463

142. Macintyre S, Macdonald L, Ellaway A. Lack of agreement between measured and self-reported distance from public green parks in Glasgow, Scotland. Int J Behav Nutr Phys Act [Internet]. 2008 May 4 [cited 2019 Apr 5];5(1):26. Available from: http://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-5-26

143. Lackey KJ, Kaczynski AT. Correspondence of perceived vs. objective proximity to parks and their relationship to park-based physical activity. Int J Behav Nutr Phys Act [Internet]. 2009 Aug 11 [cited 2019 Apr 5];6(1):53. Available from: http://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-6-53

144. McGinn AP, Evenson KR, Herring AH, Huston SL, Rodriguez DA. Exploring associations between physical activity and perceived and objective measures of the built environment. J Urban Health [Internet]. 2007 Mar [cited 2019 Apr 5];84(2):162–84.

Available from: http://www.ncbi.nlm.nih.gov/pubmed/17273926

145. McCormack GR, Cerin E, Leslie E, Du Toit L, Owen N. Objective Versus Perceived Walking Distances to Destinations. Environ Behav [Internet]. 2008 May 2 [cited 2019 Apr 5];40(3):401–25. Available from: http://journals.sagepub.com/doi/10.1177/0013916507300560

146. McCormack GR, Cerin E, Leslie E, Du Toit L, Owen N. Objective Versus Perceived Walking Distances to Destinations. Environ Behav [Internet]. 2007 May 2 [cited 2019 Apr 5];40(3):401–25. Available from: http://journals.sagepub.com/doi/10.1177/0013916507300560

147. Kweon B-S, Ellis CD, Lee S-W, Rogers GO. Large-Scale Environmental Knowledge. Environ Behav [Internet]. 2006 Jan 26 [cited 2019 Apr 5];38(1):72–91. Available from: http://journals.sagepub.com/doi/10.1177/0013916505280092

148. Tilt JH, Unfried TM, Roca B. Using Objective and Subjective Measures of Neighborhood Greenness and Accessible Destinations for Understanding Walking Trips and BMI in Seattle, Washington. Am J Heal Promot [Internet]. 2007 Mar 28 [cited 2019 Apr 5];21(4_suppl):371–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17465183

149. Jilcott SB, Evenson KR, Laraia BA, Ammerman AS. Association between physical activity and proximity to physical activity resources among low-income, midlife women. Prev Chronic Dis [Internet]. 2007 Jan [cited 2019 Apr 5];4(1):A04. Available from: http://www.ncbi.nlm.nih.gov/pubmed/17173712

150. Johnston RJ (Ronald J, Gregory D, Smith DM (David M. The Dictionary of human geography. Blackwell Reference; 1994. 724 p.

151. Buchan DS, Ollis S, Thomas NE, Baker JS. Physical activity behaviour: an overview of current and emergent theoretical practices. J Obes [Internet]. 2012 [cited 2019 Apr 3];2012:546459. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22778918

152. Kearns R, Moon G. From medical to health geography: Novelty, place and theory after a decade of change. Prog Hum Geogr [Internet]. 2002 [cited 2019 Apr 3];26(5):605–25. Available from: https://pdfs.semanticscholar.org/f6f1/d89d45812ff7000f4badb6903a80fa2482a5.pdf

153. Spence JC, Lee RE. Toward a comprehensive model of physical activity. Psychol Sport Exerc [Internet]. 2003 Jan 1 [cited 2019 Apr 3];4(1):7–24. Available from:

https://www.sciencedirect.com/science/article/pii/S1469029202000146

154. van Loon J, Frank LD, Nettlefold L, Naylor P-J. Youth physical activity and the neighbourhood environment: Examining correlates and the role of neighbourhood definition. Soc Sci Med [Internet]. 2014 Mar [cited 2018 May 23];104:107–15. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24581068

155. Alfonzo MA. To walk or not to walk? The hierarchy of walking needs. Environ Behav [Internet]. 2005 Nov 26 [cited 2019 Apr 3];37(6):808–36. Available from: http://journals.sagepub.com/doi/10.1177/0013916504274016

156. City of Saskatoon Neighbourhood Profiles [Internet]. 2017 [cited 2019 Apr 5]. Available from: https://www.saskatoon.ca/sites/default/files/documents/community-services/planning-development/research/neighbourhood-profiles/nbhd_profiles_2017_final_reduced.pdf

157. Katapally TR, Rainham D, Muhajarine N. Factoring in weather variation to capture the influence of urban design and built environment on globally recommended levels of moderate to vigorous physical activity in children. BMJ Open [Internet]. 2015 Nov 30 [cited 2019 Apr 5];5(11):e009045. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26621516

158. Katapally T, Muhajarine N. Capturing the Interrelationship between Objectively Measured Physical Activity and Sedentary Behaviour in Children in the Context of Diverse Environmental Exposures. Int J Environ Res Public Health [Internet]. 2015 Sep 7 [cited 2019 Apr 5];12(9):10995–1011. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26371015

159. Gauvin L, Richard L, Craig CL, Spivock M, Riva M, Forster M, et al. From walkability to active living potential: An "ecometric" validation study. Am J Prev Med [Internet]. 2005 Feb 1 [cited 2019 Apr 5];28(2):126–33. Available from: https://www.sciencedirect.com/science/article/pii/S0749379704003095

160. Craig CL, Brownson RC, Cragg SE, Dunn AL. Exploring the effect of the environment on physical activity: a study examining walking to work. Am J Prev Med [Internet]. 2002 Aug [cited 2019 Apr 5];23(2 Suppl):36–43. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12133736

161. Day K, Boarnet M, Alfonzo M, Forsyth A. The Irvine–Minnesota Inventory to Measure

Built Environments. Am J Prev Med [Internet]. 2006 Feb [cited 2019 Apr 5];30(2):144–52. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16459213

162. Fuller DL, Muhajarine N. Replication of the Neighborhood Active Living Potential Measure in Saskatoon, Canada. Am J Prev Med [Internet]. 2010 Oct 1 [cited 2019 Apr 5];39(4):364–7. Available from: https://www.sciencedirect.com/science/article/pii/S0749379710003880
163. Romanzini M, Petroski EL, Ohara D, Dourado AC, Reichert FF. Calibration of ActiGraph GT3X, Actical and RT3 accelerometers in adolescents. Eur J Sport Sci [Internet]. 2014 Jan 2 [cited 2019 Jul 3];14(1):91–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24533499
164. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, Mcdowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc [Internet]. 2008 Jan [cited 2019 Apr 5];40(1):181–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18091006
165. Colley R, Connor Gorber S, Tremblay MS. Quality control and data reduction procedures for accelerometry-derived measures of physical activity. Heal reports [Internet]. 2010 Mar [cited 2019 Apr 5];21(1):63–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20426228
166. Centers for Disease Control and Prevention. Physical Activity Basics | Physical Activity | CDC [Internet]. 2018 [cited 2019 Apr 5]. Available from: https://www.cdc.gov/physicalactivity/basics/index.htm?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fphysicalactivity%2Fbasics%2Fmeasuring%2Findex.html
167. Katapally T. Advancing active living research in children_addressing active living measurement and evaluation while investigating the influence of diverse environmental exposures on physical activity and sedentary behavior. 2014 [cited 2019 Apr 5];44(May):8725. Available from: https://harvest.usask.ca/handle/10388/8136
168. Children and Youth 5-17 years - CSEP | SCPE : CSEP | SCPE [Internet]. [cited 2019 Apr 5]. Available from: https://csepguidelines.ca/children-and-youth-5-17/
169. Canadian Society of Exercise Physiology. Canadian Physical Activity Guidelines [Internet]. 2014 [cited 2019 Apr 7]. 1-43 p. Available from: www.csep.ca/guidelines
170. Davison K, Lawson CT. Do attributes in the physical environment influence children's

physical activity? A review of the literature. Int J Behav Nutr Phys Act [Internet]. 2006 [cited 2019 Apr 4];3(1):19. Available from: http://ijbnpa.biomedcentral.com/articles/10.1186/1479-5868-3-19

