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Destinations matter: The association between where older adults live and their travel behavior

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Abstract

The positive effect of physical activity in the prevention and treatment of many chronic diseases and age-related disabilities, such as mobility-disability, are widely accepted. Mobility is broadly defined as the ability of individuals to move themselves within community environments. These two concepts –physical activity and mobility – are closely linked and together contribute to older adults living healthy, independent lives. Neighborhood destinations may encourage mobility, as older adults typically leave their homes to travel to specific destinations. Thus, neighborhoods with a high prevalence of destinations may provide older adults an attractive opportunity to walk, instead of drive, and thereby obtain incidental physical activity. We know surprisingly little about the specific types of destinations older adults deem relevant and even less about destinations that support the mobility of older adults with low income. Accessible neighborhood destinations may be especially important to older adults with low income as they are more likely to walk as a primary travel mode. Conversely, this population may also be at increased risk of functional impairments that negatively affect their ability to walk. As a means to fill this information gap we aimed to better understand the mobility habits of older adults with low income. Thus, our specific objectives were to: (1) describe the types of destinations older adults with low income most commonly travel to in one week; and (2) determine the association between the prevalence of neighborhood destinations and the number of transportation walking trips these individuals make (average per day). We conducted a cross-sectional study of community-dwelling older adults with low income residing within Metro Vancouver, Canada. We assessed participant travel behavior (frequency, purpose, mode, destination) using seven-day travel diaries and measured the prevalence of neighborhood destinations using the Street Smart Walk Score. We also assessed participants' sociodemographic characteristics and mobility (physical function, car access,

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confidence walking). We used a negative binomial model to determine the association between Street Smart Walk Score and number of transportation walking trips (average per day). Our sample was comprised of 150 participants (median age 74 years; 51 men) from who we acquired at least one day of travel diary data (range = 1–7 days). Participants made three trips per day (2, 5; median P_{25}, P_{75}) and travelled to six different destination types per week (5, 9; median P_{25}, P_{75}). Destinations most relevant to older adults were grocery stores, malls, and restaurants/cafés. Each 10-point increase in Street Smart Walk Score was associated with a 20% increase in the number of transportation walking trips (average per day, incidence rate ratio = 1.20, 95% CI = 1.12, 1.29). Our findings provide preliminary evidence regarding destinations that may be most relevant to older adults. They also suggest that the prevalence of these neighborhood destinations may encourage walking. As we approach a new era of healthy city benchmarks, our findings guide policy makers and developers to retrofit and develop communities that support the mobility, health, and independence of older adults.

Keywords

Destinations; Street Smart Walk Score; Older adults; Travel diaries; Walking; Built environment

1. Introduction

The world’s population is rapidly aging, with individuals aged ≥65 years projected to account for 16% of the world’s population by 2050 (United Nations Department of Economic and Social Affairs, 2011). As individuals age, health declines and the prevalence and severity of most types of disabilities increases (Brault, 2012; Statistics Canada, 2006). Mobility, broadly defined as the ability of individuals to move themselves (e.g., either independently or by using assistive devices or transportation) within community environments (Webber et al., 2010), is especially affected by age. For example, approximately 40% of American older adults aged 65 years or older experience difficulty walking, climbing stairs, or using a wheelchair, cane, crutches, or walker (Brault, 2012). Similarly, mobility limitation affects one in three Canadian older adults (Statistics Canada, 2006). Relative freedom in walking or driving is integral to healthy aging and quality of life (Satariano et al., 2012), and even a small amount of regular walking can play a key role in the maintenance of functional independence in old age (Simonsick et al., 2005). In contrast, mobility limitations are associated with decreased social participation (James et al., 2011), increased annual health care costs (Hardy et al., 2011), risk of depression (Ragland et al., 2005) and mortality (Hardy et al., 2011). Given the prevalence and consequences of mobility limitations with increased age, a better understanding of factors that support older adults’ mobility, and especially walking, is crucial to support good health in an aging population.

Older adults’ mobility is influenced by multiple levels of determinants that include environmental, financial, psychosocial, physical, and cognitive factors (Webber et al., 2010). The built environment, defined as urban design, land use, and transportation systems (Handy et al., 2002), is an important environment-level determinant of older adults’ mobility. Built environment features most consistently associated with older adults’ mobility include street connectivity and street and traffic conditions that promote pedestrian safety; destinations may also play an important role (Rosso et al., 2011). According to travel demand theory, travel is a "derived" demand, which means that individuals are typically mobile in order to reach destinations (Crane, 1996). Therefore, an understanding of destinations that are relevant to older adults is critical to the design of built environments that support older adults' mobility. Further, living in neighborhoods that are close to destinations may provide the opportunity for older adults to walk, instead of drive, and thereby obtain incidental physical activity. Some studies have found a positive association between the presence and proximity of various types of destinations and older adults' walking (Cao et al., 2010; Gauvin et al., 2012; Michael et al., 2006, 2010; Nagel et al., 2008; Nathan et al., 2012), walking for transport (Cao et al., 2010; Cerin et al., 2013; King, 2008), and physical activity (Cao et al., 2010; Cerin et al., 2013; King, 2008). However, findings regarding the specific types of destinations associated with walking are not consistent. This may be due to broad categories used to classify destinations, as well as inconsistency between studies in the specific types of destinations included in destination categories. This makes it difficult to identify which specific destinations encourage older adults' mobility. Additionally, broad categories limit the ability to translate findings into targeted changes and to specifically influence urban planning practice. Therefore, we know relatively little about the specific types of destinations relevant and deemed important to older adults.

