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An investigation of the attributes of walkable environments from the perspective of seniors in Montreal

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ABSTRACT

The objective of this paper is to investigate the attributes of walkable environments from the perspective of seniors in the Island of Montreal in Quebec, Canada. The research is based on a combination of statistical analysis of travel diary data and field work to conduct walkability audits. The approach follows a sequence of logical steps. The first step involves the estimation of a travel behavior model walking by seniors (people 65 years or older). The results of this model, in combination with cluster analysis, are used to identify sites where the model systematically under- or over-predicts walking. Subsequently, sites are targeted for walkability audits. It then becomes possible to assess the presence or absence of attributes of built environments where walking is more or less common than other factors would predict. A walkability audit of 403 street segments was used to proof the concept in this paper. The audited items were summarized in contingency tables and tested with the chi-squared test of independence to identify streetscape elements that correlate with walking for transportation.

1. Introduction

Healthy aging among Canada's 65 + senior population can reduce the economic burden faced by the country by decreasing the need for health care and long-term care needs (Laditka, 2001; Sasseville et al., 2012). A factor that improves the prospects for healthy aging is physical activity. Routine physical activity, for instance, reduces the risk of developing chronic diseases and contributes to prevent premature death (Blair et al., 2001; Blair et al., 1989; Myers et al., 2004). Although available activity guidelines have been demonstrated to be adequate to reduce health risks, inactivity among Canadian seniors is on the rise (Public Health Agency of Canada, 2010).

Physical activity behavior is influenced by numerous factors, including the physical environment (Dishman and Sallis, 1994). Past studies have identified relationships between the physical environment and physical activity among older adults (Brownson et al., 2009; Gebel et al., 2007; Heath et al., 2006; Saelens et al., 2003; Sallis, 2009). Different approaches, from complex ecological to behavior-specific models, have been used to explore this link (Handy et al., 2002; Humpel et al., 2002; King et al., 1995; Sallis et al., 1998; Stokols, 1996). Two elements stand out in the relevant literature. In terms of public health policy, walking is considered a suitable activity, and the built environment in turn is seen as an important determinant that influences walking (Owen et al., 2007; Owen et al., 2004; Sallis, 2009; Sallis and Owen, 1999; Siegel et al., 1995).

Both perceived and objective measures of built environments have been studied in earlier walkability research (Gebel et al., 2009; Gebel et al., 2011; McGinn et al., 2007; Owen et al., 2007; Owen et al., 2004). On the one hand, perceptions regarding neighborhood conditions have been studied. Available evidence indicates that perceptions, presumably by influencing behavior, can be linked to health conditions (e.g. residents who report low walkability are more likely to report poor health status) (Echeverría et al., 2008; Macleod et al., 2002). Perhaps more commonly, objective measures of the built environment are used. These are extracted from available geographic databases using geographic information systems (GIS), and include factors such as residential density, street connectivity, and land use mix (McGinn et al., 2007). A composite score is sometimes calculated based on a set of built environment features to produce a so-called walkability index (Frank et al., 2009; Leslie et al., 2007), although it has been noted that this approach is too aggregate to suggest specific policy actions (Saelens et al., 2003).

Until recently, the focus of research has been on neighborhood-scale or meso-scale attributes of built environments (Lee and Moudon, 2006; Taylor et al., 2012). However, along with neighborhood-scale built environments, street-scale features are also thought to influence the walkability of a neighborhood. This has led researchers to purposeful collection of data by means of walkability audits, a source of rich micro-level information (Araya et al., 2006; Brownson et al., 2009; Clarke et al., 2010; Griew et al., 2013; McMillan et al., 2010; Rundle et al., 2011).

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The objective of this paper is to investigate the micro-scale attributes of walkable environments from the perspective of seniors. The analysis combines the use of a modeling approach to select sites for walkability audits (Moniruzzaman et al., 2013) and fieldwork to collect information about streetscape attributes from the streets in the Island of Montreal (hereafter referred simply as Montreal).

The findings from the study provide information about the micro-scale correlates of walking behavior among seniors. The results can help planners and policy makers design initiatives to improve the walkability of urban environments.

2. Background

Interest in the street-scale features of built environments has grown at a time when physical activity is increasingly seen as an important public health issue. A challenge faced by researchers is that street-scale or micro-scale attributes are seldom collected systematically (Parmenter et al., 2008; Purciel et al., 2009). Accordingly, there have been numerous efforts to develop audit instruments to collect street-scale information. This includes school environment audit tools (Lee et al., 2013), active neighborhood audit tools (Hoehner et al., 2007), park walkability audit tools (Dills et al., 2012), neighborhood walking and cycling among children (Timperio et al., 2004), senior walkability audit tools (Michael et al., 2009), worksite walkability audit tools (Dannenberg et al., 2005), recreation facility audit tools (Cavnar et al., 2004), and rural community walkability audit tools (Brownson et al., 2004). According to Gray et al. (2012), there are over 50 different neighborhood walkability tools available. Some of these tools are very comprehensive and hence time consuming. For instance, the Walking Suitability Assessment Form (Emery et al., 2003) takes on average 30 min to audit a street segment. Other tools contain only specific walkability information and require only few minutes per segment. For instance, the Pedestrian Environment Data Scan (Clifton et al., 2007) takes only 3–5 min on average per segment.