171. Timperio A, Crawford D, Telford A, Salmon J. Perceptions about the local neighborhood and walking and cycling among children. Prev Med (Baltim) [Internet]. 2004 Jan [cited 2018 Aug 16];38(1):39–47. Available from: http://www.ncbi.nlm.nih.gov/pubmed/14672640
172. Weir LA, Etelson D, Brand DA. Parents' perceptions of neighborhood safety and children's physical activity. Prev Med (Baltim) [Internet]. 2006 Sep [cited 2019 Apr 5];43(3):212–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16712912
173. Esteban-Cornejo I, Carlson JA, Conway TL, Cain KL, Saelens BE, Frank LD, et al. Parental and Adolescent Perceptions of Neighborhood Safety Related to Adolescents' Physical Activity in Their Neighborhood. Res Q Exerc Sport [Internet]. 2016 Apr 2 [cited 2019 Apr 5];87(2):191–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/27030158
174. Aarts M-J, Mathijssen JJP, van Oers JAM, Schuit AJ. Associations Between Environmental Characteristics and Active Commuting to School Among Children: a Cross-sectional Study. Int J Behav Med [Internet]. 2013 Dec 19 [cited 2019 Apr 5];20(4):538–55. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23076641
175. Mitáš J, Sas-Nowosielski K, Groffik D, Frömel K. The safety of the neighborhood environment and physical activity in Czech and Polish adolescents. Int J Environ Res Public Health [Internet]. 2018 [cited 2019 Apr 5];15(1). Available from: http://www.ncbi.nlm.nih.gov/pubmed/29329276
176. Datar A, Nicosia N, Shier V. Parent Perceptions of Neighborhood Safety and Children's Physical Activity, Sedentary Behavior, and Obesity: Evidence from a National Longitudinal Study. Am J Epidemiol [Internet]. 2013 May 15 [cited 2019 Apr 5];177(10):1065–73. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23579555
177. Pedroni C, Dujeu M, Moreau N, Lebacq T, Méroc E, Godin I, et al. Environmental correlates of physical activity among children 10 to 13 years old in Wallonia (Belgium). BMC Public Health [Internet]. 2019 Feb 13 [cited 2019 Apr 5];19(1):187. Available from: http://www.ncbi.nlm.nih.gov/pubmed/30760269

178. Perez LG, Conway TL, Arredondo EM, Elder JP, Kerr J, McKenzie TL, et al. Where and when adolescents are physically active: Neighborhood environment and psychosocial correlates and their interactions. Prev Med (Baltim) [Internet]. 2017 Dec [cited 2019 Apr 5];105:337–44. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28987342
179. McDonald S, Dowda M, Colabianchi N, Porter D, Dishman RK, Pate RR. Perceptions of the Neighborhood Environment and Children's Afterschool Moderate-to-Vigorous Physical Activity. Pediatr Exerc Sci [Internet]. 2015 May [cited 2019 Apr 4];27(2):243–51. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25679820
180. Tappe KA, Glanz K, Sallis JF, Zhou C, Saelens BE. Children's physical activity and parents' perception of the neighborhood environment: Neighborhood impact on kids study. Int J Behav Nutr Phys Act [Internet]. 2013 Mar 27 [cited 2019 Apr 5];10(1):39. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23531282
181. Mo C, Xia T, Qin K, Mo L. Natural Tendency towards Beauty in Humans: Evidence from Binocular Rivalry. PLoS One [Internet]. 2016 [cited 2019 Apr 7];11(3):e0150147. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26930202
182. McGrath LJ, Hopkins WG, Hinckson EA. Associations of Objectively Measured Built-Environment Attributes with Youth Moderate–Vigorous Physical Activity: A Systematic Review and Meta-Analysis. Sport Med [Internet]. 2015 Jun 25 [cited 2019 Apr 4];45(6):841–65. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25618013
183. Oliver M, Mavoa S, Badland H, Parker K, Donovan P, Kearns RA, et al. Associations between the neighbourhood built environment and out of school physical activity and active travel: An examination from the Kids in the City study. Health Place [Internet]. 2015 Nov 1 [cited 2019 Apr 5];36:57–64. Available from: https://www.sciencedirect.com/science/article/pii/S1353829215001240
184. Boone-Heinonen J, Guilkey DK, Evenson KR, Gordon-Larsen P. Residential self-selection bias in the estimation of built environment effects on physical activity between adolescence and young adulthood. Int J Behav Nutr Phys Act [Internet]. 2010 Oct 4 [cited 2019 Apr 5];7(1):70. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20920341
185. Ranchod YK, Roux AVD, Evenson KR, Sánchez BN, Moore K. Longitudinal associations between neighborhood recreational facilities and change in recreational physical activity in the multi-ethnic study of atherosclerosis, 2000-2007. Am J Epidemiol [Internet]. 2014

Feb 1 [cited 2019 Apr 5];179(3):335–43. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24227016

186. Sallis JF, Floyd MF, Rodríguez DA, Saelens BE. Role of Built Environments in Physical Activity, Obesity, and Cardiovascular Disease. Circulation [Internet]. 2012 Feb 7 [cited 2019 Apr 5];125(5):729–37. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22311885

187. Sallis JF, Owen N, Fotheringham MJ. Behavioral epidemiology: A systematic framework to classify phases of research on health promotion and disease prevention. Ann Behav Med [Internet]. 2000 Dec 30 [cited 2019 Apr 5];22(4):294–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/11253440

REFERNCES (GLOSSARY)

1. Chen C-K, Bruce M, Tyler L, Brown C, Garrett A, Goggins S, et al. Analysis of an Environmental Exposure Health Questionnaire in a Metropolitan Minority Population Utilizing Logistic Regression and Support Vector Machines. J Health Care Poor Underserved [Internet]. 2013 Feb [cited 2019 Apr 5];24(1A):153–71. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23395953

2. What does the term “built environment” mean? | Visual Arts and the Built Environment [Internet]. [cited 2019 Apr 5]. Available from: http://www.uwindsor.ca/vabe/25/what-does-term-“built-environment”-mean

3. Boarnet MG, Day K, Alfonzo M, Forsyth A, Oakes M. The Irvine–Minnesota Inventory to Measure Built Environments. Am J Prev Med [Internet]. 2006 Feb [cited 2019 Apr 5];30(2):153–159.e43. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16459214

4. Puyau MR, Adolph AL, Vohra FA, Zakeri I, Butte NF. Prediction of activity energy expenditure using accelerometers in children. Med Sci Sports Exerc [Internet]. 2004 Sep [cited 2019 Apr 5];36(9):1625–31. Available from: http://www.ncbi.nlm.nih.gov/pubmed/15354047

5. Jetté M, Sidney K, Blümchen G. Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. Clin Cardiol [Internet]. 1990 Aug [cited 2019 Apr 5];13(8):555–65. Available from: http://www.ncbi.nlm.nih.gov/pubmed/2204507

6. Hurkmans E, Matthys C, Bogaerts A, Scheys L, Devloo K, Seghers J. Face-to-Face Versus Mobile Versus Blended Weight Loss Program: Randomized Clinical Trial. JMIR mHealth uHealth [Internet]. 2018 Jan 11 [cited 2019 Apr 5];6(1):e14. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29326093

7. Muhajarine N, Katapally TR, Fuller D, Stanley KG, Rainham D. Longitudinal active living research to address physical inactivity and sedentary behaviour in children in transition from preadolescence to adolescence. BMC Public Health [Internet]. 2015 Dec 17 [cited 2018 May 23];15(1):495. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/25981556

8. Buck C, Tkaczick T, Pitsiladis Y, De Bourdehaudhuij I, Reisch L, Ahrens W, et al. Objective measures of the built environment and physical activity in children: from walkability to moveability. J Urban Health [Internet]. 2015 Feb [cited 2019 Apr 7];92(1):24–38. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25380722

9. NCDs | Physical activity. WHO [Internet]. 2019 [cited 2019 Apr 5]; Available from: https://www.who.int/ncds/prevention/physical-activity/en/

10. Sedentary Behaviour Research Network. Letter to the editor: standardized use of the terms "sedentary" and "sedentary behaviours". Appl Physiol Nutr Metab [Internet]. 2012 Jun [cited 2019 Apr 5];37(3):540–2. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22540258

11. Pate RR, O'Neill JR, Lobelo F. The Evolving Definition of "Sedentary" Exerc Sport Sci Rev [Internet]. 2008 Oct [cited 2019 Apr 5];36(4):173–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18815485

12. Mansoubi M, Pearson N, Clemes SA, Biddle SJ, Bodicoat DH, Tolfrey K, et al. Energy expenditure during common sitting and standing tasks: examining the 1.5 MET definition of sedentary behaviour. BMC Public Health [Internet]. 2015 Dec 29 [cited 2019 Apr 5];15(1):516. Available from: http://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-015-1851-x

Smart Cities, Healthy Kids: Seasonality and Active Saskatoon Kids (SASK) Study

Dear Parent/Guardian,

You signed a consent form allowing your child to participate in the *Smart Cities, Healthy Kids - SASK study*. Participation is voluntary and involves completing a survey (online or paper copy) and wearing an accelerometer and GPS data logger for 7 days during three seasonal data collection periods – Fall 2014, Winter 2015, Spring/Summer2015. Your child came home today wearing these devices.

As part of this study your child will need to complete this survey about physical activity. You can help your child complete the survey. There are some questions at the end of the survey for you to answer as well.

Your answers will help the SASK project learn about how kids like to stay active and what may prevent them from participating in activities. The survey will take approximately 30 minutes of your time.

Dear Student,

This is not a test and there are no right or wrong answers**.** You can choose whether or not to fill out the survey. No one will be upset or angry if you do not complete the survey.

The SASK project will keep your individual answers PRIVATE. No one from your school will see what you write. Your individual answers will not be shared with other children or teachers. Thank you for your help!

Once the survey is complete, please seal it in the envelope provided to you and return it to your homeroom teacher by «Return_By». We will pick it up from there.