We know even less about destinations that support the mobility of older adults with low income or where they travel to meet their day-to-day needs. This is important as a limited disposable income may affect car ownership and the ability to afford taxis or even transit. Studies show older adults with low income have a greater reliance on walking as a travel mode (Cao et al., 2010; Frank et al., 2010; Turcotte, 2012). However, individuals with low income also carry increased risk of functional impairment (Koster et al., 2006, 2005). Thus this population has greater reliance on walking but may have greater mobility challenges. Since the association between the environment and an individual is influenced by the characteristics of the individual, features of the environment, and the interaction between the characteristics of the individual and the features of the environment (Noreau and Boschen, 2010), a comprehensive understanding of the association between environment-level features such as destinations and older adults' mobility, should take into account individual-level factors that may influence the capacity for an older person to be mobile. Therefore, this paper uses travel diary data gathered by the Walk the Talk: Transforming the Built Environment to Enhance Mobility in Seniors study to measure the mobility (travel behavior) of older adults with low income. Our specific objectives are to: (1) describe the specific types of destinations that older adults most commonly travel to in a week; and (2) determine the association between the prevalence of neighborhood destinations and the number of transportation walking trips older adults make (average/day).

2. Methods

2.1. Study design

Walk the Talk: Transforming the Built Environment to Enhance Mobility in Seniors is a cross-sectional study of the association between the built environment and the mobility and health of older adults (≥65 years of age) with low income that reside in Metro Vancouver, Canada. We defined older adults with low income as older adults in receipt of a Shelter Aid for Elderly Renters (SAFER) rental subsidy through BC Housing, a provincial Crown organization. The rental subsidy is available to British Columbia residents aged ≥60 years who pay more than 30% of their gross monthly household income toward rent of their residence. Metro Vancouver comprises 21 municipalities that cover a range of urban and suburban built environments and is home to 2313,000 residents (Statistics Canada, 2012). In 2011, 13.5% of Metro Vancouver's population was aged ≥65 years (Statistics Canada, 2012). Since Metro Vancouver encompasses a large geographic area, for convenience we restricted recruitment to geographic boundaries that we considered to be feasible for our research team to travel to in order to conduct measurement sessions. The geographic boundaries were defined as an approximate 1-h drive from the study centre. We then refined the boundaries slightly to align with city boundaries. We included individuals who were current SAFER recipients and resided in our study area. We excluded individuals who self-reported that they were diagnosed with dementia; left their home to go into the community less than once in a typical week; were unable to understand or speak English; were unable to walk≥10 m with or without a mobility aid (e.g., cane, walker); and/or were unable to participate in a mobility assessment involving a 4-m walk.

Our source population consisted of 5806 households in our study area that are in receipt of SAFER, have a head of household aged ≥65 years, and a telephone number on file with BC Housing. We sampled individuals using a stratified design, randomly selecting 200 households from within strata (deciles) of Walk Score® across the study area (n_{total} = 2000) in order to achieve diversity across the built environment. Walk Score is a publicly available index that uses distance from an address to the closest destination within nine different destination categories (grocery, restaurants, shopping, coffee, banks, parks, schools, books and entertainment) to calculate the walkability of an address (www.walkscore.com). Destinations located within ≤0.25 miles of an address are assigned a full score, after which score decreases with distance; destinations >1.5 mile from an address are not factored into the Walk Score. Data sources for Walk Score include business listing from providers such as Google and Localeze; road network data and park data from Open Street Map; school data from Education.com; and public transit data from transit agencies. Walk Scores for the source population and sampled individuals ranged between 0 and 100. Upper cut points (deciles) were 100 (1), 93(2), 87(3), 78(4), 72(5), 67(6), 60(7), 52(8), 43(9), 32(10).

Recruitment took place January–February 2012. BC Housing provided contact information for individuals who met our inclusion criteria. We mailed letters to these individuals to introduce the study. We followed up with a telephone call to review the study purpose, screen for eligibility and answer any relevant questions. We made up to two attempts during the daytime to establish initial phone contact with each individual.

This study was approved by the University of British Columbia's Clinical Research Ethics Board (certificate: H10-02913). All participants provided written consent. Participants received a $20 honorarium for participation in the study.

2.2. Study measures

Participants took part in one, 2-h measurement session conducted March–May 2012. We assessed mobility outcomes, perceptions of the built environment and social environment, and individual-level determinants of mobility. We provide details of measures relevant to this paper below.

2.3. Independent variables

We used a self-report questionnaire to measure participants' sociodemographic (e.g., age, sex, marital status, living arrangement, dog ownership) and selected mobility (e.g., preferences for walking, vehicle ownership, falls history) characteristics. We obtained data on the presence of comorbidities with the Functional Comorbidity Index (FCI) (Groll et al., 2005). The FCI asks participants to indicate whether they have been diagnosed with eighteen different comorbid diseases associated with physical function (Groll et al., 2005). We calculated participants' gait speed as part of the Short Physical Performance Battery; the test measures gait speed based on the time taken to walk 4-m at usual pace (Guralnik et al., 1994). Finally, we measured participants' ambulatory confidence with the Ambulatory Self-Confidence Questionnaire (ASCQ) (Asano et al., 2007). The ASCQ measures participants' perceived self-efficacy to walk in 22 different environment situations set in the home and the community (Asano et al., 2007).

2.4. Travel behavior

We used travel diaries to prospectively gather data on trips participants made in the week following measurement. Participants were asked to record all trips, where a trip was defined as one-way travel between two destinations. Data included start location (address or intersection) and time, end location and time, destination name, trip purpose (walk, volunteer, exercise, education shopping/errands, social/entertainment, health appointment, other), travel mode (walking, bicycle, wheelchair, scooter, transit, taxi, car, "other"), and accompaniment (alone, spouse, sibling, child, friend, neighbor, volunteer, other). A research assistant entered travel diary data into Excel. We established quality of data entry by checking a random sample of 10% of the entered trips.

