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The Influence of Walkability on Broader Mobility for Canadian Middle Aged and Older Adults: an examination of Walk Score™ and the Mobility Over Varied Environments Scale (MOVES)

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Abstract

Neighborhood built environments may play an important role in shaping mobility and subsequent health outcomes. However, little work includes broader mobility considerations such as cognitive ability to be mobile, social connections with community, or transportation choices. We used a population-based sample of Canadian middle aged and older adults (aged 45 and older) from the Canadian Community Health Survey-Healthy Aging (CCHS-HA, 2008–2009) to create a holistic mobility measure: Mobility over Varied Environments Scale (MOVES). Data from CCHS-HA respondents from British Columbia with MOVES were linked with Street Smart Walk Score™ data by postal code (n=2,046). Mean MOVES was estimated across sociodemographic and health characteristics. Linear regression, adjusted for relevant covariates, was used to estimate the association between Street Smart Walk Score™ and the MOVES. The mean MOVES was 30.67 (95% confidence interval (CI) 30.36, 30.99), 5th percentile 23.27 (CI 22.16, 24.38) and 95th percentile was 36.93 (CI 35.98, 37.87). MOVES was higher for those who were younger, married, higher socioeconomic status, and had better health. In unadjusted models, for every 10 point increase in Street Smart Walk Score™, MOVES increased 4.84 points (CI 4.52, 5.15). However, results attenuated after adjustment for sociodemographic covariates: each 10 point increase in Street Smart Walk Score™ was associated with a 0.10 (CI 0.00, 0.20) point increase in MOVES.

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Conflict of Interest:

The authors have no conflicts of interest to report.

The modest but important link we observed between walkability and mobility highlights the implication of neighborhood design on the health of middle aged and older adults.

Keywords

Environment Design; Mobility Limitation; Residence Characteristics; Social Environment; Walking

Selected Classifications

60.030 environmental factors; 61.030 observational studies; 70.060 healthy behavior and well-being; 100.060 behavioral risk factors; 100.170 physical activity and health; 170 older adults; 190.070 walking; 200.030 epidemiology; 210.180 older adults; elderly; 290.030 social environment influences; 290.040 social relationships and support

Introduction

In North America the population 65 years and older is expected to rise from 12.8% in 2008 to 20.8% in 2040 (1). This underscores the imperative to develop strategies facilitating later life health and mobility. Mobility has been defined as the ability to move oneself (either independently or using assistive devices or transportation) within environments that expand from one's home to the neighborhood and to regions beyond (2). By this definition mobility is multi-dimensional and fully immersed in social and community engagement, transportation, and cognition (2, 3). Mobility is also intimately linked to health status and quality of life (4–6), thus, consequences of restricted physical functioning and social participation are dire. Specifically, impaired mobility precedes physical disability (7) and is associated with falling, loss of independence or social engagement (8, 9), institutionalization, and death (7, 10–13). Thus, focusing on predictors across multiple dimensions of mobility is critical to enhance health of older adults as they command a greater proportion of the population in decades to come.

Parallel trends in urbanization suggest by 2030 87% of North Americans will live in urban areas (14). These concurrent processes set the stage to examine neighborhood environment features that influence health and mobility of older adults. Thus, environments where individuals live, work, and play form the context where health behaviors and outcomes are developed and manifest (15). As physical function declines, older adults spend more time in their residential neighborhoods and become more responsive and sensitive to neighborhood environments. Specifically, aspects of the physical environment (e.g. streets and buildings), walkability (walking access to destinations, sometimes measured by Walk ScoreTM (16, 17)), and access to transportation may play a key role in older adults' ability to maintain their physical (18–23), cognitive (24–27), social (8, 9), and transportation-related mobility (28, 29). Thus, it is befitting that advocacy groups and policy makers focus on the role that neighborhoods might play to maintain independence and mobility of older adults (30, 31).

Emerging research documents the important role of neighborhood built environments on older adult mobility (15, 21, 32–36). However, limited studies on the impact of

environments on physical, mental health, and function include older adults (18, 37). Further, no previous work examined multiple dimensions of mobility. We recently developed a holistic score (Mobility Over Varied Environments Scale, MOVES) that combines various mobility domains (38). Specifically, MOVES was designed to capture neighborhood built environment predictors across multiple dimensions of mobility. Thus, MOVES transcends measuring physical function to also assess cognitive ability to be mobile, social connections with community and transportation choices. Therefore, as a next step we aim to apply this index to more comprehensively examine the role that neighborhoods play in shaping older adult mobility.

Our specific objectives are twofold: 1. To comprehensively describe the mobility of older adults in British Columbia using the MOVES; 2. To examine the association between neighborhood walkability (measured by a composite, commercial measure, Walk ScoreTM) and MOVES as a means to explore how neighborhood built environments might facilitate this type of holistic mobility. We hypothesize that individuals living in areas with higher walkability scores have higher mobility, due to increased proximity and access to destinations, social engagement opportunities, and alternative modes of transportation.

Methods

Sample

We drew our sample of middle-aged and older adults from the Canadian Community Health Survey-Healthy Aging (CCHS-HA). CCHS-HA is a cross-sectional survey (n=30,865) that collected information related to health status, care utilization, and determinants for the population living in 10 Canadian provinces (Canadian territories were excluded). Details can be found elsewhere (39). Briefly, the Healthy Aging component of CCHS-HA was conducted from December 2008 through November 2009, surveyed people (≥ 45 years) using computer assisted personal interviewing (94% conducted in person), and achieved an overall response rate of 74.4%. Excluded from the survey's coverage were: persons living on reserves and other Aboriginal settlements, full-time members of the Canadian Forces, persons living in collective dwellings, and the institutionalized population. Our analysis included respondents if they lived in British Columbia (BC) Census Metropolitan Areas (CMAs; Vancouver, Abbotsford-Mission, Kelowna, and Victoria) and had complete information on exposure (walkability), outcome (mobility measured using MOVES), and covariates (n=2,046, representing 1,043,127 BC residents). Individuals who responded by proxy (2.2% of the CCHS-HA sample) were not included since several items for MOVES were not asked by proxy. These respondents represent 55% of the total BC respondents. This study did not require ethics review as it was deemed exempt under the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2), Article 2.4, by Simon Fraser University's Office of Research Ethics.

MOVES

Detailed methods describing how we designed and calculated the holistic measure of mobility, MOVES, can be found elsewhere (38). Briefly, MOVES was grounded in the conceptual mobility frameworks of Webber et. al. (2) and the World Health Organization's

International Classification of Functioning, Disability, and Health (ICF) (3). These conceptual frameworks spanned four domains: physical (i.e. physical function and activity), cognitive (i.e. cognition and psychology), social (i.e. community engagement, participation, and sense of belonging), and transportation (i.e. use of various modes). To create MOVES we adopted an iterative process and engaged expert qualitative and quantitative researchers (expert panel) from diverse research fields to guide selection of measures deemed relevant to MOVES.