If you have any questions about this study or would like to do the survey online instead, you may contact the project coordinator by email at tracy.ridalls@usask.ca or by phone at 306-966-2237. If you need help with any survey questions or if there is a problem with the survey, please email sask.survey.help@usask.ca.

MARKING INSTRUCTIONS

- **Use a pencil only.**
- **Do not use ink, ball point or felt tip pens.**
- **Erase cleanly any marks you wish to change.**

CORRECT: ■ ☑ ☒

If you would like to do this survey online, please contact Tracy Ridalls at tracy.ridalls@usask.ca or 306-966-2237.

SECTION A: ABOUT ME AND MY FAMILY

This survey is being completed by a

- ☐ Child
- ☐ Parent or guardian
- ☐ Child and parent/guardian together
- ☐ Other, please specify… _____

1. I am a

- ☐ Girl
- ☐ Boy
- ☐ Choose not to answer

2. What grade are you in?

- ☐ 5
- ☐ 6
- ☐ 7
- ☐ 8
- ☐ Choose not to answer

3. How old are you?

- ☐ 9
- ☐ 10
- ☐ 11
- ☐ 12
- ☐ 13
- ☐ 14
- ☐ 15
- ☐ Choose not to answer

4. What is the name of your school?

_____

5. What is your background? (check all that apply)

- ☐ Aboriginal (i.e., First Nations, Métis, or Inuit)
- ☐ Arab
- ☐ Black/African
- ☐ Chinese
- ☐ Filipino
- ☐ Japanese
- ☐ Korean
- ☐ Latin American
- ☐ South Asian (e.g., East Indian, Pakistani, Sri Lankan)
- ☐ Southeast Asian (e.g., Vietnamese, Cambodian, Malaysian
- ☐ West Asian (e.g., Iranian, Afghan)
- ☐ White/Caucasian
- ☐ Other, please specify… _____
- ☐ Choose not to answer

6. Who do you live with most of the time?

- ☐ Both parents (biological or adopted)
- ☐ Mother only
- ☐ Father only
- ☐ Mother part time, father part time
- ☐ Other family (grandmother, aunt, uncle, etc.)
- ☐ Group home or foster home
- ☐ Other, please specify… _____
- ☐ Choose not to answer

7. How many brothers and sisters live with you right now? (please include step siblings, half siblings and foster siblings)

- ☐ I don't have any brothers or sisters
- ☐ 0
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6 or more
- ☐ Choose not to answer

8. In general would you say your overall health is:

- ☐ Excellent
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor
- ☐ Choose not to answer

9. Is it hard for you to do physical activities (such as sports or playing outside) because of health problems (such as physical disabilities or asthma) that have lasted 6 months or longer?

- ☐ Yes
- ☐ No
- ☐ Don't know/not sure
- ☐ Choose not to answer

10. Please choose the answer that is closest to how you feel about your weight.

- ☐ I think I'm overweight (by about 5 pounds or more)
- ☐ I think I'm underweight (by about 5 pounds or more)
- ☐ I think my weight is okay
- ☐ Choose not to answer

11. In the past 7 days, have any of your family members offered to be active with you?

- ☐ Yes
- ☐ No *(skip to question 12)*
- ☐ Choose not to answer

11a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

12. In the past 7 days, has anyone driven you to a place where you can do physical activity?

- ☐ Yes
- ☐ No *(skip to question 13)*
- ☐ Choose not to answer

12a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

13. In the past 7 days, have any of your family members participated in their own sports or exercise?

- ☐ Yes
- ☐ No *(skip to question 14)*
- ☐ Choose not to answer

13a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

SECTION B: REGISTERED ACTIVITIES

These are some questions about registered activities that you may participate in. A registered activity is one that you sign up for. Many registered activities have a fee that you pay but some are free, like at your community association or through your school. Some examples of registered activities are swimming lessons, league sports like soccer or baseball, track and field club, or dance classes.

14. Did you do any registered activities in the past 7 days?

- ☐ Yes *(skip to question 15 on next page)*
- ☐ No
- ☐ Choose not to answer

14a. If no, why didn't you do any registered activities in the past 7 days?

- ☐ I was sick or injured
- ☐ My activity was cancelled
- ☐ I am not registered in any activities right now
- ☐ The weather was not good
- ☐ The activity I wanted to do was too expensive
- ☐ I was on holiday
- ☐ Other

(If you answered this question, skip to question 16)

Only answer this question if you said yes to question 14.

15. Please think about the past 7 days and write down the registered activities you participated in. Use the lists below when filling in the table. There is room to include up to seven (7) different activities.

    When answering, think about:
    - the sports or games you did (including practice/training),
    - how many times per week you did them, and
    - the usual amount of time you spent doing them each time.

Choose your registered activity and location from each of the lists below. If a registered activity that you have done or a location you have gone is not listed, please write down the name of the activity you did and/or the location that you went**.**

Registered activities:

Badminton	Dance	Gymnastics	Skiing	Tennis
Baseball	Fencing	Ice hockey	Soccer	Track and field
Basketball	Football	Martial arts	Street/floor hockey	Volleyball
Bowling	Golfing	Skating	Swimming	

Location of each activity: School, Park, Leisure centre

Name of registered activity	How many times did you do this activity in the past 7 days?	In the past 7 days, how long did you usually do this activity each time?	Where did you do this activity in the past 7 days?
Example: *Baseball*	Example: *5 times*	Example: *45 minutes*	Example: *Park*

SECTION C: NON-REGISTERED ACTIVITIES

These are some questions about the non-registered activities that you may participate in. A non-registered activity is something that you do without signing up for it. Some examples of non-registered activities might be walking to school, riding your bike with friends, or going to the public swim time at the local pool.

16. Did you do any non-registered activities in the past 7 days?

- ☐ Yes *(skip to question 17 on next page)*
- ☐ No
- ☐ Choose not to answer

16a. If no, why didn't you do any non-registered activities in the past 7 days?

- ☐ I was sick or injured
- ☐ My activity was cancelled
- ☐ No one wanted to do the activity with me
- ☐ There was no way for me to get to my activity
- ☐ The weather was not good
- ☐ I had too much homework
- ☐ I had to do chores instead
- ☐ I was on holiday
- ☐ Other

(If you answered this question, skip to question 18)

Only answer this question if you said yes to question 16.

17. Please think about the past 7 days and write down the non-registered activities you participated in. Use the lists below when filling in the table. There is room to include up to seven (7) different activities.

    When answering, think about:
    - the sports or games you did (including practice/training),
    - how many times per week you did them, and
    - the usual amount of time you spent doing them each time.

Choose your non-registered activity and location from each of the lists below. If a non-registered activity that you have done or a location you have gone is not listed, please write down the name of the activity you did and/or the location that you went.

Non-registered activities:

Baseball	Dance	Gymnastics	Running	Street hockey	Walking	Football
Basketball	Downhill skiing	Golf	Floor hockey	Swimming	Wii Fit®	Yoga
Biking outside	Skateboarding	Hacky Sac	Skiing	Trampoline	Wrestling	
Bowling	Gardening/yard work	Ice hockey	Skipping	Volleyball	Weight training	

Location of each activity: Friend's house, Home, Leisure centre, Neighbourhood, Park, School

Name of non-registered activity	How many times did you do this activity in the past 7 days?	In the past 7 days, how long did you usually do this activity each time?	Where did you do this activity in the past 7 days?
Example: *Football*	Example: *2 times*	Example: *1 hour 15 minutes*	Example: *Park*

18. In the past 7 days, have you exercised with a friend?

- ☐ Yes
- ☐ No *(skip to question 19)*
- ☐ Choose not to answer

18a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

19. In the past 7 days, have you biked to a friend's house?

- ☐ Yes
- ☐ No *(skip to question 20)*
- ☐ Choose not to answer

19a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

20. In the past 7 days, have you walked to a friend's house?

- ☐ Yes
- ☐ No *(skip to question 21)*
- ☐ Choose not to answer

20a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

21. In the past 7 days, have you walked or biked to school?

- ☐ Yes *(skip to question 21a)*
- ☐ No *(skip to question 21b)*
- ☐ Choose not to answer

21a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday *(skip to question 22)*

21b. If no, why didn't you bike or walk to school? Choose all that apply.