2.5. Destinations

We used the four-digit 2012 North American Industry Classification System (NAICS) to systematically code the names of destinations visited by participants into seventy-two destination categories (referred to as destinations from herein). The NAICS provides a framework for classification of businesses according to type of economic activity. We modified the NAICS by collapsing small and large grocery stores into a single destination and by the addition of five destinations reflective of participants' travel: private residence (other than the participants' residences); nursing/care home; park, beach, trail; neighborhood stroll (walks for exercise or pleasure that began and ended at a participant's residence); pleasure drive (trips made by car that began and ended at a participant's residence). Some NAICS destinations have non-intuitive titles, and we refer to these throughout the manuscript according to the most common type of business represented by the destination. These include [NAICS (business)]: lessor of real estate (mall); depository credit intermediation (bank); religious organization (place of worship); other information services (library); individual and family services (seniors' center); other amusement and recreation industry (recreation centers). Given our focus was on daily travel, we excluded trips with missing travel modes and trips that were for tourism-related activities [i.e. sight-seeing, travel outside of the study area (e.g., Vancouver Island)] from our analyses.

2.6. Statistical analyses

Participants' sociodemographic and mobility characteristics, overall travel behavior (frequency, purpose, travel mode, number destinations visited per week), and travel behavior (frequency, purpose) stratified by destination are summarized with median (25th and 75th percentiles) or count (percent). The denominator for frequency of travel to a given destination is participants who made >1 trip to a given destination. The variable "likes to walk outside" was measured with a five-point scale. We dichotomized this variable for our analyses given there were very few responses in categories aside from "very much like to walk outside." We present descriptive data for destinations that ≥20% of participants traveled to during the observation week.

We used a negative binomial model to determine the association between Street Smart Walk Score® (used as a proxy measure for the prevalence of neighborhood destinations) and number (counts) of transportation walking trips; the number of days that travel diary data were collected was included as an exposure variable. The Street Smart Walk Score was developed by Walk Score after the recruitment of Walk the Talk participants in 2012. We use the Street Smart Walk Score for analyses as it incorporates an updated methodology that better reflects the pedestrian-walking experience (Frank, 2013). The correlation between participants' Street Smart Walk Scores and the Walk Scores obtained at time of recruitment was $r = 0.92$. We excluded walking trips that were clearly for leisure, where we defined leisure as those trips that were going for a walk, or exercise on the trip in and of itself (e.g., neighborhood strolls, where the start and end location was the participant's house), which accounted for <10% of walking trips. We fitted three multivariable models: one that investigated the main effect of Street Smart Walk Score on number (counts) of transportation walking trips (average/day); a second model identical to the first but with variables entered into the model to control for the potential effect of age and sex; and a final model identical to the second but where we controlled for sociodemographic and mobility characteristics that had bivariate associations with the outcome at $p \leq 0.20$ (Vittinghoff et al., 2006). Bivariate analyses included *t*-tests for dichotomous data and Pearson's correlation coefficients for continuous data. We chose sociodemographic and mobility characteristic variables based on their known association with travel behavior and mobility (Brown and Flood, 2013; Moniruzzaman et al., 2013; Turcotte, 2012). In order to test the effect of the exclusion of walking trips that were clearly for leisure on our estimates of effect, we also ran sensitivity analyses with "all walking trips" as the outcome and obtained similar results, with the exception that the variable "lives alone" was not significantly associated with "all walking trips" in the fully adjusted model (data not shown). To investigate the potential effect of clustering within participants' city of residence we also ran two more models: one a model that included fixed effects for city and a model with a cluster robust variance (Cerin, 2011). The point estimates for a 10-point change in Street Smart Walk for the model with a city fixed effects was similar to our original model that did not adjust for clustering. There are problems with using these two models when there are varying cluster sizes and small sizes of clusters (as is the case in our study), and as such we have chosen to present the simplest model (without adjustment for clustering) in our paper. We considered $p<0.05$ to be statistically significant in multivariable analyses. All analyses were carried out with Stata version 13.0 (Stata Corp, TX).

3. Results

Fig. 1 represents the flow of participants into the study. One hundred and sixty one individuals participated in the study and overall study recruitment rate was 8% (161 participants/1995 mailed invitations). Ninety three percent (150/161) of participants contributed at least one day of travel diary data for analysis. Of the 11 travel diaries not included in our analysis, eight were returned blank, one was illegible, and one was excluded because a participant was not based at their home. One participant refused to fill out a travel diary due to language barriers. Participants that completed travel diaries logged trips for a median of seven days.

Table 1 shows participants' sociodemographic and mobility characteristics. Participants were 74 years old (70, 79; median P_{25}, P_{75}) approximately two-thirds were female, and 80% lived alone. Participants had few physical mobility limitations, as assessed by self-report and objective measures. Only half of participants stated that they had a vehicle at disposal. Street Smart Walk Score and ten sociodemographic and mobility characteristics were associated with number of walking trips (average/day).

Participants recorded a total of 3334 trips. Participants made three (2,5; median P_{25}, P_{75}) trips per day. Thirty-four percent of participants reported that they stayed at home on at least one day of the observation week. Most trips were made by car (41%) or by walking (38%). Public transit accounted for 17% of all trips. Only 4% of trips were made by other travel modes such as bicycle or taxi. The most common trip purpose was shopping/errands (50% of all trips), social/entertainment/eating out (24% of all trips), and exercise (15% of all trips). The remainders of trips were made to attend health appointments, for volunteer/work, or other (e.g., religious, education).