The two steps toward creation of MOVES were: 1) concept-based selection of CCHS-HA items for MOVES and 2) statistical refinement (using Cronbach's alpha and Principal Components Analysis), scoring, and compilation. Ultimately, MOVES was created for every individual with complete data on measures included in MOVES (92.5% of the CCHS-HA national sample; n=28,555). Measures the expert panel selected to be incorporated into MOVES were activities of daily living, elements of the Health Utilities Index (both cognitive and physical), physical activity, fear of falling, transportation modes, sense of belonging in the local community, and frequency of participation in community activities. Measures within each domain were averaged so that each domain received equal weight, 10 points. A final score for MOVES was created by summing across the four domains for a possible score of 0 to 40.

Walkability

Walkability was measured using Street Smart Walk Score™ (www.walkscore.com, version: August 21, 2013). Street Smart Walk Score™ is a commercial measure of walkability that allocates points based on street-network distances to a range of amenities one would walk to (schools, shops, restaurants, parks, etc.). It then penalizes scores based on street characteristics (low intersection density and long block length representing lower walkability) to yield a score from 0 ("Very car-dependent") to 100 ("Walker's paradise"). Walk Score™ has been validated within both the US (16, 17, 40) and Canada (41). In previous studies it was associated with walking for transport and obesity (42–44).

We used the latitude and longitude of population-weighted centroid dissemination areas to purchase data for 4,527 dissemination areas (census areas with populations of 400–700 people) within CMAs in BC. Postal codes were assigned to their respective dissemination areas and a Street Smart Walk Score™ was linked to participants' residential postal codes. We used Street Smart Walk Score™ as a continuous variable and standard cut-points that defined categories: 0 to 24 = "Very car-dependent," 25 to 49 = "Car-dependent," 50 to 69 = "Somewhat walkable," 70 to 89 = "Very walkable," and 90 to 100 = "Walker's paradise."

Sociodemographic, Living, and Health Covariates

We examined MOVES to i) ascertain its association with a range of mobility determinants, and ii) with a subset of covariates (selected *a priori*) developed linear models to assess associations between Street Smart Walk Score™ and MOVES. We included the following demographic variables in our analyses; respondent age (45–54; 55–64; 65–74; 75–84; 85+), sex (male; female), marital status (married or common-law; widowed or separated or divorced; single, never married), education (less or secondary school graduation; some post-

secondary; post-secondary graduation), retirement status (completely retired; partially retired or not retired), total household income from all sources (less than \$19,999; \$20,000 to \$49,999; \$50,000 to \$99,999; \$100,000 and over), and cultural/racial background (not white; white). We also assessed select characteristics about respondents' living arrangements including household size (alone; two people; three or more people) and home ownership (not owned by the respondent; owned by the respondent). Health was reported using self-perceived health (excellent; very good; good; fair; poor), having arthritis (excluding fibromyalgia), having chronic conditions, and depressive symptoms (felt depressed or lost interest in things for two weeks or more during the past year; did not feel either depressed nor lost interest in things) (45).

Statistical Analyses

Data matching and analyses took place within the Statistics Canada Research Data Centre at Simon Fraser University, Burnaby, British Columbia. To examine patterns using MOVES we estimated means across sociodemographic and health characteristics and compared them using analysis of variance (ANOVA). We assessed bivariate associations between Street Smart Walk Score™ and sociodemographic and health characteristics using Rao-Scott Chi-Square. Adjustment for confounding variables was determined *a priori* using first Directed Acyclic Graphs and DAGitty (46, 47) and then statistical tests of associations with both the exposure and outcomes. To estimate the association between Street Smart Walk Score™ and the MOVES we developed a linear regression models, which included MOVES and each subdomain as the dependent variables, Street Smart Walk Score™ as independent variables and age, sex, education, retirement status, and self-perceived health as relevant covariates. As no covariate significantly ($p < 0.1$) modified the association between Street Smart Walk Score™ and MOVES, we did not include interaction terms in the final models. We weighted demographic frequencies using the Statistics Canada proportional sampling scheme and applied Balanced Repeated Replication (BRR) with 500 bootstrap weight variables. All statistical analyses were conducted using SAS, version 9.4 (Cary, NC).

Results

Sample Characteristics

Our CCHS-HA sample was comprised of 2,046 respondents, representing 1,043,127 BC residents. Approximately 40% of the CCHS-HA sample used in these analyses were aged 45–54; slightly more than 27% were aged 65 or older, and more than half were either partially or not retired (Table 1). Approximately three-quarters of respondents were married, had post-secondary degrees, were white, owned their home, did not have arthritis, had at least one chronic condition and did not have depressive symptoms. Fewer than 20% lived alone and more than half reported very good or excellent self-perceived health.

Sample Characteristics with Street Smart Walk Score™

More than half of the sample lived in neighborhoods defined as “Car dependent” (Street Smart Walk Score™ 0–49), about a quarter in “Somewhat walkable” neighborhoods (Street Smart Walk Score™ 50–69), and the remaining (about 25%) lived in either “Very Walkable” or “Walker’s Paradise” neighborhoods (Table 2). Participants in neighborhoods defined as

“Walker’s Paradise” tended to be older, less likely to be married, had lower household incomes, were non-white, lived alone, did not own their home, and had a wider distribution of perceptions about their health.

MOVES

Within the sample, mean MOVES was 30.7 (95% confidence interval (CI) 30.4, 31.0). The 5th percentile score was 23.3 (CI 22.2, 24.4) and the 95th percentile was 36.9 (CI 36.0, 37.9). MOVES was higher for younger participants (Figure 1), those who were married or lived with more people, and who had higher socioeconomic status (still employed, higher education, higher income, owned their homes) (Table 1). Those with better self-perceived health, no arthritis, no chronic conditions, and no depressive symptoms also had higher MOVES. MOVES domains also differed by individual characteristics. In the physical, cognitive, and social domains, patterns were similar to overall MOVES. The transportation domain, however, had some different patterns; income was not as strong of a determinant of transportation mobility and transportation mobility did not vary across health conditions (arthritis, chronic disease, and depressive symptoms).

Living in more walkable areas was associated with increased mobility (Table 3). In unadjusted models, for every 10 point increase in Street Smart Walk ScoreTM, MOVES increased 4.84 points (CI 4.52, 5.15). However, results attenuated substantially after adjusting for relevant sociodemographic covariates: 10 point increase in Street Smart Walk ScoreTM was associated with a 0.10 (CI 0.00, 0.20) point increase in MOVES. Several individual characteristics had strong associations with MOVES, for example, a decrease in MOVES of -0.97 (CI -1.63, -0.30) for those with secondary school graduation compared to those with post-secondary graduation and 6.25 (CI 5.06, 7.44) additional MOVES points for those in excellent health compared to those in poor health. Estimates for other covariates are in supplemental table S1. Results for the association between Street Smart Walk ScoreTM and each subdomain (Table 3) show that in unadjusted models neighborhood walkability was most strongly associated with the cognitive domain (mean difference for 10-unit increase in Street Smart Walk ScoreTM 1.42 (CI 1.32, 1.52)), while the weakest association was found with the transportation domain (mean difference for 10-unit increase in Street Smart Walk ScoreTM 1.00 (CI 0.94, 1.06)). However, after adjustment for covariates, the strongest association was found between neighborhood walkability and the transportation domain (representing increased transit modes); for a 10-unit increase in Street Smart Walk ScoreTM, transportation increases 0.21 points (CI 0.14, 0.29). In fact, other domains, including physical and cognitive, showed lower scores at higher neighborhood walkability after adjustment and the social domain no longer had an association.