- ☐ School is too far from my house
- ☐ I didn't have time
- ☐ Someone drove me
- ☐ The weather wasn't good for walking or biking
- ☐ I caught the bus instead
- ☐ I was sick or injured and couldn't walk or bike
- ☐ It was not safe
- ☐ Other, please specify… _____

22. In the past 7 days, did you walk or bike to the corner/convenience store?

- ☐ Yes
- ☐ No *(skip to question 23)*
- ☐ I never go here *(skip to question 23)*
- ☐ Choose not to answer

22a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

23. In the past 7 days, did you walk or bike to the bus stop?

- ☐ Yes
- ☐ No *(skip to question 24)*
- ☐ I never go here *(skip to question 24)*
- ☐ Choose not to answer

23a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

24. In the past 7 days, did you walk or bike to the library?

- ☐ Yes
- ☐ No *(skip to question 25)*
- ☐ I never go here *(skip to question 25)*
- ☐ Choose not to answer

24a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

25. In the past 7 days, did you walk or bike to a church or place of worship?

- ☐ Yes
- ☐ No *(skip to question 26)*
- ☐ I never go here *(skip to question 26)*
- ☐ Choose not to answer

25a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

26. In the past 7 days, did you walk or bike to a family member's house?

- ☐ Yes
- ☐ No *(skip to question 27)*
- ☐ I never go here *(skip to question 27)*
- ☐ Choose not to answer

26a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

27. In the past 7 days, did you walk or bike to a restaurant?

- ☐ Yes
- ☐ No *(skip to question 28)*
- ☐ I never go here *(skip to question 28)*
- ☐ Choose not to answer

27a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

28. In the past 7 days, did you walk or bike to a shopping mall?

- ☐ Yes
- ☐ No *(skip to question 29)*
- ☐ I never go here *(skip to question 29)*
- ☐ Choose not to answer

28a. If yes, on which days? Check all that apply.

- ☐ Monday ☐ Tuesday ☐ Wednesday
- ☐ Thursday ☐ Friday ☐ Saturday
- ☐ Sunday

29. In the past 7 days, did you walk or bike to a grocery store?

- ☐ Yes
- ☐ No *(skip to question 30)*
- ☐ I never go here *(skip to question 30)*
- ☐ Choose not to answer

29a. If yes, on which days? Check all that apply.

☐ Monday ☐ Tuesday ☐ Wednesday
☐ Thursday ☐ Friday ☐ Saturday
☐ Sunday

30. In the past 7 days, did you walk or bike to an entertainment outlet (e.g. Ruckers, movie theatre, etc.)?

☐ Yes
☐ No *(skip to question 31 on next page)*
☐ I never go here *(skip to question 31 on next page)*
☐ Choose not to answer

30a. If yes, on which days? Check all that apply.

☐ Monday ☐ Tuesday ☐ Wednesday
☐ Thursday ☐ Friday ☐ Saturday
☐ Sunday

SECTION D: WHERE I GO TO DO ACTIVITIES

31. Did you go to any of the places below to do physical activity in the past 7 days? If yes, circle each place and answer all the questions in that row. The first row has been filled in as an example.

Where I went in the past 7 days	Can you walk or bike easily to this location?	How did you get to this location in the past 7 days?	How many times did you go there on a weekday in the past 7 days?	How many times did you go there last weekend?	In the past 7 days, how long were you usually active there each time?
Backyard	Yes No	*Walked*	*3 times*	*4 times*	*1 hour 30 min*
Backyard	Yes No				
Basketball court	Yes No				
Bike trails	Yes No				
Dance/gymnastics studio	Yes No				
Golf course	Yes No				
Park	Yes No				
Playing field (soccer, softball, etc.)	Yes No				
Running track	Yes No				
Skating rink/outdoor rink	Yes No				
Swimming pool	Yes No				
Tennis court	Yes No				
Walking/hiking trails	Yes No				
Other (please specify):	Yes No				
Other (please specify):	Yes No				
Other (please specify):	Yes No				

☐ I don't exercise

☐ Choose not to answer

32. Last week, how did you travel TO school each day?

	Monday	Tuesday	Wednesday	Thursday	Friday
Bike	☐	☐	☐	☐	☐
Walk	☐	☐	☐	☐	☐
School bus	☐	☐	☐	☐	☐
Taxi	☐	☐	☐	☐	☐
Carpool	☐	☐	☐	☐	☐
City bus	☐	☐	☐	☐	☐
Scooter	☐	☐	☐	☐	☐
Skateboard/long board	☐	☐	☐	☐	☐
Parent/guardian or sibling drove me	☐	☐	☐	☐	☐
I didn't go to school that day	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐

☐ Choose not to answer

33. Last week, how did you travel FROM school each day?

	Monday	Tuesday	Wednesday	Thursday	Friday
Bike	☐	☐	☐	☐	☐
Walk	☐	☐	☐	☐	☐
School bus	☐	☐	☐	☐	☐
Taxi	☐	☐	☐	☐	☐
Carpool	☐	☐	☐	☐	☐
City bus	☐	☐	☐	☐	☐
Scooter	☐	☐	☐	☐	☐
Skateboard/long board	☐	☐	☐	☐	☐
Parent/guardian or sibling drove me	☐	☐	☐	☐	☐
I didn't go to school that day	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐

☐ Choose not to answer

34. How long does it take you to walk to the closest park from your house?

☐ Less than 5 minutes
☐ 5-10 minutes
☐ 10-20 minutes
☐ More than 20 minutes
☐ There are no parks close to my home
☐ Choose not to answer

35. Which of the following things are found in your neighbourhood? Choose all that apply.

☐ Sidewalks
☐ Heavy traffic
☐ Hills
☐ Street lights
☐ Scary dogs
☐ Enjoyable scenery/parks
☐ People walking or exercising
☐ Criminal activity
☐ Choose not to answer

36. Please fill in the following chart.

Do you have any of the following items in your home, yard or apartment complex? Choose all that apply.	For the items that you checked off in the first column, how many times did you use them last week for at least 15 minutes? (e.g. 0 times, 1 time, 3 times)
☐ Backyard rink	
☐ Balls or racquets	
☐ Basketball hoop	
☐ Bicycle (for outside)	
☐ Canoe, row boat, kayak	
☐ Ice skates	
☐ Hockey nets or sticks	
☐ Play structure (swing set)	
☐ Roller blades	
☐ Sport shoes (e.g. cleats, dance shoes, running shoes)	
☐ Skis (snow or water)	
☐ Sleds	
☐ Snowboard	
☐ Stationary equipment (e.g. treadmill, bike)	
☐ Step aerobics, slide aerobics	
☐ Swimming pool	
☐ Trampoline	
☐ Weight lifting equipment	
☐ Fitness video games (e.g. Wii Fit®, Dance Dance Revolution®)	

☐ I have no equipment
☐ Choose not to answer

37. Do you have enough supplies and pieces of sports equipment (like balls, bicycles, skates) to use for physical activity at home?

☐ Yes
☐ No
☐ I'm not sure
☐ Choose not to answer

38. Do you think it's difficult to walk or jog in your neighbourhood because of things like traffic and no sidewalks?

☐ Yes
☐ No
☐ I'm not sure
☐ Choose not to answer

39. Do you think it's difficult to walk or jog in your neighbourhood because of scary dogs or people?

- ☐ Yes
- ☐ No
- ☐ I'm not sure
- ☐ Choose not to answer

40. Do you think it's difficult to cross the street in your neighbourhood during the day?

- ☐ Yes
- ☐ No
- ☐ I'm not sure
- ☐ Choose not to answer

41. Do you think there are enough playgrounds, parks, or gyms that are close to your home that you can get to easily?

- ☐ Yes
- ☐ No
- ☐ I'm not sure
- ☐ Choose not to answer

42. Do you think it's safe to walk or jog in your neighbourhood during the day?

- ☐ Yes
- ☐ No
- ☐ I'm not sure
- ☐ Choose not to answer

43. Do you think it's safe to ride your bike on the road in your neighbourhood?

- ☐ Yes
- ☐ No
- ☐ I'm not sure
- ☐ Choose not to answer

SECTION E: OTHER ACTIVITIES

44. On a typical *WEEKDAY* (Monday to Friday), how much time do you spend (from when you wake up until you go to bed) doing the following?

	None	15 min. or less	30 min.	1 hour	2 hours	3 hours	4 hours	5 hours	6 or more hours	Choose not to answer
Watching television shows or movies (Netflix, cable, DVDs or online)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Playing computer or video games (includes iPads, smartphones or other tablets)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sitting and listening to music	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sitting and talking/texting on phone	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Doing homework	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sitting and reading a book or magazine	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Playing a musical instrument	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Doing artwork or crafts	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Riding on a bus or in a car	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sitting and playing with toys (e.g. Lego, puzzles)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

45. On a typical *WEEKEND DAY* (Saturday and Sunday), how much time do you spend (from when you wake up until you go to bed) doing the following?

	None	15 min. or less	30 min.	1 hour	2 hours	3 hours	4 hours	5 hours	6 or more hours	Choose not to answer
Watching television shows or movies (Netflix, cable, DVDs or online)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Playing computer or video games (includes iPads, smartphones or other tablets)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sitting and listening to music	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sitting and talking/texting on phone	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Doing homework	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sitting and reading a book or magazine	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Playing a musical instrument	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Doing artwork or crafts	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Riding on a bus or in a car	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sitting and playing with toys (e.g. Lego, puzzles)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

SECTION F: SLEEP BEHAVIOUR

This section asks about your regular sleep patterns. Please think carefully before giving your answers and be as accurate and as specific as you can be. You may have the same answer for some questions and that is okay. Please answer for the last 7 days.

Answer the following questions like this:

e.g. What time do you usually go to bed on a school night?

8:45pm

Remember: 12am = midnight
12pm = noon (lunch time)

School nights would be nights before a day that you are going to school – usually Sunday to Thursday nights.