Participants made trips to six different destinations per week (5, 9; median P_{25}, P_{75}) and made 1–2 trips per week (median) to each destination that they visited. Fig. 2 displays the number of participants that made at least one trip to the most commonly visited destinations. More than 75% of participants made a trip to the grocery store and over 50% of participants made a trip to a restaurant/café and/or a mall during the week data were collected. Between 20 and 42% of participants made at least one trip to the nine other most common destinations.

The most common destinations visited for the purpose of shopping/running errands were the grocery store, mall, bank, health and personal care store, and library. The most common destinations visited for the purpose of socialization/entertainment/eating out were restaurants/cafés and private residences. The most common destinations visited for the purpose of exercise were neighborhoods, natural environments, and recreation centers. A similar proportion of participants made a trip to exercise in a natural environment such as a park or the beach, and/or around their neighborhood as made a trip to exercise in a more formal exercise setting (i.e. recreation centers). Seniors' centers were most commonly visited by older adults for the purpose of exercise as well as for the purpose of socialization/ entertainment/eating out.

Table 2 displays negative binomial models fitted to determine the association between Street Smart Walk Score (used as a proxy measure for the prevalence of neighborhood destinations) and number of transportation walking trips (average/day). There was a significant positive association between Street Smart Walk Score and number of transportation walking trips (average/day) in all three models. The final model demonstrates that for each 10 point increase in Street Smart Walk Score, the number of transportation walking trips (average/day) increased by 20% (IRR = 1.20, 95% CI = 1.12, 1.29). There was a significant positive association between number of transportation walking trips (average/ day) and liking to walk very much (IRR = 2.10, 95% CI = 1.40, 3.09) and living alone (IRR = 1.62, 95%CI = 1.05, 2.5) and a significant negative association between number of transportation walking trips (average/day) and vehicle availability (IRR = 0.56, 95% CI = 0.40, 0.77) and number of comorbidities (IRR = 0.86, 95% CI = 0.79, 0.94). Liking to walk very much [vs. 1–4 (not at liking to walk to somewhat liking to walk) on a five-point scale] increased the number of transportation walking trips (average/day) by 108% and living alone increased the number of transportation walking trips (average/day) by 62%. Having a vehicle available in the week before assessment decreased the number of transportation walking trips (average/day) by 44% and each additional comorbidity decreased the number of transportation walking trips (average/day) by 14%.

4. Discussion

We extend the literature on older adults' travel behavior through identification of the types of destinations that older adults most commonly travel to in a week and investigation of the association between the prevalence of neighborhood destinations and the frequency of older adults' walking trips. Our approach is novel in that we captured specific destinations older adults travel to, and collected these data in a population of older adults with low income. We found that the destinations most relevant to older adults with low income were grocery stores, malls, and restaurants/cafés and that the prevalence of neighborhood destinations was positively associated with the number of walking trips taken by this population.

Although low income may be a risk factor for functional limitations in older adults (Koster et al., 2006, 2005), we found that our participants reported few functional limitations, as measured by self-report and objective measures of mobility and health. Most participants (~80%) did not require a mobility aid when walking outside and participants' gait speed was 0.98 m/s (median); this is greater than the 0.8 m/s gait speed considered necessary for community ambulation (Fritz and Lusardi, 2009) but is less than the 1.2 m/s gait speed required to cross a street (Asher et al., 2012; Montufar et al., 2007). Being of low income may have affected participants' travel behavior. Half did not have access to a car, and perhaps related to this, we found a relatively high proportion of walking trips (38%).

Regionally, only 8.4% of trips are by foot for older adults (TransLink, 2010)—almost 5-fold less than in our study participants. Only 41% of participants' trips were taken by car, a stark contract with studies of older adults from the United States where almost 90% of trips were by car (Boschmann and Brady, 2013; Lynott et al., 2009). Our results concur with other studies that reported low socioeconomic status might increase the reliance of older adults on walking as a travel mode (Cao et al., 2010; Frank et al., 2010; Kemperman and Timmermans, 2009; Turcotte, 2012).

We believe this is the first study to measure specific destinations to which older adults travel with seven day travel diaries. Two other studies have reported older adults' frequency of travel to destinations (King et al., 2003; Smith, 2001) historically, over longer time periods. Smith and Sylvestre asked older adult participants to recall the *frequency* with which they made trips to a pre-determined list of eight destinations *in the past year* (banks; grocery stores; friends'/relatives' homes; pharmacies; rec centres; place of worship; volunteering/work; senior centres) (Smith, 2001). More than 90% of participants reported visiting a grocery store at least once per week; frequency of travel to the other destinations varied based on participants' person-level characteristics (sex, comorbidities, living arrangements, income) (Smith, 2001). King et al. (2003) asked about walking trips only, asking participants to recall the frequency of *walking trips* made in *the last month* to eleven destinations. More than 20% of participants reported walking to a convenience/deli/grocery store as well as the park, and 17.5% of participants reported walking to a restaurant/pub/or bar (King et al., 2003). This study provides information on destinations visited by foot, but of course it is probable that if trips made by modes other than walking were recorded by participants, the frequency of visits to each destination would change.

We found that living in neighborhoods with a greater prevalence of destinations was associated with making more transportation walking trips. This suggests that given the opportunity to travel to destinations of interest nearby, older adults may be willing to walk instead of drive to reach them. Two recent studies have found that the presence of destinations, measured in terms of destination diversity (Cerin et al., 2013; Rosso et al., 2013) and prevalence (Cerin et al., 2013), is associated with the *within*-neighborhood mobility of older adults. These analyses, like our multivariable analysis using Street Smart Walk Score, rely on composite indices of walkability categories that were not tailored to older adult populations. The destinations identified in our study provide preliminary evidence for the types of destinations that should be included in future studies of older adults' walking for transportation.