Discussion

We created and applied a mobility score (MOVES) to consider factors that influence the holistic mobility of older adults. Specifically, MOVES considers the contribution of physical mobility, cognitive ability, transportation use, and social or community interactions on the propensity for middle aged and older adults to move about their neighborhoods. We extend the limited literature and our understanding of the role different built environments play in

shaping mobility. Across a population-based sample of middle-aged and older adults in British Columbia, those who lived in more walkable neighborhoods were more highly mobile. However, the influence of walkable built environments was less after accounting for relevant sociodemographic characteristics.

Our finding that greater walkability was associated with higher MOVES was consistent with previous work in older adults examining specific components of MOVES (18, 37). For example, in the physical domain, higher outdoor walking or physical activity (19, 20, 22, 48–50), and lower mobility disability (33, 34, 51) were associated with pedestrian friendly neighborhoods with more destinations. This may result from those with higher mobility patterns during adulthood (e.g. more engagement, higher physical activity) maintaining activity levels as they age. Alternately, specific environment features may enable more physical activity even for those who have developed physical mobility restrictions. For example, shorter distance to destinations or more supportive pedestrian structures (e.g. sidewalks and crosswalks) may facilitate walking trips, especially amongst older adults. To this point, in a concept mapping project we conducted with intersectoral stakeholders, sidewalks and crosswalks emerged as prominent built environment aspects influencing older adult's outdoor walking (52). In the cognitive domain, others have reported associations between cognitive decline (24–27) or depression (53) and the neighborhood environment. The opportunity for older adults to frequently engage in social activities and easier access to destinations for these social activities are potential explanations. Previous research in the social domain supports associations between walkable neighborhoods and social connections (54–57). Finally, a substantial body of work in the planning sector explored the role walkability played in transportation options and mode choice (29, 58–61). Importantly, mode choice is one novel element directly assessed by MOVES. Earlier studies reported neighborhood, trip and personal and household characteristics shaped the type of transportation older adults choose (29). That is, older adults are more likely to use transit if they live within five blocks of a bus stop, and more likely to share a ride with others when making multiple stops or doing errands. Conversely, they are less likely to use transit to do their shopping or run errands (29). In summary, our work supports the growing evidence body identifying the important role neighborhood features play to facilitate all the domains of mobility assessed by MOVES.

We know that many individual factors influence mobility of older adults (2) – especially when mobility-disability ensues and in those most frail (34). Thus, it was unsurprising that, after adjusting for sociodemographic characteristics, the association between Street Smart Walk Score™ and MOVES was attenuated. These individual factors may be especially important within our relatively homogenous study population that were mostly younger, married, white, and had high educations and incomes. Future research should test this relationship in a more diverse context. Despite this, our results suggest a role for neighborhood environment that persists even accounting for the many individual level factors. Importantly, although the size of the association for walkability was small in statistical models, positive neighborhood changes impact the entire residential population living in the area, across many years. Thus, policy changes that address built environments, such as “Age Friendly City” designations (14), Complete Streets policies or other Smart Growth developments (30, 62), have potential for widespread impacts when considered at

population levels rather than at the individual level. However, several potential factors may play roles in the reduction of the association after adjustment for confounders. First, individual sociodemographic characteristics may influence where our respondents choose to live, or can afford to live. If neighborhood environments are highly associated with a variable tightly linked with older adult mobility, the association in unadjusted models would be confounded by these influential variables. However, in this study we saw respondents in more walkable places had characteristics associated with lower mobility (older, non-married, non-white, non-homeowners, and wider distribution of perceived health), which we expect would bias unadjusted models downward. A second explanation may be that neighborhood walkability is strongly associated with some (e.g. transportation) but not all components of MOVES. For example, after controlling for potential covariates, we found small and nonsignificant associations with the social domain, and larger and significant associations with the transportation domain (which is understandable as dense, walkable places often have more transport options). These might have canceled each other out in models examining composite MOVES. Finally, our study included large metropolitan areas in BC, home to 55% of the population and representing 1,043,127 people. We did not include those who reside outside the CMAs, as walkability and its relevance may differ in rural contexts due to transportation patterns, cultural context, and relevant spatial scale (63, 64). Despite this, almost three-quarters of respondents lived in “Somewhat walkable” or “Car-dependent” neighborhoods. This homogeneity has potential to reduce statistical variance of our exposure and, as a result, associations between Street Smart Walk Score™ and mobility that would be observed across the entire spectrum of walkability. It would be of future interest to discern the relationship between older adult residential choices, neighborhood environments, and mobility.

We highlight a number of study strengths. We used an objective, standardized measure of neighborhood walkability and a novel, holistic measure of mobility that more aptly captures ability to engage. A recent systematic review highlighted a need for standardized, objective measures of the built environment (23). In contrast to many of the studies reviewed, our work uses Street Smart Walk Score™ which has been validated (16, 17, 40) and shown to be associated with walking (42–44, 65). Another advantage of Street Smart Walk Score™ is that it is a composite index of access to destinations and street design. This provided the opportunity to understand more comprehensively the role neighborhood walkability plays in older adult mobility. Another strength is generalizability of our results. CCHS-HA was designed to represent the Canadian population, or in our case, BC residents in metropolitan areas.

We also acknowledge limitations of our study. First, urban planners and other municipal staff often face decisions around specific design features, or in specific corridors. Thus, using composite walkability may present a challenge for municipalities trying to extract direct policy recommendations. Second, we were only able to use CCHS-HA participants who lived in CMAs, where we had Street Smart Walk Score™. Third, as per any cross-sectional study we are unable to draw causal inference. Finally, our results may have been influenced by residual confounding from unmeasured individual and neighborhood characteristics.

Conclusion

“Population ageing is unprecedented, without parallel in the history of humanity.” (66) This global reality demands comprehensive approaches to conceptualizing mobility. To address this need we used a holistic mobility measure to understand the potential for neighborhood built environments to facilitate mobility for older people.

Given that mobility is critical to promoting healthy behaviors and outcomes (12, 13), social connectedness (8, 28), isolation (9), and quality of life (5) our findings have relevance for researchers, policy makers, practitioners, and older adults. The modest but important link observed between our measure and neighborhood walkability has potential across iterations of residents to influence population-level mobility and health. Thus, we urge others to consider context as an important factors determining mobility.