46. What time do you usually go to bed on a school night?

☐ Choose not to answer

47. What was the earliest time that you went to bed on a school night last week?

☐ Choose not to answer

48. What was the latest time that you went to bed on a school night last week?

☐ Choose not to answer

School days would be the days that you have school – Monday to Friday.

49. What time do you usually wake up on a school day?

☐ Choose not to answer

50. What was the earliest time that you woke up on a school day last week?

☐ Choose not to answer

51. What was the latest time that you woke up on a school day last week?

☐ Choose not to answer

Weekend or vacation nights would be nights before a day that you don't have school.

52. What time do you usually go to bed on a Friday/Saturday or vacation night?

☐ Choose not to answer

53. What was the earliest time that you went to bed on a Friday/Saturday or vacation night last week?

☐ Choose not to answer

54. What was the latest time that you went to bed on a Friday/Saturday or vacation night last week?

☐ Choose not to answer

Weekend or vacation mornings would be mornings on days that you don't have school.

55. What time do you usually wake up on a Saturday/Sunday or vacation day?

☐ Choose not to answer

56. What was the earliest time that you woke up on a Saturday/Sunday or vacation day last week?

☐ Choose not to answer

57. What was the latest time that you woke up on a Saturday/Sunday or vacation day last week?

☐ Choose not to answer

SECTION G: OTHER – Optional questions

58. What do you think your school can do to help kids your age become more physically active?

59. Can you tell us what you think would make the park closest to your house better?

SECTION H: ABOUT YOUR PARENT/GUARDIAN

This section is for your parent or guardian to complete.

These are some questions about **registered activities** that you may participate in. A registered activity is one that you sign up for. Many registered activities have a fee that you pay but some are free like at your community association. Some examples of registered activities are swimming lessons, league sports like soccer or baseball, track and field club, or dance classes.

1. Did you do any registered activities in the past 7 days?

- ☐ Yes
- ☐ No *(skip to question 3)*
- ☐ Choose not to answer

2. Please think about the last 7 days and write down the registered activities you participated in. Use the list of registered activities provided below. If a registered activity that you have done is not listed please write it down.

Registered activities:

Aerobics	Bowling	Gymnastics	Skiing	Yoga
Badminton	Dance	Ice hockey	Soccer	
Baseball	Football	Martial arts	Swimming	
Basketball	Golfing	Pilates	Tennis	

Name of Registered Activity	How many times did you do this activity in the past 7 days?	On average, how much time did you spend doing this activity each time in the past 7 days?	Did you do this activity with your child?
e.g. Pilates	*1 time*	*1 hour 30 min*	*No*

These are some questions about **non-registered activities** that you may participate in. A non-registered activity is something that you do without signing up for it. Some examples of non-registered activities might be walking to school, riding your bike, or going to the public swim time at the local pool.

3. Did you do any non-registered activities in the past 7 days?

- ☐ Yes
- ☐ No *(skip to question 5)*
- ☐ Choose not to answer

4. Please think about the last 7 days and write down the non-registered activities you participated in. Use the list of non-registered activities provided below. If a non-registered activity that you have done is not listed below, please write it down.

Non-registered activities:

Baseball	Dance	Ice hockey	Skiing (cross-country)	Treadmill	Wii Fit®
Basketball	Elliptical	Running	Skiing (downhill)	Volleyball	Yoga
Biking outside	Football	Skateboard	Street/Floor hockey	Walking	Yard work/Gardening
Bowling	Golf	Skating	Swimming	Weight training	

Name of Non-Registered Activity	How many times did you do this activity in the past 7 days?	On average, how much time did you spend doing this activity each time in the past 7 days?	Did you do this activity with your child?
e.g. Walking	*5 times*	*30 minutes*	*No*

5. What is your household annual income?

- ☐ Less than $20 000
- ☐ $20 000 to less than $40 000
- ☐ $40 000 to less than $60 000
- ☐ $60 000 to less than $80 000
- ☐ $80 000 to less than $100 000
- ☐ $100 000 to less than $150 000
- ☐ $150 000 or more
- ☐ Don't know
- ☐ Choose not to answer

This column is about Parent/Guardian 1 (parent/guardian completing the survey).

How are ***you*** related to the child participating in the study?

- ☐ Mother
- ☐ Father
- ☐ Step-mother
- ☐ Step-father
- ☐ Foster mother
- ☐ Foster father
- ☐ Other relationship (please write in below).

Example grandmother, uncle, etc.

_____

What is your job title? (example: electrician, store manager, teacher, cashier, etc.)

_____

What is the highest level of education completed?

- ☐ Less than high school
- ☐ Completed high school
- ☐ Some college/trade school (e.g. SIAST)
- ☐ Completed college/trade school (e.g. SIAST)
- ☐ Some university
- ☐ Completed university (e.g. BA, MA, PhD)
- ☐ Choose not to answer

This column is about Parent/Guardian 2 (if applicable).

How is Parent/Guardian 2 related to the child participating in the study?

- ☐ Mother
- ☐ Father
- ☐ Step-mother
- ☐ Step-father
- ☐ Foster mother
- ☐ Foster father
- ☐ Other relationship (please write in below)

Example grandmother, uncle, etc.

_____

What is Parent 2's job title? (example: electrician, store manager, teacher, cashier, etc.)

_____

What is the highest level of education completed?

- ☐ Less than high school
- ☐ Completed high school
- ☐ Some college/trade school (e.g. SIAST)
- ☐ Completed college/trade school (e.g. SIAST)
- ☐ Some university
- ☐ Completed university (e.g. BA, MA, PhD)
- ☐ Choose not to answer

Thank you for completing this survey. Please seal it in the envelope provided to you and return it to your child's homeroom teacher by «Return_By». We will pick it up from your child's school.

Neighbourhood Active Living Potential

Neighbourhood: _____

Observer: _____

Time In: _____ Time Out: _____ Date: _____

1. Number of Destinations

1	2	3	4	5	6
None	Few	Some	Adequate	Many	Very Many

Notes: _____

_____

2. Variety of Destinations

1	2	3	4	5	6
Homogenous	Mostly Homogenous	Somewhat Homogenous	Somewhat Mixed	Mixed	Highly Mixed

Notes: _____

_____

3. Inclusive of Pedestrians

1	2	3	4	5	6
Highly not Inclusive	Mostly not Inclusive	Somewhat not Inclusive	Somewhat Inclusive	Mostly Inclusive	Highly Inclusive

Notes: _____

_____

4. Exclusive of Pedestrians

1	2	3	4	5	6
Highly not exclusive	Mostly not exclusive	Somewhat not exclusive	Somewhat exclusive	Mostly exclusive	Highly exclusive

Notes: _____

_____

5. Social Dynamic – Likelihood of Interaction

1	2	3	4	5	6
Highly not likely	Mostly not likely	Somewhat not likely	Somewhat Likely	Mostly Likely	Highly Likely

Notes: _____

_____

6. Street Network Addresses Pedestrian Needs

1	2	3	4	5	6
Highly not addressed	Mostly not addressed	Somewhat not addressed	Somewhat Addressed	Mostly Addressed	Highly Addressed

Notes: _____

_____

7. Street Network Limits Pedestrians

1	2	3	4	5	6
Highly not limited	Mostly not limited	Somewhat not limited	Somewhat limited	Mostly limited	Highly Limited

Notes: _____

_____

8. Street Network Addresses Cyclist's Needs

1	2	3	4	5	6
Highly not addressed	Mostly not addressed	Somewhat not addressed	Somewhat Addressed	Mostly Addressed	Highly Addressed

Notes: _____

_____

9. Street Network Limits Cyclists

1	2	3	4	5	6
Highly not limited	Mostly not limited	Somewhat not limited	Somewhat limited	Mostly limited	Highly Limited

Notes: _____

_____

10. Transportation System Connections

1	2	3	4	5	6
Highly not connected	Mostly not connected	Somewhat not connected	Somewhat Connected	Mostly Connected	Highly Connected

Notes: _____

_____

11. Environmental Stimulus

1	2	3	4	5	6
Highly not Stimulating	Mostly not Stimulating	Somewhat not Stimulating	Somewhat Stimulating	Mostly Stimulating	Highly Stimulating

Notes: _____

_____

12. Stimulus Impact - Overwhelming

1	2	3	4	5	6
Highly not Overwhelming	Mostly not Overwhelming	Somewhat not Overwhelming	Somewhat Overwhelming	Mostly Overwhelming	Highly Overwhelming

Notes: _____

_____

13. Visual Interest

1	2	3	4	5	6
Highly not Interesting	Mostly not Interesting	Somewhat not Interesting	Somewhat Interesting	Mostly Interesting	Highly Interesting

Notes: _____

_____

14. Effort to Walk Around

1	2	3	4	5	6
Highly not Difficult	Mostly not Difficult	Somewhat not Difficult	Somewhat Difficult	Mostly Difficult	Highly Difficult

Notes: _____

_____

15. Effort to Bicycle Around

1	2	3	4	5	6
Highly not Difficult	Mostly not Difficult	Somewhat not Difficult	Somewhat Difficult	Mostly Difficult	Highly Difficult