The Press-Competence model (Noreau and Boschen, 2010) posits that features of the built environment (e.g., presence of destinations) and individual-level factors (e.g., physical function, health, self-efficacy) interact to influence behavior. Similarly, the Theory of Planned Behavior (Ajzen, 1991) states that individuals' attitudes, norms, and perceived behavioral control influence whether or not individuals intend to walk and thereby influence whether or not they do walk. In our study, individual-level factors associated with making more transportation walking trips per day were: lack of vehicle access, a lower number of comorbidities, living alone, and enjoyment of walking. This highlights the importance of relevant neighborhood destinations for older adults without access to a car (such as those with low income). Municipal planners might also consider the specific needs of older adults with health disparities and older adults with unfavorable attitudes toward walking in their pedestrian planning model.

Our study has several strengths that include measurement of participants' travel behavior with travel diaries. Most studies that have investigated the association between destinations and older adults' mobility relied on participants' self-report of past travel behavior. These methodologies may be susceptible to recall bias. To the best of our knowledge, no studies have asked older adult participants to record their habitual travel behavior over the span of a week. Adherence was high; 93% (150/161) of participants filled out travel diaries for a median of seven days. We used a classification system (NAICS) common to transportation research in order to systematically classify destinations. Finally, we recruited participants who lived across a wide range of built environment settings.

Study limitations include our recruitment rate. Eight percent of the low income population who were invited to participate in our study agreed to participate. Other surveys of older adults and the built environment reported recruitment rates on the order of ~20% (Davis et al., 2011; King et al., 2011). Our focus was a lower income population that is traditionally more difficult to recruit into research studies. Reasons suggested for this greater challenge are (i) access barriers (e.g., lack of awareness, associated "out of pocket costs"), (ii) participation concerns (e.g., privacy, trust), and (iii) demographic barriers (life stresses, illiteracy) (Schnirer, 2011). The sex distribution in our sample is comparable to individuals in the sampling frame, and the age just somewhat younger (median age 74 versus 77 years old). To facilitate participation of older adults across all levels of mobility, we picked up participants by van at their door and transported them to measurement sessions. We also stratified our sampling to recruit participants across diverse built environment settings. Of note, recruitment rates were marginally lower in one lower walkability setting; however, we are unable to discern whether those who did not participate were more or less likely to walk. Another limitation of the study includes restrictions that NAICS coding presented. For example, we were unable to determine what specific destinations participants travelled to within the mall (the second most commonly visited destination in this study). This may have resulted in misclassification if trips were made to visit a specific store or office within the mall. Second, we cannot state whether trips to health and personal care stores were for medical-related purpose, as a wide variety of home and food items are now typically available at this destination. Finally, in reality a trip made to a destination may be made in order to both reach a destination, as well as for exercise. In our dataset, these trips are categorized as transportation walking.

5. Conclusion

Given the shifting demographic toward an ageing population, it is somewhat surprising how little we know about the influence of neighborhoods on older adults' mobility and their ability to live independently in their homes. Municipal planning, transportation, and parks and recreation sectors represent key partners in the development and implementation of thoughtful evidence-based neighborhood design. Our findings provide preliminary evidence that identifies destinations that may be most relevant to older adults, and suggests that the presence of neighborhood destinations may encourage walking. As we approach a new era of healthy city benchmarks, our findings might guide policy makers and developers to retrofit and develop communities that support the mobility, health, and independence of older adults. Specific suggestions include the avoidance of food deserts, as well as zoning to include more destinations that are relevant to older adults (especially grocery stores) in neighborhoods with a high proportion of older adult residents, such as assisted living sites and retirement villages. Finally, we envision that our findings might also encourage researchers to conduct longer term prospective and intervention studies to evaluate the effect of changes to the built environment on older adults' mobility.

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References

Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Processes. 1991; 50:179–211.

Asano M, Miller WC, Eng JJ. Development and psychometric properties of the ambulatory self-confidence questionnaire. Gerontology. 2007; 53:373–381. [PubMed: 17622732]

Asher L, Aresu M, Falaschetti E, Mindell J. Most older pedestrians are unable to cross the road in time: a cross-sectional study. Age Ageing. 2012; 41:690–694. [PubMed: 22695790]

Boschmann EE, Brady SA. Travel behaviors, sustainable mobility, and transit-oriented developments: a travel counts analysis of older adults in the Denver, Colorado metropolitan area. J Transp Geogr. 2013; 33:1–11.

Brault, M. Americans with Disabilities 2010: US Census Bureau. 2012. Retrieved March 31, 2014 from 〈http://www.census.gov/prod/2012pubs/p70-131.pdf〉

Brown CJ, Flood KL. Mobility limitation in the older patient: a clinical review. JAMA. 2013; 310:1168–1177. [PubMed: 24045741]

Cao X, Mokhtarian PL, Handy SL. Neighborhood design and the accessibility of the elderly: an empirical analysis in Northern California. Int J Sustainable Transp. 2010; 4:347–371.

Cerin E. Statistical approaches to testing the relationships of the built environment with resident-level physical activity behavior and health outcomes in cross-sectional studies with cluster sampling. J Plann Lit. 2011; 26:151–167.