Individual-level sociodemographic characteristics remain strong agents of mobility and need also be considered. We welcome future studies delving deeper into the way older adults engage with their neighborhood social and physical environments, and the potential interaction of individual mobility influences within diverse environments. We envision that our results may encourage crucial and much needed dialogue among urban planners, public health practitioners, gerontologists, community members, and other stakeholders regarding neighborhood supports for the mobility of people of all ages and abilities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Kinsella, KG., Wan, H. Census USBot. An aging world: 2008. US Department of Commerce, Economics and Statistics Administration, US Census Bureau; 2009.
2. Webber SC, Porter MM, Menec VH. Mobility in older adults: a comprehensive framework. *The Gerontologist*. 2010;gnq013.
3. World Health Organisation. International Classification of Functioning, Disability and Health (ICF). 2014. Available from: <http://www.who.int/classifications/icf/en/>
4. Groessl EJ, Kaplan RM, Rejeski WJ, Katula JA, King AC, Frierson G, et al. Health-related quality of life in older adults at risk for disability. *American journal of preventive medicine*. 2007; 33(3): 214–8. [PubMed: 17826582]
5. Metz D. Mobility of older people and their quality of life. *Transport policy*. 2000; 7(2):149–52.
6. Yeom HA, Fleury J, Keller C. Risk factors for mobility limitation in community-dwelling older adults: a social ecological perspective. *Geriatric nursing*. 2008; 29(2):133–40. [PubMed: 18394514]

7. Hirvensalo M, Rantanen T, Heikkinen E. Mobility Difficulties and Physical Activity as Predictors of Mortality and Loss of Independence in the Community-Living Older Population. *Journal of the American Geriatrics Society*. 2000; 48(5):493–8. [PubMed: 10811541]
8. Rosso AL, Taylor JA, Tabb LP, Michael YL. Mobility, disability, and social engagement in older adults. *Journal of aging and health*. 2013; 25(4):617–37. [PubMed: 23548944]
9. Gardner P. The role of social engagement and identity in community mobility among older adults aging in place. *Disability and rehabilitation*. 2014; 36(15):1249–57. [PubMed: 24099580]
10. Rubenstein LZ, Powers CM, MacLean CH. Quality indicators for the management and prevention of falls and mobility problems in vulnerable elders. *Annals of Internal Medicine*. 2001; 135(8_Part_2):686–93. [PubMed: 11601951]
11. von Bonsdorff M, Rantanen T, Laukkanen P, Suutama T, Heikkinen E. Mobility limitations and cognitive deficits as predictors of institutionalization among community-dwelling older people. *Gerontology*. 2006; 52(6):359–65. [PubMed: 16905887]
12. Boyle PA, Buchman AS, Barnes LL, James BD, Bennett DA. Association between life space and risk of mortality in advanced age. *Journal of the American Geriatrics Society*. 2010; 58(10):1925–30. [PubMed: 20831722]
13. Cooper R, Kuh D, Hardy R. Objectively measured physical capability levels and mortality: systematic review and meta-analysis. *Bmj*. 2010; 341:c4467. [PubMed: 20829298]
14. World Health Organization. Global age-friendly cities: A guide. World Health Organization; 2007.
15. Clarke P, Nieuwenhuijsen ER. Environments for healthy ageing: a critical review. *Maturitas*. 2009; 64(1):14–9. [PubMed: 19695800]
16. Carr LJ, Dunsiger SI, Marcus BH. Validation of Walk Score for estimating access to walkable amenities. *British Journal of Sports Medicine*. 2010 bjsports69609.
17. Carr LJ, Dunsiger SI, Marcus BH. Walk Score™ as a global estimate of neighborhood walkability. *American journal of preventive medicine*. 2010; 39(5):460–3. [PubMed: 20965384]
18. Rosso AL, Auchincloss AH, Michael YL. The urban built environment and mobility in older adults: a comprehensive review. *Journal of aging research*. 2011
19. Berke EM, Koepsell TD, Moudon AV, Hoskins RE, Larson EB. Association of the built environment with physical activity and obesity in older persons. *American journal of public health*. 2007; 97(3):486–92. [PubMed: 17267713]
20. Fisher KJ, Li F, Michael Y, Cleveland M. Neighborhood-level influences on physical activity among older adults: a multilevel analysis. *Journal of aging and physical activity*. 2004; 12(1):45–63. [PubMed: 15211020]
21. Kerr J, Rosenberg D, Frank L. The role of the built environment in healthy aging community design, physical activity, and health among older adults. *Journal of Planning Literature*. 2012; 27(1):43–60.
22. Michael YL, Beard T, Choi D, Farquhar S, Carlson N. Measuring the influence of built neighborhood environments on walking in older adults. *Journal of Aging and Physical Activity*. 2006
23. Van Cauwenberg J, De Bourdeaudhuij I, De Meester F, Van Dyck D, Salmon J, Clarys P, et al. Relationship between the physical environment and physical activity in older adults: a systematic review. *Health & place*. 2011; 17(2):458–69. [PubMed: 21257333]
24. Clarke PJ, Weuve J, Barnes L, Evans DA, de Leon CFM. Cognitive decline and the neighborhood environment. *Annals of Epidemiology*. 2015; 25(11):849–54. [PubMed: 26253697]
25. Lang IA, Llewellyn DJ, Langa KM, Wallace RB, Huppert FA, Melzer D. Neighborhood deprivation, individual socioeconomic status, and cognitive function in older people: analyses from the English Longitudinal Study of Ageing. *Journal of the American Geriatrics Society*. 2008; 56(2):191–8. [PubMed: 18179489]
26. Sheffield KM, Peek MK. Neighborhood context and cognitive decline in older Mexican Americans: results from the Hispanic Established Populations for Epidemiologic Studies of the Elderly. *American Journal of Epidemiology*. 2009:kwp005.
27. Wight RG, Aneshensel CS, Miller-Martinez D, Botticello AL, Cummings JR, Karlamangla AS, et al. Urban neighborhood context, educational attainment, and cognitive function among older adults. *American Journal of Epidemiology*. 2006; 163(12):1071–8. [PubMed: 16707655]

