

Neighbourhood Design, Travel, and Health in Metro Vancouver: Using a Walkability Index

Executive Summary



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Photo: Shana Johnstone
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Metro Vancouver Walkability Index. We thank the British Columbia Recreation and Parks Association and the Vancouver Foundation for their financial support of the research applications of the Walkability Index described in this report. We are appreciative of Gordon Price for his photo contributions. Finally, we thank the Health and Community Design Collaborative (HCDC) for their support.

About the Report

Neighbourhood Design, Travel, and Health in Metro Vancouver is a new resource for land use and transportation planners, municipal and regional decision makers, engineers, health officials, and others on the physical environment factors that contribute to walkable (pedestrian-friendly, transit-supportive) neighbourhood design in Metro Vancouver.

This Executive Summary introduces the Metro Vancouver Walkability Index (VWI) developed at the University of British Columbia to measure neighbourhood urban form characteristics in Metro Vancouver, and summarizes results from local studies that have applied the VWI to explore associations between neighbourhood design and travel behaviour, physical activity, obesity, and air pollution exposure.

Next steps are identified for both research and practice to advance our understanding of neighbourhood urban form impacts on travel patterns, health, and environmental outcomes. Additional background, study details, research methods, neighbourhood profiles and regional variability, and recommendations can be found in the full report.

The Importance of Walkable Neighbourhoods

The ways in which we design and build our neighbourhoods have substantive implications for our health and quality of life. Auto-dependant neighbourhood design that supports a sedentary lifestyle appears to be a significant contributor to observed increases in obesity rates, stress, out-of-pocket travel costs, air pollution and greenhouse gas emissions across many urban areas. In contrast, walkable neighbourhood design that enables residents to enjoy active lifestyles not dependent on private vehicles is one means by which we can promote physical activity and reduce vehicle emissions.

Walkable neighbourhood design that is compact, connected, and mixed use has been associated with a number of benefits across social, economic, environmental, and health outcomes:

- Compact, mixed-use neighbourhoods include many types of destinations within a short distance from home that can be easily reached by walking and cycling, thereby providing more equitable access for residents to a range of services and amenities.¹
- Greater residential densities and street connectivity of walkable neighbourhoods support higher levels of public transit service and ridership.²
- Neighbourhood design that encourages walking, cycling, and transit use is associated with better public health as higher levels of physical activity from active transportation are linked to fewer chronic health issues.^{3,4}
- Reduced vehicle dependence associated with more walkable places has been linked to annual travel-related cost savings in the thousands of dollars for individuals and



Photo: Shana Johnstone

households who are able to utilize transit,^{5,6} and is also linked with the generation of less air pollution and greenhouse gas emissions.⁷

- Sprawling, automobile-oriented neighbourhoods may account for hundreds of millions of dollars annually in hidden health costs imposed by associated traffic, air pollution and sedentary lifestyles.⁸
- Heightened perceptions of social capital and sense of community, while less researched, are also likely a function of neighbourhood design.^{9,10,11}

Walkable neighbourhood design may provide a key mechanism to promote healthy and active lifestyles and foster more sustainable transportation choices. In Metro Vancouver, tools like the VWI now exist to advance our understanding of the specific factors that constitute neighbourhood walkability in this region—those place types that may support walking, but also cycling and transit.

- 1 Saelens, B.E., J.F. Sallis, L.D. Frank. 2003. Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literature. *Annals of Behavioral Medicine*, 25 (2), 80-91.
- 2 Ryan, S., L.D. Frank. 2009. Pedestrian environments and transit ridership. *Journal of Public Transportation*, 12 (1), 39-57.
- 3 Transportation Research Board and Institute of Medicine of the National Academies. 2005. *Does the Built Environment Influence Physical Activity? Examining the Evidence*. Special Report 282. Washington, D.C.: Transportation Research Board.
- 4 Frank, L.D., M. Andresen, T. Schmid. 2004. Obesity relationships with community design, physical activity, and time spent in cars. *American Journal of Preventive Medicine*, 27 (2), 87-96.
- 5 Bernstein, S., C. Makarewicz, K. McCarty. 2005. *Driven to Spend: Pumping dollars out of our households and communities*. Center for Neighborhood Technology and the Surface Transportation Policy Project.
- 6 American Public Transportation Association. 2010. *Transit Savings Report – September 2010*. Available online at: http://www.publictransportation.org/facts/100917_transit_savings.asp
- 7 Transportation Research Board and National Research Council of the National Academies. 2009. *Driving and the Built Environment: The effects of compact development on motorized travel, energy use, and CO2 emissions*. Special Report 298. Washington, D.C.: Transportation Research Board.
- 8 American Public Health Association and Urban Design 4 Health, Inc. 2009. *The Hidden Health Care Costs of Transportation*. Washington, D.C.: American Public Health Association.
- 9 Osolen, R., N-M. Lister. 2004. *Social capital, Urban Sprawl, and Smart Growth: A preliminary investigation into sustainable communities in Canada*. Discussion Paper Series, No. 3. Victoria, B.C.: Community Research Connections.
- 10 Leyden, K.M. 2003. Social capital and the built environment: the importance of walkable neighborhoods. *American Journal of Public Health*, 93 (9), 1546-1551.
- 11 Wood, L., L.D. Frank, B. Giles-Corti. 2010. Sense of community and its relationship with walking and neighborhood design. *Social Science and Medicine*.