To reduce the cost of walkability audits, past studies have used either random or systematic selection methods to select sites for walkability audits. Kelly et al. (2013) used geographically stratified sampling to select segments in two US cities. They stratified the neighborhood blocks into eight strata by two poverty classes, two race classes, and two commercial land use classes and then randomly selected 50 segments from each stratum. Griew et al. (2013) on the other hand used a weighted method to identify areas to study walkability. In their approach, a large UK town in the North West of England was first chosen and then a buffer of 800 m from the population weighted centroid of the town was created to identify neighborhoods for the audit. Finally, 25% of the 216 eligible street segments within the buffer were randomly audited both in person and using Google Street View to test reliability of their audit tool. Ben-Joseph et al. (2013) in a comparison study between on-site and three different virtual audits in Boston used participants' nearest intersection from home location to select street segments. A total of 84 segments were audited within 1000 m of 21 participants' addresses. However, it is not reported whether selection of segments was random or systematic. In another study in the US, Millstein et al. (2013) collected micro-scale environmental data based on the macro-scale walkability index that defined neighborhoods as having low or high walkability. Shortest routes were mapped from the participant's home to the nearest pre-defined destination within a quarter-mile and segments along the shortest routes were selected to conduct walkability audits. Witten et al. (2012) used a similar method to categorize neighborhoods as having low or high walkability, and then selected 48 neighborhoods for four New Zealand cities (six high and six low walkable neighborhoods in each city). Rundle et al. (2011), in a virtual walkability audit in New York City, chose 38 high-walkable face blocks, equally divided between poor ($>=20\%$ of population classified as poor) and non-poor ($<20\%$ classified as poor) census tracts where highly walkable face blocks were identified in another study using GIS measures (Neckerman et al., 2009). Clarke et al. (2010) used a secondary source, the Chicago Community Adult Health Study (Sampson et al., 2002), to identify 343 stratified neighborhood blocks. From these blocks, they selected 60. This yielded a total of 244 street segments for virtual audits and ensured full coverage of blocks across the city of Chicago. In a study to evaluate the walkability of the most frequently visited health care facility, Kwong Wah Hospital, in Hong Kong, Loo and Lam (2012) selected all major walking paths from the surrounding public transit stations to the Kwong Wah Hospital. In another study by Barnett et al. (2015) in Hong Kong, 400 m road network buffers around participants' residential blocks were used for selecting street segments for walkability audit.

As the literature above shows, a number of approaches have been implemented to select samples of street segments for walkability audits. Most approaches are descriptive and are often based on only one or two confounding factors, such as income, race, concentration of population, or walkability indices estimated from macro-scale built environmental factors. However, it is not unreasonable to anticipate that other confounding factors might be important as well. For instance, age, gender, occupation, and job density are all factors known to influence travel behavior (Cervero et al., 2009; Kitamura et al., 1997; Moniruzzaman et al., 2013; Páez et al., 2013). Selection approaches that omit these factors are likely to be biased. Nonetheless, it becomes cumbersome to draw conclusions when a large number of confounding factors are incorporated into the descriptive selection approaches. This study therefore adopts and adapts the model-based approach proposed by Moniruzzaman and Páez (2012) to select street segments. Use of a modeling approach allows the incorporation of a large number of confounding factors believed to influence walking behavior.

3. Materials and methods

A systematic approach to select sites for walkability audits was introduced by Moniruzzaman and Páez (2012). The basis of the approach is to use a model of travel behavior to predict pedestrian travel. Analysis of residual pattern of the model is conjectured to represent systematic factors that could influence walkability—including elements of the micro-scale environment. Residual pattern can be retrieved using a suitable technique. In the case of aggregated data, Moniruzzaman and Páez (2012) use the spatial filtering technique of Griffith (2004). In this paper, we demonstrate an alternative approach for the case of disaggregated data. Once residual pattern has been retrieved, it can be used to identify areas where walking is under- or over-predicted by the model, or in other words, locations where walking is more or less prevalent than the model predicts. Before describing the method in detail, we introduce our context of this paper.

3.1. Context and data

Montreal is the second most populous metropolitan area in Canada (after Toronto), and the most populous metropolitan area in the province of Quebec (Fig. 1). The percentage of seniors has been rapidly increasing in the Montreal metropolitan area. There were 204,680 people who were 65 and over in 2006 and the number increased by 64,160 in just 5 years (i.e. in 2011), giving a growth of 12.9% in the age cohort (Statistics Canada, 2012). More locally, this figure exceeded 60% in some of the census subdivisions. A study by Morency and Chapleau (2008) showed that seniors in this region were becoming geographically dispersed at a higher rate than the general population.

Data for this study were obtained from Montreal Household Travel Survey. This is a data collection program started in 1970 and periodically conducted approximately every 5 years since then. This study used the 2008 version of the database which is the ninth edition of this Origin–Destination survey program conducted for the entire metropolitan area. This is one of the largest travel diary databases in the world with a sampling proportion of 4.1%, for the ninth edition, from 3.7 million population in the area (Statistics Canada, 2012).