28. Marottoli RA, de Leon CFM, Glass TA, Williams CS, Cooney LM, Berkman LF. Consequences of driving cessation decreased out-of-home activity levels. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. 2000; 55(6):S334–S40.
29. Kim S, Ulfarsson G. Travel mode choice of the elderly: effects of personal, household, neighborhood, and trip characteristics. *Transportation Research Record: Journal of the Transportation Research Board*. 2004; (1894):117–26.
30. U.S. Environmental Protection Agency. *Growing Smarter, Living Healthier: A guide to Smart Growth and Active Aging*. Washington, DC: 2009.
31. Farber, N., Shinkle, D., Lynott, J., Fox-Grage, W., Harrell, R. *Aging in Place: A State Survey of Livability Policies and Practices*. Washington, DC: AARP Public Policy Institute; 2011.
32. Keysor JJ, Jette AM, LaValley MP, Lewis CE, Torner JC, Nevitt MC, et al. Community environmental factors are associated with disability in older adults with functional limitations: the MOST study. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*. 2010; 65(4):393–9.
33. Clarke P, Ailshire JA, Bader M, Morenoff JD, House JS. Mobility disability and the urban built environment. *American Journal of Epidemiology*. 2008; 168(5):506–13. [PubMed: 18667526]
34. Clarke P, Ailshire JA, Lantz P. Urban built environments and trajectories of mobility disability: findings from a national sample of community-dwelling American adults (1986–2001). *Social science & medicine*. 2009; 69(6):964–70. [PubMed: 19643522]
35. Clarke P, Gallagher NA. Optimizing mobility in later life: The role of the urban built environment for older adults aging in place. *Journal of Urban Health*. 2013; 90(6):997–1009. [PubMed: 23592019]
36. Satariano WA, Ivey SL, Kurtovich E, Kealey M, Hubbard AE, Bayles CM, et al. Lower-body function, neighborhoods, and walking in an older population. *American journal of preventive medicine*. 2010; 38(4):419–28. [PubMed: 20307811]
37. Yen IH, Michael YL, Perdue L. Neighborhood environment in studies of health of older adults: a systematic review. *American journal of preventive medicine*. 2009; 37(5):455–63. [PubMed: 19840702]
38. Hirsch JA, Winters M, Sims-Gould J, Clarke P, Ste-Marie N, Ashe M, et al. *Mobility Over Varied Environments Score (MOVES): a Composite Metric of Mobility*. Under Review.
39. Statistics Canada. *Canadian Community Health Survey - Healthy Aging (CCHS)*. 2008. Available from: <http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5146#a2>
40. Duncan DT, Aldstadt J, Whalen J, Melly SJ, Gortmaker SL. Validation of Walk Score® for estimating neighborhood walkability: an analysis of four US metropolitan areas. *International journal of environmental research and public health*. 2011; 8(11):4160–79. [PubMed: 22163200]
41. Manaugh K, El-Geneidy A. Validating walkability indices: How do different households respond to the walkability of their neighborhood? *Transportation Research Part D: Transport and Environment*. 2011; 16(4):309–15.
42. Brown SC, Pantin H, Lombard J, Toro M, Huang S, Plater-Zyberk E, et al. Walk score®: associations with purposive walking in recent Cuban immigrants. *American journal of preventive medicine*. 2013; 45(2):202–6. [PubMed: 23867028]
43. Hirsch JA, Diez Roux AV, Moore KA, Evenson KR, Rodriguez DA. Change in walking and body mass index following residential relocation: the multi-ethnic study of atherosclerosis. *American journal of public health*. 2014; 104(3):e49–e56.
44. Hirsch JA, Moore KA, Evenson KR, Rodriguez DA, Roux AV. Walk score® and transit score® and walking in the multi-ethnic study of atherosclerosis. *American journal of preventive medicine*. 2013; 45(2):158–66. [PubMed: 23867022]
45. Kessler RC, Andrews G, Colpe LJ, Hiripi E, Mroczek DK, Normand S-L, et al. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological medicine*. 2002; 32(06):959–76. [PubMed: 12214795]
46. Shrier I, Platt RW. Reducing bias through directed acyclic graphs. *BMC medical research methodology*. 2008; 8(1):70. [PubMed: 18973665]
47. Textor J, Hardt J, Knüppel S. DAGitty: a graphical tool for analyzing causal diagrams. *Epidemiology*. 2011; 22(5):745.

48. King AC, Sallis JF, Frank LD, Saelens BE, Cain K, Conway TL, et al. Aging in neighborhoods differing in walkability and income: associations with physical activity and obesity in older adults. *Social Science & Medicine*. 2011; 73(10):1525–33. [PubMed: 21975025]
49. Owen N, Cerin E, Leslie E, Coffee N, Frank LD, Bauman AE, et al. Neighborhood walkability and the walking behavior of Australian adults. *American journal of preventive medicine*. 2007; 33(5): 387–95. [PubMed: 17950404]
50. Patterson PK, Chapman NJ. Urban form and older residents' service use, walking, driving, quality of life, and neighborhood satisfaction. *American Journal of Health Promotion*. 2004; 19(1):45–52. [PubMed: 15460101]
51. Beard JR, Blaney S, Cerda M, Frye V, Lovasi GS, Ompad D, et al. Neighborhood characteristics and disability in older adults. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*. 2009:gbn018.
52. Hanson HM, Schiller C, Winters M, Sims-Gould J, Clarke P, Curran E, et al. Concept mapping applied to the intersection between older adults' outdoor walking and the built and social environments. *Preventive medicine*. 2013; 57(6):785–91. [PubMed: 24012832]
53. Berke EM, Gottlieb LM, Moudon AV, Larson EB. Protective association between neighborhood walkability and depression in older men. *Journal of the American Geriatrics Society*. 2007; 55(4): 526–33. [PubMed: 17397430]
54. Leyden KM. Social capital and the built environment: the importance of walkable neighborhoods. *American journal of public health*. 2003; 93(9):1546–51. [PubMed: 12948978]
55. Richard L, Gauvin L, Gosselin C, Laforest S. Staying connected: neighbourhood correlates of social participation among older adults living in an urban environment in Montreal, Quebec. *Health Promotion International*. 2009; 24(1):46–57. [PubMed: 19098293]
56. Sugiyama T, Thompson CW. Outdoor environments, activity and the well-being of older people: conceptualising environmental support. *Environment and Planning A*. 2007; 39(8):1943–60.
57. Mahmood A, Chaudhury H, Michael YL, Campo M, Hay K, Sarte A. A photovoice documentation of the role of neighborhood physical and social environments in older adults' physical activity in two metropolitan areas in North America. *Social science & medicine*. 2012; 74(8):1180–92. [PubMed: 22365935]
58. Frank L, Bradley M, Kavage S, Chapman J, Lawton TK. Urban form, travel time, and cost relationships with tour complexity and mode choice. *Transportation*. 2008; 35(1):37–54.
59. Saelens BE, Sallis JF, Frank LD. Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. *Annals of behavioral medicine*. 2003; 25(2):80–91. [PubMed: 12704009]
60. Frank LD, Saelens BE, Powell KE, Chapman JE. Stepping towards causation: do built environments or neighborhood and travel preferences explain physical activity, driving, and obesity? *Social science & medicine*. 2007; 65(9):1898–914. [PubMed: 17644231]
61. Winters M, Brauer M, Setton EM, Teschke K. Built environment influences on healthy transportation choices: bicycling versus driving. *Journal of urban health*. 2010; 87(6):969–93. [PubMed: 21174189]
62. Smart Growth America. National Complete Streets Coalition. 2016. Available from: <http://www.smartgrowthamerica.org/complete-streets/complete-streets-fundamentals/complete-streets-faq>
63. Frost SS, Goins RT, Hunter RH, Hooker SP, Bryant LL, Kruger J, et al. Effects of the built environment on physical activity of adults living in rural settings. *American Journal of Health Promotion*. 2010; 24(4):267–83. [PubMed: 20232609]
64. Feng J, Glass TA, Curriero FC, Stewart WF, Schwartz BS. The built environment and obesity: a systematic review of the epidemiologic evidence. *Health & place*. 2010; 16(2):175–90. [PubMed: 19880341]
65. Tuckel P, Milczarski W. Walk Score™, Perceived Neighborhood Walkability, and Walking in the US. *American journal of health behavior*. 2015; 39(2):242–56. [PubMed: 25564837]
66. United Nations. World population ageing: 1950–2050. New York: Department of Economic and Social Affairs, Population Division; 2002.