Notes: _____

_____

16. Options for Action in Case of Physical Danger

1	2	3	4	5	6
None	Few	Some	Adequate	Many	Very Many

Notes: _____

_____

17. Perception of Safety from Crime

1	2	3	4	5	6
Highly not Threatening	Mostly not Threatening	Somewhat not Threatening	Somewhat Threatening	Mostly Threatening	Highly Threatening

Notes: _____

_____

18. Threat of Traffic to Pedestrians

1	2	3	4	5	6
Highly not Threatening	Mostly not Threatening	Somewhat not Threatening	Somewhat Threatening	Mostly Threatening	Highly Threatening

Notes: _____

_____

19. Threat of Traffic to Cyclists

1	2	3	4	5	6
Highly not Threatening	Mostly not Threatening	Somewhat not Threatening	Somewhat Threatening	Mostly Threatening	Highly Threatening

Notes: _____

_____

20. Accessibility of path/sidewalk/ walking surface for people with disabilities

1	2	3	4	5	6
Not at all Accessible	Mostly not Accessible	Somewhat not Accessible	Somewhat Accessible	Mostly Accessible	Completely Accessible

Notes: _____

_____

21. Are the crossing signals and other signs adapted for people with disabilities

1	2	3	4	5	6
Not at all Adapted	Mostly not Adapted	Somewhat not Adapted	Somewhat Adapted	Mostly Adapted	Completely Adapted

Notes: _____

_____

22. Are the surroundings adapted for people with disabilities

1	2	3	4	5	6
Not at all Adapted	Mostly not Adapted	Somewhat not Adapted	Somewhat Adapted	Mostly Adapted	Completely Adapted

Notes: _____

_____

	Segment # (insert at top of column)															
	Date															
	Time in															
	Observer															
	Neighbourhood															
	Weather	Clear =7; Mainly Sunny =6; Mainly Cloudy =5; Overcast =4; Light Rain =3; Showers =2;														
	Wind	Calm = 1; Light wind = 2; Strong wind = 3														
	If this segment is adjoining other segments, indentify which ones.															
Take pictures at the beginning of the segment																
Answer questions 1 - 6 based on this end of the segment																
1a	What street/avenue/etc. is this segment?															
1b	What is the cross street at the beginning of the segment?															
Street Crossing																
2a	Consider the places at this end of the segment that are intended for pedestrians to cross the street. Are these places marked for pedestrian crossing? If no skip to 2e.	all =2; some=1; none = 0; cul de sac = 8														
2b	What type of marking do the crosswalks have?															
	Pedestrian crossing sign	yes = 1; no = 0; NA = 8														
	White painted lines	yes = 1; no = 0; NA = 8														
	Zebra striping	yes = 1; no = 0; NA = 8														
	Raised Crosswalk	yes = 1; no = 0; NA = 8														
	Different road surface or paving (i.e. tiles,colored concrete, etc.)	yes = 1; no = 0; NA = 8														
	Illuminated overhead sign	yes = 1; no = 0; NA = 8														
	Curb bulb out	yes = 1; no = 0; NA = 8														
	Other - describe	yes = 1; no = 0; NA = 8														
2c	What is the condition of these crossings?	good = 3; fair = 2; poor = 1; none = 0														
2d	Is the sidewalk connected to the crosswalk?	all =2; some=1; none = 0; N/A = 8														
2e	Is the sidewalk connected to the road?	all =2; some=1; none = 0; N/A = 8														
3a	Are there curb cuts at all places where crossing is expected to occur?	all =2; some=1; none = 0														
3b	Are curb cuts graded for visual impairments?	all =2; some=1; none = 0; N/A = 8														
3c	In the absence of curb cuts are there nearby alleys/ driveways that could be used instead?	yes = 1; no = 0; NA = 8														
3d	What is the condition of the curb cuts?	good = 3; fair = 2; poor = 1; NA = 8														

3e	Are the curb cuts connected to the crosswalks?	all =2; some=1; none = 0; N/A = 8													
Segment # (insert at top of column)															
4a	Is this an uncontrolled intersection? If yes skip to 4c.	yes = 1; no = 0													
4b	Indicate if the following traffic/pedestrian signals/systems are present and/or functional. Mark all that apply.														
	Traffic signal	present and functional = 2; present = 1; absent = 0													
	Stop sign	present and functional = 2; present = 1; absent = 0													
	Yield sign	present and functional = 2; present = 1; absent = 0													
	Pedestrian activated signal	present and functional = 2; present = 1; absent = 0													
	Pedestrian underpass/overpass/bridge	present and functional = 2; present = 1; absent = 0													
	Number countdown	present and functional = 2; present = 1; absent = 0													
	Audio assisted signals for visual impairments	present and functional = 2; present = 1; absent = 0													
	Flashing hand	present and functional = 2; present = 1; absent = 0													
4c	How many vehicle lanes are there for cars? (including lanes intended for driving and turning).	Six or more= 6; five= 5; four = 4; three = 3; two = 2; one = 1; NA (no lanes for car travel) = 8													
5	For an individual who is on this segment how safe (traffic wise) do you think it is to cross the street from this segment?	very safe = 2; moderately safe = 1; unsafe = 0; cul de sac = 8													
6	For an individual who is on this segment how convenient (traffic wise) do you think it is to cross the street from this segment?	very convenient = 2; moderately convenient = 1; inconvenient = 0; cul de sac = 8													
Neighbourhood Identification															
7	Does the segment have banners that identify the neighbourhood?	yes = 1; no = 0													
8a	Is this segment a . . .	one way = 1; two way = 2													
8b	Is this a pedestrianized street?	yes = 1; no = 0													
9a	Is there a pedestrian refuge?	yes = 1; no = 0													
9b	Is the pedestrian refuge accessible?	yes = 1; no = 0; NA = 8													
Views															
10	If there a significant open view rate its attractiveness.	attractive = 3; neutral = 2; unattractive = 1; NA (no views) = 8													
Take a picture of the open view.															
11	What types of dwellings are present on this segment? Mark all that apply. If no dwellings skip to 12.														

	Single Family Detatched (1 unit)	yes = 1; no = 0; NA = 8													
Segment # (insert at top of column)															
	Single Family Duplex (2 units)	yes = 1; no = 0; NA = 8													
	Townhouse/condo/apartment (3+ Units)	yes = 1; no = 0; NA = 8													
	Mobile/manufactured Home	yes = 1; no = 0; NA = 8													
	Other - describe	yes = 1; no = 0; NA = 8													
12	How many buildings on this segment have front decks or balconies?	some/a lot = 2; few = 1; none = 0													
13a	How many buildings have garage doors facing the street?	some/a lot = 2; few = 1; none = 0													
13b	Are garages dominating the streetscape?	yes = 1; no = 0; NA = 8													
14	Mark off all types of public space on this area and rate their attractiveness. If none skip to 15.	yes = 1; no = 0													
	Plaza or square	attractive = 3; neutral = 2; unattractive = 1; NA = 8													
	Playground	attractive = 3; neutral = 2; unattractive = 1; NA = 8													
	Landscaped open space	attractive = 3; neutral = 2; unattractive = 1; NA = 8													
	Playing fields	attractive = 3; neutral = 2; unattractive = 1; NA = 8													
	Community garden/allotment	attractive = 3; neutral = 2; unattractive = 1; NA = 8													
	Other - describe	attractive = 3; neutral = 2; unattractive = 1; NA = 8													
15a	Are there greenbelts/trails/paths other than sidewalks connected to the segment? If no paths skip to 16.	yes = 1; no =0													
15b	Please indicate if the path/trail is . . .														
	Unsealed	yes = 1; no =0													
	Sealed	yes=1; no = 0													
	Elephant	yes = 1; no =0													
	Other - describe	yes=1; no = 0													
16	Are any of the following other elements present? Mark all that apply. If no skip to 17.	yes = 1; no = 0													
	Abandoned building/house/lot	yes=1; no = 0													
	Undeveloped land	yes = 1; no = 0													
	Agricultural land/farming	yes=1; no = 0													

	Renovation/construction	yes = 1; no = 0														
	Railway Tracks	yes=1; no = 0														
	Utility Substation	yes = 1; no = 0														
Segment # (insert at top of column)																
	Transformer Box	yes = 1; no = 0														
	Other - describe	yes=1; no = 0														
17	Are there nature features present on this segment? If no skip to 18a.	yes = 1; no = 0														
	Open Field (not playing field)	yes=1; no = 0														
	Lake/Pond	yes = 1; no = 0														
	Fountain/Reflecting Pool	yes=1; no = 0														
	Stream/River/Canal/Creek	yes = 1; no = 0														
	Forest/Woods	yes=1; no = 0														
	Other - describe	yes = 1; no = 0														
18a	Is this segment exclusively residential?	yes=1; no = 0														
18b	Are there schools? Mark all that apply. If no skip to 18c.	yes=1; no = 0														
	Elem/Middle/Junior High	yes = 1; no = 0														
	High School/ Collegiate	yes=1; no = 0														
	University/College/Institute	yes = 1; no = 0														
	Daycare/Childcare	yes=1; no = 0														
	Other - describe	yes = 1; no = 0														
18c	Are there recreational/leisure/fitness facilities? Mark all that apply. If no skip to 18d.	yes=1; no= 0														
	Gym/Fitness Center (incl yoga)	yes = 1; no = 0														
	Indoor Arena	yes=1; no= 0														
	Indoor Community Pool	yes = 1; no = 0														
	Golf course	yes=1; no= 0														
	Outdoor Community Pool	yes = 1; no = 0														