Cerin E, Lee KY, Barnett A, Sit CH, Cheung MC, Chan WM, Johnston JM. Walking for transportation in Hong Kong Chinese urban elders: a cross-sectional study on what destinations matter and when. Int J Behav Nutr Phys Act. 2013; 10:78. [PubMed: 23782627]

Crane R. On form versus function: will the new urbanism reduce traffic, or increase it? J Plann Edu Res. 1996; 15:117–126.

Davis MG, Fox KR, Hillsdon M, Sharp DJ, Coulson JC, Thompson JL. Objectively measured physical activity in a diverse sample of older urban UK adults. Med Sci Sports Exercise. 2011; 43:647–654.

Frank, LD. Enhancing Walk Score's Ability to Predict Physical Activity and Active Transportation. 2013. Retrieved March 28, 2014 from 〈http://activelivingresearch.org/files/2013_Bike-WalkScore_Frank.pdf〉

Frank LF, Kerr J, DR, King A. Healthy aging and where you live: community design relationships with physical activity and body weight in older Americans. J Phys Act Health. 2010; 7(Sl):S82–90. [PubMed: 20440017]

Fritz S, Lusardi M. White Paper: Walking Speed: the Sixth Vital Sign. J Geriatr Phys Ther. 2009; 32(2):2–5. [PubMed: 19856629]

Gauvin L, Richard L, Kestens Y, Shatenstein B, Daniel M, Moore SD, Payette H. Living in a well-serviced urban area is associated with maintenance of frequent walking among seniors in the VoisiNuAge study. J Gerontol B: Psychol Sci Soc Sci. 2012; 67:76–88. [PubMed: 22227735]

Groll DL, To T, Bombardier C, Wright JG. The development of a comorbidity index with physical function as the outcome. J Clin Epidemiol. 2005; 58:595–602. [PubMed: 15878473]

Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Wallace RB. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994; 49:M85–94. [PubMed: 8126356]

Handy SL, Boarnet MG, Ewing R, Killingsworth RE. How the built environment affects physical activity—views from urban planning. Am J Prev Med. 2002; 23:64–73. [PubMed: 12133739]

Hardy SE, Kang Y, Studenski SA, Degenholtz HB. Ability to walk 1/4 mile predicts subsequent disability, mortality, and health care costs [Comparative Study]. J Gen Intern Med. 2011; 26:130–135. [PubMed: 20972641]

James BD, Boyle PA, Buchman AS, Bennett DA. Relation of late-life social activity with incident disability among community-dwelling older adults. J Gerontol A: Biol Sci Med Sci. 2011; 66:467–473. [PubMed: 21300745]

Kemperman A, Timmermans H. Influences of built environment on walking and cycling by latent segments of aging population. Transp Res Rec. 2009; 2134:1–9.

King AC, Sallis JF, Frank LD, Saelens BE, Cain K, Conway TL, Kerr J. Aging in neighborhoods differing in walkability and income: associations with physical activity and obesity in older adults. Soc Sci Med. 2011; 73:1525–1533. [PubMed: 21975025]

King D. Neighborhood and individual factors in activity in older adults: results from the neighborhood and senior health study. J Aging Phys Act. 2008; 16:144–170. [PubMed: 18483439]

King WC, Brach JS, Belle S, Killingsworth R, Fenton M, Kriska AM. The relationship between convenience of destinations and walking levels in older women. Am J Health Promot. 2003; 18:74–82. [PubMed: 13677965]

Koster A, Bosma H, van Groenou MIB, Kempen GIJM, Penninx BWJH, van Eijk JTHN, Deeg DJH. Explanations of socioeconomic differences in changes in physical function in older adults: results from the longitudinal aging study Amsterdam. BMC Public Health. 2006; 6:244. [PubMed: 17022819]

Koster A, Penninx BWJH, Bosma H, Kempen GIJM, Harris TB, Newman AB, Kritchevsky SB. Is there a biomedical explanation for socioeconomic differences in incident mobility limitation? J Gerontol A: Biol Sci Med Sci. 2005; 60:1022–1027. [PubMed: 16127107]

Lynott J, McAuley WJ, McCutcheon M. Getting out and about: the relationship between urban form and senior travel patterns. J House Elderly. 2009; 23:390–402.

Michael Y, Beard T, Choi D, Farquhar S, Carlson N. Measuring the influence of built neighborhood environments on walking in older adults. J Aging Phys Act. 2006; 14:302–312. [PubMed: 17090807]

Michael YL, Perdue LA, Orwoll ES, Stefanick ML, Marshall LM. Osteoporotic Fractures in Men Study G. Physical activity resources and changes in walking in a cohort of older men. Am J Public Health. 2010; 100:654–660. [PubMed: 20167887]

Moniruzzaman M, Páez A, Nurul Habib KM, Morency C. Mode use and trip length of seniors in Montreal. J Transp Geogr. 2013; 30:89–99.

Montufar J, Arango J, Porter M, Nakagawa S. Pedestrians' normal walking speed and speed when crossing a street. Transp Res Rec: J Transp Res Board. 2007; 2002:90–97.