Highlights

- Population aging and urbanization highlight the role of neighborhoods for older adult mobility
- Mobility Over Varied Environments Scale (MOVES) measures multiple mobility domains
- Mobility was patterned by individual sociodemographic, living, and health characteristics
- Respondents living in more walkable neighborhoods had higher mobility scores (MOVES)
- Results diminish after accounting for individual sociodemographic characteristics

Figure 1. Patterns of Mobility over Varied Environments Score (MOVES) by Age and Gender within CCHS-HA respondents from British Columbia (2008–2009). Solid line represents overall age trend, dashed light grey line represents females, and dotted dark grey line represents males.

Table 1
Sociodemographic, living, and health characteristics of CCHS-HA British Columbia Respondents (2008–2009) in Census Metropolitan Areas (n=2046) and mean Mobility over Varied Environments Score (MOVES) across those characteristics

Variable	Percent (95% CI)	Mean MOVES ^b (95% CI)	p-value ^c	Mean Physical Domain ^b (95% CI)	p-value ^c	Mean Cognitive Domain ^b (95% CI)	p-value ^c	Mean Social Domain ^b (95% CI)	p-value ^c	Mean Transport Domain ^b (95% CI)	p-value ^c
Age			<.0001		<.0001		<.0001		0.0399		0.0005
45–54	40.5 (36.3, 44.8)	31.6 (31.0, 32.1)		8.8 (8.6, 9.0)		9.5 (9.3, 9.6)		7.1 (6.8, 7.3)		6.2 (5.8, 6.6)	
55–64	31.8 (28.3, 35.4)	31.5 (31.0, 32.0)		8.4 (8.2, 8.6)		9.5 (9.4, 9.6)		7.3 (7.1, 7.4)		6.3 (5.9, 6.7)	
65–74	17.1 (15.1, 19.1)	29.5 (29.1, 29.9)		7.9 (7.8, 8.0)		8.5 (8.3, 8.7)		7.4 (7.2, 7.5)		5.7 (5.5, 6.0)	
75–84	9.6 (8.2, 11.0)	26.7 (26.0, 27.4)		6.9 (6.6, 7.1)		7.5 (7.1, 7.8)		7.1 (6.9, 7.3)		5.3 (5.0, 5.6)	
85+	0.9 (0.4, 1.4)	25.8 (23.1, 28.6)		6.5 (5.7, 7.2)		6.4 (4.6, 8.3)		6.8 (6.2, 7.3)		6.2 (5.2, 7.1)	
Sex			0.0636		0.0002		0.0017		0.0613		0.183
Male	46.9 (42.9, 50.8)	31.0 (30.5, 31.5)		8.5 (8.4, 8.7)		9.3 (9.1, 9.4)		7.3 (7.1, 7.4)		5.9 (5.6, 6.2)	
Female	53.1 (49.2, 57.1)	30.4 (30.0, 30.8)		8.1 (8.0, 8.3)		9.0 (8.8, 9.1)		7.1 (6.9, 7.2)		6.2 (5.9, 6.5)	
Marital Status			<.0001		<.0001		<.0001		<.0001		<.0001
Married or common-law	77.6 (74.8, 80.5)	31.1 (30.7, 31.5)		8.4 (8.3, 8.5)		9.2 (9.1, 9.3)		7.3 (7.2, 7.5)		6.1 (5.9, 6.4)	
Widowed or separated or divorced	18.8 (16.1, 21.5)	29.3 (28.8, 29.8)		8.0 (7.8, 8.2)		8.6 (8.4, 8.9)		6.8 (6.6, 6.9)		5.9 (5.6, 6.2)	
Single, never married	3.6 (2.5, 4.6)	29.1 (28.3, 29.9)		8.1 (7.7, 8.5)		9.3 (8.9, 9.7)		6.0 (5.5, 6.5)		5.7 (5.0, 6.4)	
Highest level of education			<.0001		<.0001		<.0001		<.0001		<.0001
Less or secondary school graduation	18.9 (16.0, 21.9)	29.2 (28.6, 29.8)		8.1 (7.8, 8.4)		8.7 (8.5, 9.0)		6.9 (6.7, 7.2)		5.5 (5.1, 5.8)	
Some post-secondary	6.9 (5.1, 8.7)	31.1 (30.2, 31.9)		8.4 (8.0, 8.8)		9.2 (9.0, 9.5)		7.4 (7.0, 7.7)		6.1 (5.5, 6.6)	
Post-secondary graduation	74.2 (70.9, 77.5)	31.0 (30.6, 31.4)		8.4 (8.2, 8.5)		9.2 (9.1, 9.3)		7.2 (7.1, 7.4)		6.2 (6.0, 6.5)	
Retirement status			<.0001		<.0001		<.0001		0.3429		<.0001
Completely retired	32.3 (29.2, 35.4)	28.7 (28.3, 29.1)		7.4 (7.3, 7.6)		8.4 (8.2, 8.5)		7.2 (7.1, 7.4)		5.6 (5.4, 5.8)	
Partially retired or not retired	67.7 (64.6, 70.8)	31.6 (31.2, 32.0)		8.7 (8.6, 8.9)		9.5 (9.3, 9.6)		7.1 (7.0, 7.3)		6.3 (6.0, 6.6)	
Total Household Income^a			<.0001		<.0001		<.0001		<.0001		0.0467
Less than \$19,999	7.4 (5.5, 9.2)	27.5 (26.2, 28.9)		7.1 (6.7, 7.5)		8.3 (7.9, 8.7)		6.3 (5.9, 6.7)		5.9 (5.2, 6.7)	
\$20,000 to \$49,999	21.4 (18.6, 24.2)	29.2 (28.7, 29.7)		7.9 (7.6, 8.1)		8.7 (8.5, 8.9)		7.0 (6.8, 7.2)		5.6 (5.4, 5.9)	
\$50,000 to \$99,999	39.0 (34.5, 43.4)	31.2 (30.6, 31.9)		8.5 (8.3, 8.7)		9.2 (9.0, 9.4)		7.2 (7.0, 7.5)		6.3 (5.8, 6.8)	