	Outdoor Hockey Arena	yes=1; no= 0													
	Other - describe	yes = 1; no = 0													
18d	Are there public/civic buildings present? Mark all that apply. If no skip to 18e.	yes=1; no= 0													
Segment # (insert at top of column)															
	Community Centre/ Civic Centre	yes = 1; no = 0													
	Library	yes=1; no= 0													
	Museum	yes = 1; no = 0													
	Auditorium/Concert Hall	yes=1; no= 0													
	Theater	yes = 1; no = 0													
	Post Office	yes=1; no= 0													
	Police Station	yes = 1; no = 0													
	Courthouse	yes=1; no= 0													
	Community Service Organizations	yes=1; no= 0													
	Firehall	yes = 1; no = 0													
	Other - describe	yes=1; no= 0													
18e	Are there any institutional uses? Mark all that apply. If no skip to 18f.	yes = 1; no = 0													
	Religious Institution	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Healthcare/Medical Clinic including dental or vision.	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Other	Six or more= 3; three to five= 2; one to two= 1; zero=0													
18f	Are there any commercial uses? Mark all that apply. If no skip to 18g.	yes=1; no= 0													
	Retail Stores	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Bank/Financial Service	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Hotel	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Car Dealership	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Gas/Service station	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Pharmacy	Six or more= 3; three to five= 2; one to two= 1; zero=0													

	Home Business	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Other	Six or more= 3; three to five= 2; one to two= 1; zero=0													
18g	Office	Six or more= 3; three to five= 2; one to two= 1; zero=0													
18h	Services	Six or more= 3; three to five= 2; one to two= 1; zero=0													
18i	Are there any industrial/manufacturing elements? If no skip to 19a.	yes = 1; no = 0													
Segment # (insert at top of column)															
	Light(paint, fabric)	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Med/Heavy industrial (chemicals, oil)	Six or more= 3; three to five= 2; one to two= 1; zero=0													
19a	Determine whether any of these distinctive retail types are present (focusing on the form of the building).														
	Big Box Shops (includes super stores or warehouse stores)	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Shopping Mall	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Stripmall/Row of shops	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Drive thru	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Vertical mixed use	Six or more= 3; three to five= 2; one to two= 1; zero=0													
19b	How many of these land uses are present on this segment?														
	Bars/Night Clubs	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Adult Uses	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Cheque Cashing Stores	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Pawn Shops	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Liquor Stores	Six or more= 3; three to five= 2; one to two= 1; zero=0													
19c	How many of the following gathering places are on this segment?														
	Bookstores	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Art or Craft Galleries	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Movie Theatre	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Games Room	Six or more= 3; three to five= 2; one to two= 1; zero=0													
	Other - describe	Six or more= 3; three to five=													

20a	Are there food outlets/stores on this segment? If no then skip to 21.	yes = 1; no = 0														
20b	Are any of the following restaurant types are present? If none skip to 20c.	yes = 1; no = 0														
	Type 1 (i.e., limited menu/preparation/fast food, McDonald's, KFC, Orange Julius)	Six or more= 3; three to five= 2; one to two= 1; zero=0														
	Type 2 (i.e., restaurants, Kelsey's, BP's)	Six or more= 3; three to five= 2; one to two= 1; zero=0														
	Type 3 (i.e., banquet facilities, hotels, buffets)	Six or more= 3; three to five= 2; one to two= 1; zero=0														
20c	How many ethnic restaurants are present?	Six or more= 3; three to five= 2; one to two= 1; zero=0														
Segment # (insert at top of column)																
20d	How many of the following specialty shop types are present? If none skip to 20e.	yes = 1; no = 0														
	Coffee Shop	Six or more= 3; three to five= 2; one to two= 1; zero=0														
	Bakery	Six or more= 3; three to five= 2; one to two= 1; zero=0														
	Butcher	Six or more= 3; three to five= 2; one to two= 1; zero=0														
	Deli	Six or more= 3; three to five= 2; one to two= 1; zero=0														
	Farmers' market	Six or more= 3; three to five= 2; one to two= 1; zero=0														
20e	Are any of the following types of stores are present? If none skip to 20f.	yes = 1; no = 0														
	Convienence Store	Six or more= 3; three to five= 2; one to two= 1; zero=0														
	Grocery Store	Six or more= 3; three to five= 2; one to two= 1; zero=0														
	Ethnic Grocery Store	Six or more= 3; three to five= 2; one to two= 1; zero=0														
	Other - describe	Six or more= 3; three to five= 2; one to two= 1; zero=0														
20f	Are there outdoor dining areas on this segment? (e.g. outdoor tables at coffee shops or plazas, cafés, etc.)	yes = 1; no = 0														
20g	How many street vendors or stalls are on this segment?	some/a lot = 2; few = 1; none = 0														
Transportation																
21a	Is there a public transportation hub or bus transit mall on this segment?	yes = 1; no = 0														
21b	How many bus stops are on this segment? If none skip to 22a.	Three of more = 3; two = 2; one=1; none = 0														
21c	How many bus routes service this segment?	Six or more= 3; three to five= 2; one to two= 1; zero=0														
21d	At the bus stop, is there a . . .															
	Bench	yes = 1; no = 0; NA = 8														

	Shelter	yes = 1; no = 0; NA = 8													
	Route Map	yes = 1; no = 0; NA = 8													
Bicycle Lanes															
22a	Are there bicycle lanes on the segment? If no skip to 23a.	yes = 1; no = 0													
22b	How are the bicycle lanes demarcated? Mark all that apply.														
	Paint	yes = 1; no = 0; NA = 8													
	Signage	yes = 1; no = 0; NA = 8													
	Other - describe	yes = 1; no = 0; NA = 8													
22c	What is the quality of the demarcation?	good = 3; fair = 2; poor = 1; NA = 8													
Segment # (insert at top of column)															
22d	Is the bike lane maintained?	yes = 1; no = 0; NA = 8													
23a	Are there bike parking facilities available on this segment?	yes = 1; no = 0													
23b	How many bikes can be parked at these facilities?	1-5 = 1; 6-15 = 2; 16+ = 3; NA = 8													
23c	How many bikes are currently parked on this segment?	0 =0; 1-5 = 1; 6-15 = 2; 16+ = 3													
23d	How safe do you feel it is for a bike to ride on this segment?	very safe = 2; pretty safe = 1; unsafe = 0;													
24	Is there a snow route on this segment?	yes = 1; no = 0													
Barriers															
25a	Are any barriers found on this segment? If no skip to 26a.	yes = 1; no = 0													
25b	Heavy traffic	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; cannot be overcome = 3													
25c	Freeway	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; cannot be overcome = 3													
25d	Railway	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; cannot be overcome = 3													
25e	Road Construction	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; cannot be overcome = 3													
25f	Other - describe	no barrier = 0; can be overcome = 1; can be somewhat overcome = 2; cannot be overcome = 3													

	Take a picture of the barrier															
Sidewalks																
26a	How many sides of the street have sidewalks?	two = 2; one = 1; none = 0														
26b	Is the sidewalk complete on one or both sides?	both = 2; one = 1; neither = 0														
26c	What is the condition or maintenance of the sidewalk?	good = 3; fair = 2; poor = 1; NA = 8														
26d	At any point along the segment do driveways, alley ways or parking lot entrances affect the quality of the sidewalks?	yes = 1; no = 0; NA =8														
26e	Is this segment universally accessible on one or both sides?	both = 2; one = 1; neither = 0														
26f	Please indicate if any of the following buffers are present.															
	Parked cars	yes = 1; no = 0														
	Grass	yes = 1; no = 0														
	Trees	yes = 1; no = 0														
Segment # (insert at top of column)																
	Landscaped buffer strip	yes = 1; no = 0														
	Paving, Bricks and/or concrete, gravel	yes = 1; no = 0														
	Other buffer - describe	yes = 1; no = 0														
Mid Block Crossing																
27a	Is there a marked mid block crossing for pedestrians? If no skip to 28.	yes = 1; no = 0														
27b	What type of marking does this crosswalk have?															
	White painted lines	yes = 1; no = 0; NA = 8														
	Zebra striping	yes = 1; no = 0; NA = 8														
	Different road surface or paving (i.e. tiles,colored concrete, etc.)	yes = 1; no = 0; NA = 8														
	Signage	yes = 1; no = 0; NA = 8														
	Overhead illuminated sign	yes = 1; no = 0; NA = 8														
	Pedestrian crossing sign	yes = 1; no = 0; NA = 8														
	Other - describe	yes = 1; no = 0; NA = 8														
Steepness																
28	How steep or hilly is this segment? Mark all that apply.	steep slope = 2; moderate slope = 1; flat or gentle slope = 0														
Sidewalk Amenities																
29a	Are there benches (not a bus stop), chairs and/or ledges for sitting on this segment?	yes = 1; no = 0														