Nagel CL, Carlson NE, Bosworth M, Michael YL. The relation between neighborhood built environment and walking activity among older adults. Am J Epidemiol. 2008; 168:461–468. [PubMed: 18567638]

Nathan A, Pereira G, Foster S, Hooper P, Saarloos D, Giles-Corti B. Access to commercial destinations within the neighbourhood and walking among Australian older adults. Int J Behav Nutr Phys Act. 2012; 9:133. [PubMed: 23164357]

Noreau L, Boschen K. Intersection of participation and environmental factors: a complex interactive process. Arch Phys Med Rehabil. 2010; 91:S44–53. [PubMed: 20801279]

Ragland DR, Satariano WA, MacLeod KE. Driving cessation and increased depressive symptoms. J Gerontol A Biol Sci Med Sci. 2005; 60:399–403. [PubMed: 15860482]

Rosso AL, Auchincloss AH, Michael YL. The urban built environment and mobility in older adults: a comprehensive review. J Aging Res. 2011:816106. [PubMed: 21766033]

Rosso AL, Grubesic TH, Auchincloss AH, Tabb LP, Michael YL. Neighborhood amenities and mobility in older adults. Am J Epidemiol. 2013; 178:761–769. [PubMed: 23666814]

Satariano WA, Guralnik JM, Jackson RJ, Marottoli RA, Phelan EA, Prohaska TR. Mobility and aging: new directions for public health action. Am J Public Health. 2012; 102:1508–1515. [PubMed: 22698013]

Schnirer, LSCH. Recruitment and Engagement of Low-income Populations: Service Provider and Research Perspectives. 2011. Retrieved March 31, 2014 from ⟨http://www.cup.ualberta.ca/wp-content/uploads/2011/07/Recruitment-and-Engagement-of-Low-Income-Populations1.pdf⟩

Simonsick EM, Guralnik JM, Volpato S, Balfour J, Fried LP. Just get out the door! Importance of walking outside the home for maintaining mobility: findings from the Women's Health and Aging Study. JAGS. 2005; 53:198–203.

Smith GS, GM. Determinants of the travel behavior of the suburban elderly. Growth Change. 2001; 32:395–412.

Statistics, Canada. Participation and Activity Limitation Survey 2006: Analytical Report. 2006. Retrieved March 31, 2014 from ⟨http://www.statcan.gc.ca/pub/89-628-x/89-628-x2007002-eng.htm⟩

Statistics, Canada. Vancouver, British Columbia (Code 933) and British Columbia (Code 59) (table). Census Profile 2011 Census Statistics Canada Catalogue no 98-316-XWE. 2012. Retrieved March 31, 2014 from ⟨http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E⟩

TransLink. TransLink's 2008 Regional Trip Diary Survey: Final Report. 2010. Retrieved March 31, 2014 from ⟨http://www.translink.ca/~/media/Documents/plans_and_projects/trip_diary/2008%20TransLink%20Trip%20Diary%20Survey%20Report.ashx⟩

Turcotte, M. Profile of Seniors' Transportation Habits. 2012. Retrieved March 31, 2014 from ⟨http://www.statcan.gc.ca/pub/11-008-x/2012001/article/11619-eng.pdf⟩

United Nations Department of Economic and Social Affairs. World Urbanization Prospects: The 2011 Revision. 2011. Retrieved September 9, 2013 from ⟨http://esa.un.org/unup/index.html⟩

Vittinghoff, E., Glidden, DV., Shiboski, SC., McCulloch, CE. Regression Methods in Biostatistics: Linear, Logistic, Survival, and Repeated Measures Models. 1. New York, NY: 2006.

Webber SC, Porter MM, Menec VH. Mobility in older adults: a comprehensive framework. Gerontologist. 2010; 50:443–450. [PubMed: 20145017]

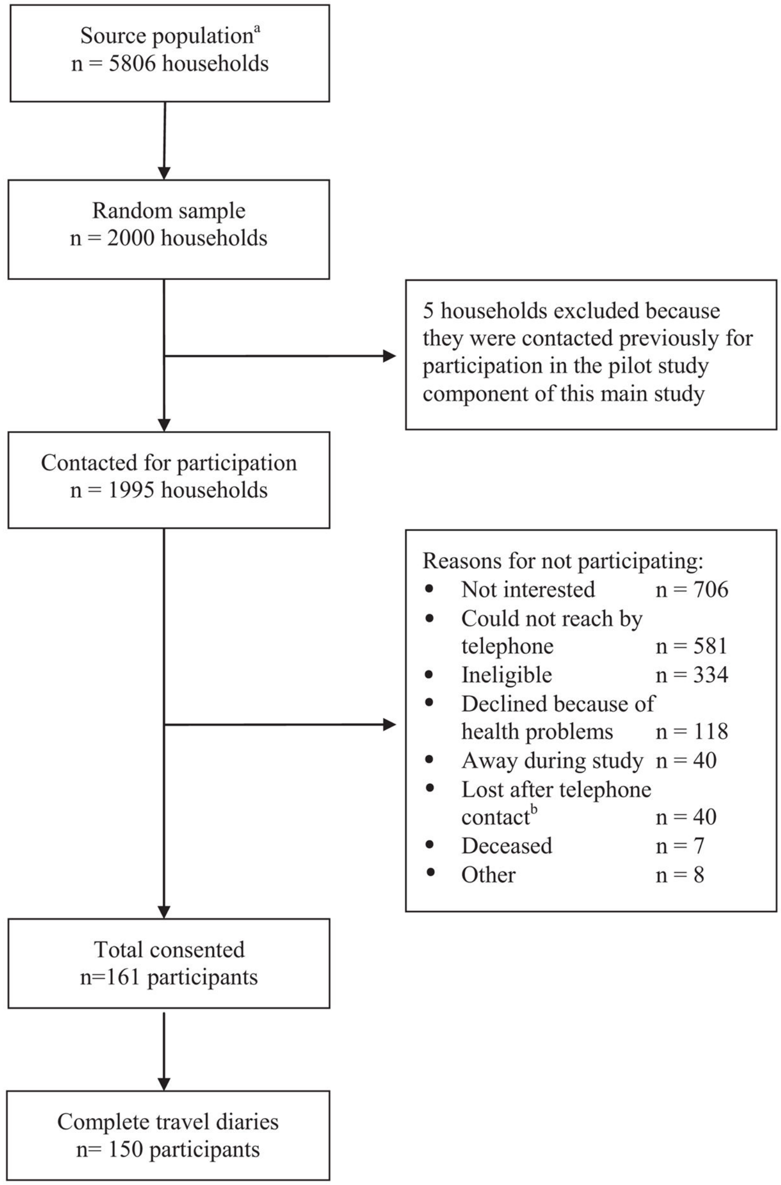

Fig. 1.