Variable	Percent (95% CI)	Mean MOVES ^b (95% CI)	p-value ^c	Mean Physical Domain ^b (95% CI)	p-value ^c	Mean Cognitive Domain ^b (95% CI)	p-value ^c	Mean Social Domain ^b (95% CI)	p-value ^c	Mean Transport Domain ^b (95% CI)	p-value ^c
\$100,000 and over	32.3 (28.1, 36.6)	31.7 (31.2, 32.2)	0.598	8.8 (8.6, 9.0)	0.6397	9.4 (9.3, 9.6)	0.2708	7.4 (7.1, 7.6)	0.3192	6.1 (5.7, 6.5)	0.5596
Cultural/Racial Background^a											
Not White	27.2 (23.4, 30.9)	30.6 (29.8, 31.3)		8.3 (8.1, 8.5)		9.0 (8.7, 9.3)		7.1 (6.9, 7.3)		6.2 (5.8, 6.6)	
White	72.8 (69.1, 76.6)	30.8 (30.4, 31.1)		8.3 (8.2, 8.5)		9.2 (9.1, 9.3)		7.2 (7.1, 7.3)		6.1 (5.8, 6.3)	
Household size											
Alone	19.2 (16.9, 21.5)	29.3 (28.9, 29.8)	<.0001	8.0 (7.8, 8.1)	<.0001	8.9 (8.7, 9.0)	<.0001	6.7 (6.5, 6.9)	<.0001	5.8 (5.6, 6.1)	<.0001
Two people	44.8 (40.9, 48.8)	30.9 (30.4, 31.3)		8.2 (8.1, 8.4)		9.1 (9.0, 9.3)		7.3 (7.2, 7.5)		6.2 (5.8, 6.5)	
Three or more people	35.9 (31.8, 40.1)	31.1 (30.5, 31.8)		8.6 (8.4, 8.8)		9.2 (9.0, 9.4)		7.2 (7.0, 7.5)		6.1 (5.7, 6.5)	
Home Ownership^a											
Not owned by the respondent	15.2 (12.6, 17.7)	29.3 (28.5, 30.1)	0.0002	7.6 (7.3, 7.9)	<.0001	8.7 (8.4, 8.9)	0.0005	6.7 (6.4, 7.0)	0.0011	6.3 (5.8, 6.7)	0.3502
Owned by the respondent	84.8 (82.3, 87.4)	30.9 (30.6, 31.3)		8.4 (8.3, 8.6)		9.2 (9.1, 9.3)		7.3 (7.1, 7.4)		6.0 (5.8, 6.3)	
Self-perceived health											
Excellent	22.4 (19.2, 25.7)	32.2 (31.6, 32.8)	<.0001	8.6 (8.4, 8.8)	<.0001	9.6 (9.4, 9.7)	<.0001	7.6 (7.5, 7.8)	<.0001	6.4 (6.0, 6.8)	0.0002
Very good	33.4 (29.4, 37.4)	31.5 (31.0, 32.1)		8.7 (8.5, 8.8)		9.4 (9.3, 9.5)		7.2 (7.0, 7.4)		6.2 (5.8, 6.7)	
Good	29.8 (26.3, 33.3)	30.3 (29.8, 30.9)		8.3 (8.1, 8.5)		9.0 (8.8, 9.2)		7.1 (6.9, 7.3)		6.0 (5.7, 6.3)	
Fair	10.4 (8.3, 12.5)	28.0 (27.3, 28.8)		7.4 (7.1, 7.8)		8.3 (7.9, 8.6)		6.8 (6.4, 7.1)		5.6 (5.1, 6.0)	
Poor	4.1 (2.8, 5.3)	24.8 (23.4, 26.2)		6.4 (5.8, 7.0)		7.1 (6.4, 7.7)		6.5 (5.9, 7.0)		4.8 (4.0, 5.6)	
Has arthritis											
Yes	22.5 (19.4, 25.6)	29.1 (28.3, 29.9)	<.0001	7.7 (7.5, 7.9)	<.0001	8.5 (8.2, 8.8)	<.0001	7.0 (6.8, 7.2)	0.0806	5.9 (5.5, 6.4)	0.4572
No	77.5 (74.4, 80.6)	31.1 (30.8, 31.5)		8.5 (8.4, 8.6)		9.3 (9.2, 9.4)		7.2 (7.1, 7.4)		6.1 (5.9, 6.4)	
Has a chronic condition^a											
Has two or more chronic conditions	53.5 (49.5, 57.5)	29.6 (29.2, 30.1)	<.0001	7.9 (7.8, 8.1)	<.0001	8.7 (8.5, 8.9)	<.0001	7.1 (7.0, 7.3)	0.5955	5.9 (5.6, 6.2)	0.2841
Has one chronic condition	20.3 (16.9, 23.7)	31.6 (30.9, 32.3)		8.7 (8.5, 8.9)		9.4 (9.3, 9.6)		7.2 (6.9, 7.5)		6.3 (5.7, 6.8)	
Has no chronic conditions	26.2 (22.6, 29.9)	32.0 (31.3, 32.6)		8.8 (8.6, 9.0)		9.7 (9.5, 9.8)		7.2 (7.0, 7.5)		6.2 (5.8, 6.6)	
Depressive symptoms^a											
No	90.2 (87.4, 92.9)	30.9 (30.5, 31.2)	0.0006	8.4 (8.2, 8.5)	0.009	9.2 (9.1, 9.3)	0.0002	7.2 (7.1, 7.4)	0.002	6.1 (5.9, 6.3)	0.6196
Yes	9.8 (7.1, 12.6)	29.2 (28.4, 30.0)		7.9 (7.6, 8.2)		8.4 (8.0, 8.9)		6.6 (6.2, 7.0)		6.3 (5.7, 6.9)	

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Only a sub sample of the 2046 respondents had these variables: income reported for n=1695; cultural/racial background reported for n=2003; home ownership reported for n=2042; chronic condition reported for n=2035; depressive symptoms reported for n=2020.

MOVES ranges from 0 to 40; each subdomain ranges from 0 to 10.

P-value from Analysis of variance (ANOVA) across categories of each sociodemographic characteristic

Sociodemographic, living, and health characteristics of 2008–2009 CCHS-HA British Columbia Respondents (2008–2009) in Census Metropolitan Areas (n=2046) across Street Smart Walk Score™ Categories

Table 2

Variable	Walker's Paradise ^b		Very Walkable ^b		Somewhat Walkable ^b		Car-Dependent ^b		p-value ^c
	Percent	(95% CI)	Percent	(95% CI)	Percent	(95% CI)	Percent	(95% CI)	
Overall Percentage of Total	7.6	(6.1, 9.2)	17.6	(14.6, 20.6)	23.4	(20.1, 26.7)	51.4	(47.4, 55.4)	
Age									0.0102
45–54	34.4	(23.2, 45.6)	41.0	(30.5, 51.5)	36.2	(27.8, 44.7)	43.2	(37.1, 49.3)	
55–64	32.2	(22.8, 41.5)	28.0	(20.8, 35.2)	39.7	(31.9, 47.5)	29.6	(24.4, 34.7)	
65–74	15.8	(10.4, 21.3)	16.5	(12.2, 20.8)	15.2	(11.5, 19.0)	18.4	(15.3, 21.4)	
75–84	14.7	(9.7, 19.8)	13.4	(9.5, 17.3)	7.4	(5.2, 9.6)	8.6	(6.5, 10.6)	
85+	2.8	(0.0, 6.6)	1.1	(0.0, 2.2)	1.5	(0.1, 3.0)	0.3	(0.1, 0.5)	
Sex									0.1727
Male	45.9	(35.5, 56.3)	53.3	(44.1, 62.4)	50.3	(42.3, 58.3)	43.3	(37.6, 48.9)	
Female	54.1	(43.7, 64.5)	46.7	(37.6, 55.9)	49.7	(41.7, 57.7)	56.7	(51.1, 62.4)	
Marital Status									<.0001
Married or common-law	60.4	(50.9, 69.8)	67.7	(58.8, 76.6)	77.1	(71.5, 82.7)	83.8	(80.5, 87.2)	
Widowed or separated or divorced	29.3	(20.9, 37.8)	27.2	(18.4, 36.1)	18.8	(13.9, 23.8)	14.3	(11.2, 17.4)	
Single, never married	10.3	(5.2, 15.4)	5.1	(2.7, 7.4)	4.1	(1.2, 6.9)	1.9	(0.8, 2.9)	
Highest level of education									0.2382
Less or secondary school graduation	13.5	(8.5, 18.4)	21.7	(13.0, 30.4)	23.3	(17.5, 29.1)	16.7	(12.7, 20.8)	
Some post-secondary	5.2	(2.3, 8.0)	5.7	(2.9, 8.6)	5.8	(2.1, 9.5)	8.0	(5.1, 10.9)	
Post-secondary graduation	81.3	(75.5, 87.2)	72.5	(63.7, 81.3)	70.8	(64.3, 77.4)	75.3	(70.6, 80.0)	
Retirement status									0.5412
Completely retired	38.1	(28.5, 47.7)	34.7	(27.4, 42.1)	31.6	(25.4, 37.8)	30.9	(26.6, 35.2)	
Partially retired or not retired	61.9	(52.3, 71.5)	65.3	(57.9, 72.6)	68.4	(62.2, 74.6)	69.1	(64.8, 73.4)	
Total Household Income^a									0.0002
Less than \$19,999	7.8	(4.3, 11.2)	11.1	(7.1, 15.2)	6.5	(4.2, 8.8)	6.4	(3.3, 9.6)	
\$20,000 to \$49,999	31.0	(22.3, 39.8)	28.5	(21.5, 35.6)	22.7	(16.4, 29.1)	17.1	(13.5, 20.6)	
\$50,000 to \$99,999	36.7	(26.5, 46.8)	41.0	(31.2, 50.7)	43.1	(33.7, 52.6)	36.7	(30.3, 43.2)	