29b	Are there public pay phones on this segment?	yes = 1; no = 0														
29c	Are there newspaper boxes on this segment?	yes = 1; no = 0														
29d	Are there mailboxes on this segment?	yes = 1; no = 0														
29e	Is there an ATM on this segment?	yes = 1; no = 0														
29f	Are there public garbage cans/recycling receptacles on this segment?	yes = 1; no = 0														
29g	Are there obvious public restrooms on this segment that are clearly open to the public?	yes = 1; no = 0														
29h	Indicate if any of these sidewalk obstructions are present. Mark all that apply. If no skip to 30a.	yes = 1; no = 0														
	Poles or signs	yes = 1; no = 0														
	Parked cars	yes = 1; no = 0														
	Greenery	yes = 1; no = 0														
	Garbage cans	yes = 1; no = 0														
	Construction/rennovation	yes = 1; no = 0														
	Street lights	yes = 1; no = 0														
	Other - describe	yes = 1; no = 0														
Street Trees																
30a	How many street trees are on this segment? (Only include trees that are on the public right of way).	some/a lot = 2; few = 1; none = 0														
Segment # (insert at top of column)																
30b	Is the sidewalk shaded by trees?	completely = 2; partially = 1; no shade = 0														
Buildings																
31a	How many storeys are most buildings on the segment?	5 or more = 3; 3-4 = 2; 1-2 = 1; heights vary, no predominant height = 0; NA = 8														
31b	Are the facades adapted to human scale?	some/a lot = 2; few = 1; none = 0														
31c	How much of this segment has blank walls or buildings with blank walls (include fences)?	some/a lot = 2; few = 1; none = 0														
32	Does at least 50% of the segment have buildings?	yes = 1; no = 0														
Parking																
33	Are there parking facilities, including parking lots, visible on this segment (do not include parking structures that are completely underground)?	yes = 1; no = 0														
34	Is there an overpass/underpass connected to this segment?	yes = 1; no = 0														
Traffic features																
35a	Is there a posted speed limit on this segment? Only include those on the segment itself.	yes = 1; no = 0														
35b	What is the posted speed?	less than 20 = 1; 20-40 = 2; more than 40 = 3; more than one speed limit posted = 4; NA = 8														
36	Are there measures on this segment that could slow down traffic? Mark all that apply. If no skip to 37a.	yes = 1; no = 0														
	School Zone sign/ playground ahead sign	yes = 1; no = 0														
	Speed bump/bump/dip	yes = 1; no = 0														

	Raised Crosswalk	yes = 1; no = 0													
	Roundabout	yes = 1; no = 0													
	Curb bulb/extensions	yes = 1; no = 0													
37a	Is there a cul-de-sac or permanent street closing on this segment?	yes = 1; no = 0													
37b	Is there a pedestrian access point or cut through point that allows pedestrians to go from one segment to another (even though vehicular traffic may not be able to)?	yes = 1; no = 0													
37c	Is there an alley?	yes = 1; no = 0													
37d	Do any of the alley or parking lot entrances pose a danger to pedestrians?	yes = 1; no = 0; NA= 8													
Other features of the segment															
38	Is there public art that is visible on this segment?	yes = 1; no = 0													
39	Are there billboards or large signs present on this segment?	yes = 1; no = 0													
Olfactory/Aural Character															
40a	Is the predominant smell unpleasant?	yes = 1; no = 0													
40b	Do you hear any of the following overwhelming sounds? If no skip to 41.														
	Planes	constant = 3; intermittent = 2; minimal = 1; none= 0													
	Trains	constant = 3; intermittent = 2; minimal = 1; none = 0													
	Automobiles	constant = 3; intermittent = 2; minimal = 1; none = 0													
Segment # (insert at top of column)															
	Sirens	constant = 3; intermittent = 2; minimal = 1; none = 0													
	Industrial	constant = 3; intermittent = 2; minimal = 1; none = 0													
Safety															
41	How many buildings on this segment have windows with bars? (proportion)	some/a lot = 2; few = 1; none = 0													
42	Are there poorly maintained buildings on this segment?	yes = 1; no = 0													
43a	How much graffiti is apparent on this segment?	some/a lot = 2; few = 1; none = 0													
43b	Are there gang signs or markers present?	yes = 1; no = 0													
Take a representative picture of the graffiti															
44a	How much litter is apparent on this segment?	some/a lot = 2; few = 1; none = 0													
44b	Are there needles or drug paraphernalia present?	yes = 1; no = 0													
45	Are there dumpsters visible on this segment?	some/a lot = 2; few = 1; none = 0													

46	Is there visible electrical wiring overhead on the segment?	yes = 1; no = 0														
Lighting																
47	Is there outdoor lighting on the segment? (Include lighting that is intended to light public paths and public spaces)	yes = 1; no = 0														
48	Please indicate if the lighting is . . .															
	Human scale	yes = 1; no = 0; NA = 8														
	Vehicle scale	yes = 1; no = 0; NA = 8														
People																
49	Are there any lurking places present on this segment?	yes = 1; no = 0														
50	How safe do you feel from crime on this segment?	very safe = 2; pretty safe = 1; unsafe = 0;														
51	Are there opportunities for passive surveillance?	some/a lot = 2; few = 1; none = 0														
Dogs																
52a	Are there any loose/unsupervised/barking dogs on this segment that seem menacing?	yes = 1; no = 0														
52b	Are there "Beware of Dog" signs present?	some/a lot = 2; few = 1; none = 0														
	Take a picture of the intersection at this end of the segment															
53	What is the cross street at the end of the segment?															
Answer questions 54-59 based on this end of the segment																
Street Crossing																
54a	Consider the places at this intersection that are intended for pedestrians to cross the street. Are these places marked for pedestrian crossing? If no skip to 54e. If cul de sac skip to 57.	all =2; some=1; none = 0; cul de sac = 8														
54b	What type of marking do the crosswalks have?															
	Pedestrian crossing sign	yes = 1; no = 0; NA = 8														
	White painted lines	yes = 1; no = 0; NA = 8														
	Zebra striping	yes = 1; no = 0; NA = 8														
	Raised Crosswalk	yes = 1; no = 0; NA = 8														
Segment # (insert at top of column)																
	Different road surface or paving (i.e. tiles,colored concrete, etc.)	yes = 1; no = 0; NA = 8														
	Illuminated overhead sign	yes = 1; no = 0; NA = 8														
	Curb bulb out	yes = 1; no = 0; NA = 8														
	Other - describe	yes = 1; no = 0; NA = 8														
54c	What is the condition of these crossings?	good = 3; fair = 2; poor = 1; none = 0														
54d	Is the sidewalk connected to the crosswalk?	all =2; some=1; none = 0; N/A = 8														
54e	Is the sidewalk connected to the road?	all =2; some=1; none = 0; N/A = 8														
55a	Are there curb cuts at all places where crossing is expected to	all =2; some=1; none = 0; N/A														

55b	Are curb cuts graded for visual impairments?	all =2; some=1; none = 0; N/A = 8													
55c	In the absence of curb cuts are there nearby alleys/driveways that could be used instead?	yes = 1; no = 0; NA = 8													
55d	What is the condition of the curb cuts?	good = 3; fair = 2; poor = 1; NA = 8													
55e	Are the curb cuts connected to the crosswalks?	all =2; some=1; none = 0; NA = 8													
56a	Is this an uncontrolled intersection? If yes skip to 56c.	yes = 1; no = 0													
56b	Indicate if the following traffic/pedestrian signals/systems are present and/or functional. Mark all that apply.														
	Traffic signal	present and functional = 2; present = 1; absent = 0													
	Stop sign	present and functional = 2; present = 1; absent = 0													
	Yield sign	present and functional = 2; present = 1; absent = 0													
	Pedestrian activated signal	present and functional = 2; present = 1; absent = 0													
	Pedestrian underpass/overpass/bridge	present and functional = 2; present = 1; absent = 0													
	Number countdown	present and functional = 2; present = 1; absent = 0													
	Audio assisted signals for visual impairments	present and functional = 2; present = 1; absent = 0													
	Flashing hand	present and functional = 2; present = 1; absent = 0													
56c	How many vehicle lanes are there for cars? (including turning lanes)	six or more = 6; five = 5; four = 4; three = 3; two = 2; one = 1; NA (no lanes for car travel) = 8													
57	For an individual who is on this segment how safe (traffic wise) do you think it is to cross the street from this segment?	very safe = 2; moderately safe = 1; unsafe = 0; cul de sac = 8													
58	For an individual who is on this segment how convenient (traffic wise) do you think it is to cross the street from this segment?	very convenient = 2; moderately convenient = 1; inconvenient = 0; cul de sac = 8													
	Time out