Flow of study participants, ([a]Households in our study area that receive a Shelter Aid for Elderly Renters rental subsidy from BC Housing, have a head of household aged ≥65 years, and a telephone number on file with BC Housing. [b]Could not be reached again after expression of interest in study participation).

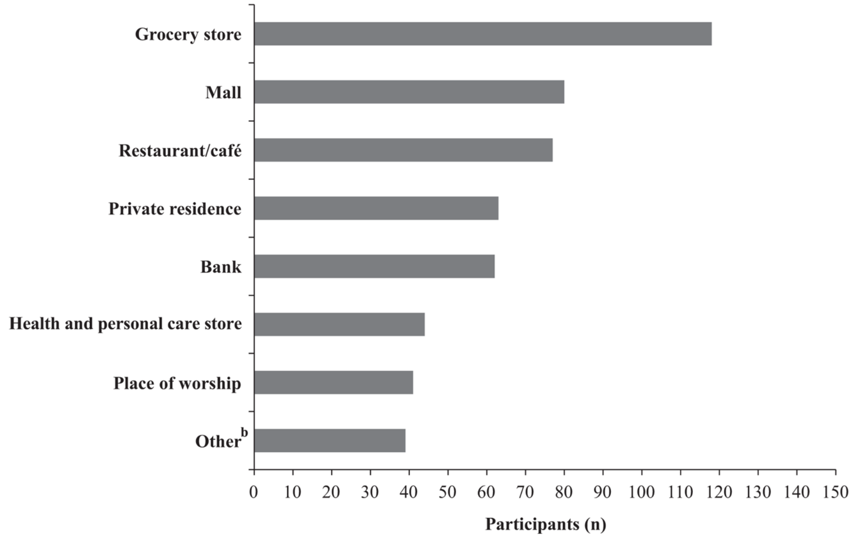

Fig. 2.
Number of participants that made >1 trip/week to most common destinations. Only the destinations that ≥20% of participants made a trip to are presented. [b]Other (*n*): library (38); neighborhood [stroll] (38); seniors' center (37); natural environment (34); recreation center (31).

Table 1

Select sociodemographic and mobility characteristics of older adults with low income (n = 150) and bivariate association between each variable and number of walking trips (average/day).

Variable	*N*	%	*p*-Value[a]
Street Smart Walk Score	150	80 (54, 92) [b]	<0.001
Age	150	74 (70, 79) [b]	0.11
Sex			0.45
Men	51	34	
Women	99	66	
Married			0.70
Yes	13	9	
No	137	91	
Living arrangement			0.11
Lives alone	121	81	
Lives with others	29	19	
Likes to walk outside			<0.001
Very much (5 on a 5-point scale)	104	69	
Less than very much (1–4 on a 5-point scale)	46	31	
Use mobility aid			<0.05
Yes	24	16	
No	126	84	
Had vehicle at disposal in last 7 days (n = 148)			<0.001
Yes	79	53	
No	69	47	
Owns a dog			0.30
Yes	15	10	
No	135	90	
Fell in previous 6 months			<0.05
Yes	31	21	
No	119	79	
Number of comorbidities[c] (n = 148)	148	3 (1,4) [b]	<0.001
Gait speed (m/s)	150	0.99 (0.83, 1.15) [b]	0.08
Community ambulator (gait speed ≥0.8 m/s)			
No	32	21	0.20
Yes	118	79	
Ambulatory confidence questionnaire	150	8.89 (7.50, 9.73) [b]	0.001

[a] Bivariate analyses included *t*-tests for dichotomous data and Pearson's correlation coefficients for continuous data.

[b] Median (P_{25}, P_{75}).

[c] Total number; measured with the Functional Comorbidity Index.

Table 2

Association between number of transport walking trips (average/day) and Street Smart Walk Score. Data are presented as unadjusted and adjusted incident rate ratios [95% confidence intervals (CI)].

	Unadjusted incidence rate ratio (95% CI) (*n* = 145)	Adjusted incidence rate ratio (95% CI)	
		Model 1 (*n* = 145)	**Model 2[a] (*n* = 141)**
Street Smart Walk Score (10-point change)	1.29 (1.19, 1.39)	1.30 (1.20, 1.40)	1.20 (1.12, 1.29)
Age (10-year change)	0.74 (0.54, 1.0)	0.66 (0.54, 0.90)	0.78 (0.58, 1.03)
Female	0.86 (0.56, 1.3)	1.00 (0.69, 1.46)	0.80 (0.54, 1.16)
Lives alone	1.54 (0.93, 2.54)	–	1.62 (1.05, 2.50)
Very much likes to walk[b]	3.20 (2.11, 4.86)	–	2.10 (1.40, 3.09)
Vehicle available	0.57 (0.39, 0.85)	–	0.56 (0.40, 0.77)
Comorbidities[c]	0.84 (0.77, 0.93)	–	0.86 (0.79, 0.94)

[a] Only present variables that are significant at $p<0.05$.

[b] 5 (very much likes to walk) vs. 1–4 (not at all liking to walk to somewhat liking to walk) on a 5-point scale.

[c] Total number; measured with the Functional Comorbidity Index.