Variable	Walker's Paradise ^b	Very Walkable ^b	Somewhat Walkable ^b	Car-Dependent ^b	p-value ^c
\$100,000 and over	Percent (95% CI) 24.5 (15.7, 33.4)	Percent (95% CI) 19.4 (11.4, 27.3)	Percent (95% CI) 27.7 (20.1, 35.2)	Percent (95% CI) 39.8 (33.2, 46.3)	<.0001
Cultural/Racial Background^a					
Not White	30.0 (20.1, 39.8)	42.1 (32.0, 52.2)	32.8 (24.2, 41.5)	19.0 (14.9, 23.1)	
White	70.0 (60.2, 79.9)	57.9 (47.8, 68.0)	67.2 (58.5, 75.8)	81.0 (76.9, 85.1)	
Household size					<.0001
Alone	39.8 (30.5, 49.1)	21.8 (16.6, 27.0)	19.7 (14.6, 24.7)	15.1 (12.0, 18.2)	
Two people	47.1 (36.5, 57.6)	40.5 (31.7, 49.3)	41.3 (33.8, 48.8)	47.6 (41.8, 53.4)	
Three or more people	13.1 (6.9, 19.4)	37.7 (27.2, 48.2)	39.0 (30.5, 47.6)	37.3 (31.5, 43.2)	
Home Ownership^a					<.0001
Not owned by the respondent	38.5 (29.0, 48.0)	21.3 (14.5, 28.1)	14.6 (8.9, 20.4)	9.9 (6.8, 13.0)	
Owned by the respondent	61.5 (52.0, 71.0)	78.7 (71.9, 85.5)	85.4 (79.6, 91.1)	90.1 (87.0, 93.2)	
Self-perceived health					0.0157
Excellent	22.9 (15.5, 30.2)	16.1 (11.2, 20.9)	19.3 (13.4, 25.2)	26.0 (20.8, 31.2)	
Very good	30.2 (19.1, 41.2)	25.6 (17.0, 34.1)	40.4 (32.1, 48.6)	33.3 (27.5, 39.2)	
Good	29.5 (20.5, 38.5)	40.4 (30.5, 50.3)	28.1 (21.2, 35.0)	26.9 (22.4, 31.4)	
Fair	12.3 (6.2, 18.4)	13.8 (9.0, 18.5)	9.5 (5.9, 13.1)	9.3 (6.0, 12.6)	
Poor	5.1 (2.2, 8.0)	4.2 (1.9, 6.5)	2.7 (0.9, 4.5)	4.5 (2.3, 6.6)	
Has arthritis					0.1966
Yes	21.3 (14.0, 28.6)	19.6 (14.5, 24.7)	19.4 (14.9, 23.9)	25.1 (19.9, 30.2)	
No	78.7 (71.4, 86.0)	80.4 (75.3, 85.5)	80.6 (76.1, 85.1)	74.9 (69.8, 80.1)	
Has a chronic condition^a					0.0798
Has two or more chronic conditions	64.8 (54.1, 75.6)	60.0 (50.8, 69.2)	44.5 (36.9, 52.1)	53.7 (47.9, 59.5)	
Has one chronic condition	19.6 (8.8, 30.5)	16.7 (11.5, 21.9)	25.2 (17.4, 33.1)	19.3 (14.5, 24.2)	
Has no chronic conditions	15.6 (9.4, 21.8)	23.3 (14.7, 31.9)	30.3 (22.0, 38.6)	27.0 (21.9, 32.0)	
Depressive symptoms^a					0.5259
No	92.6 (88.7, 96.6)	86.3 (76.9, 95.6)	91.0 (86.7, 95.3)	90.7 (86.9, 94.5)	
Yes	7.4 (3.4, 11.3)	13.7 (4.4, 23.1)	9.0 (4.7, 13.3)	9.3 (5.5, 13.1)	

^a Only a sub sample of the 2046 respondents had these variables: income reported for n=1695; cultural/racial background reported for n=2042; chronic condition reported for n=2035; depressive symptoms reported for n=2020.

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^b Street Smart Walk Score™ categories: Car-dependent (combined Vary car-dependent, 0 to 24, and Car-dependent, 25 to 49); Somewhat walkable, 50 to 69; Very walkable, 70 to 89; Walker's Paradise, 90 to 100.

^c P-value from Rao-Scott Chi-square test across categories of Street Smart Walk Score™

Table 3

Associations between Street Smart Walk Score™, Mobility Over Varied Environments Score (MOVES), and MOVES domains in the 2008–2009 CCHS-HA British Columbia Respondents (2008–2009) in Census Metropolitan Areas (n=2046)

	MOVES ^b	Physical Domain ^b	Cognitive Domain ^b	Social Domain ^b	Transportation Domain ^b
	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)
Unadjusted Association for Street Smart Walk Score™ (10-units)	4.84 (4.52, 5.15) ***	1.30 (1.20, 1.39) ***	1.42 (1.32, 1.52) ***	1.12 (1.05, 1.20) ***	1.00 (0.94, 1.06) ***
Adjusted ^d Association for Street Smart Walk Score™ (10-units)	0.10 (0.00, 0.20) *	-0.05 (-0.08, -0.01) *	-0.04 (-0.08, 0.00) *	-0.02 (-0.07, 0.02)	0.21 (0.14, 0.29) ***

* = p<0.05;

** = p<0.01;

*** = p<0.001

^aAdjusted models include age, sex, education, retirement status, and self-perceived health

^bMOVES ranges from 0 to 40; each subdomain ranges from 0 to 10.