Measuring Walkable Neighbourhoods

What the Index Measures: Components of Neighbourhood Walkability

Residential density is the number of residential units per acre designated for residential use within a neighbourhood buffer. Higher densities indicate more people live in the area.

Commercial density (or Retail Floor Area Ratio) is the amount of area designated for commercial use within a neighbourhood buffer, using a ratio of commercial floor area to commercial land area. Higher ratio numbers indicate higher commercial density.

Land use mix is the evenness of square footage distribution across residential, commercial (including retail and services), entertainment, and office development within a neighbourhood buffer. A higher value in this measure indicates a more even distribution of land between the land use types.

Street connectivity is measured by the number of street intersections in a neighbourhood buffer. More intersections suggest a greater degree of network connectivity enabling more direct travel between two points using existing streets and pathways.

Measuring the physical environment characteristics of neighbourhoods is the first step to understanding how walkable an area is. Neighbourhood walkability is largely a function of the proximity between destinations and the degree to which we can travel directly between places where we live, work, and play.¹² Planning tools and models that are able to capture the nuances of proximity and connectivity as they relate to travel and health outcomes can help inform and contribute to related planning, policy, and investment decisions.

The Metro Vancouver Walkability Index

The Metro Vancouver Walkability Index (VWI) is a high-resolution spatial database used to quantify fine-scale physical urban environment features across “neighbourhoods” in the Metro

Vancouver region. Using Geographic Information Systems (GIS), neighbourhoods are spatially defined by drawing a 1-kilometer street network buffer (representing a 10- to 15-minute walking distance) from each postal code centroid in the region (figure 1). The 1-kilometer network buffer establishes the area that people can actually access around their homes along the existing street network, and is considered an accurate approach to measuring the physical environment unique to each place of residence.¹³

The VWI combines parcel-level land use data from the British Columbia Assessment Authority, street network data from CanMap, and census data to measure four urban form elements known to shape the design of neighbourhoods¹⁴ within each neighbourhood buffer. These four key components are residential density, commercial density, land use mix, and street connectivity. Data on these

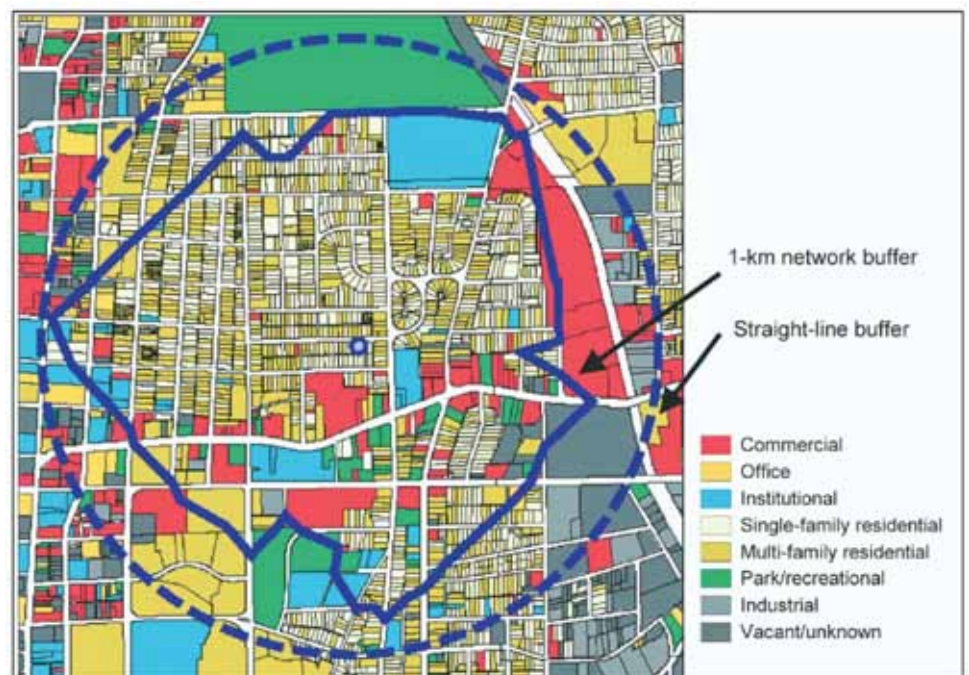


Figure 1 Measuring urban form inside a 1-kilometer street network buffer.

Walkability in Metro Vancouver

four components are combined into a composite value of overall walkability to measure the physical aspects of the environment that Metro Vancouver residents encounter every day, in their immediate neighbourhoods. These urban form elements all play a role in shaping the walkability of our neighbourhoods, separately or in combination. Statistically, a combined measure of walkability is useful to avoid problems of multicollinearity between variables that are highly correlated with one another (for example, areas with higher residential densities often have more mixed use and connected streets).¹⁵

Neighbourhood walkability levels vary significantly across Metro Vancouver (figure 2). High walkability levels emerge in many distinct but separated areas. Variation in walkability levels within each municipality is also important to note. When we consider the development history of the region, the spatial distribution of walkable areas on the map makes sense. High walkability neighbourhoods are generally found in early settlement areas, original town sites, and those places that developed around early twentieth century streetcar lines that necessitated a compact urban form. Walkable areas have also developed around more modern rapid transit

(SkyTrain, Express Bus, etc.) routes and hubs. The region's least walkable areas generally emerged during the automobile and highway era of the post-World War II period.

12 Frank, L.D., P.O. Engelke, T.L. Schmid. 2003. *Health and Community Design: The impact of the built environment on physical activity*. Washington, D.C.: Island Press.

13 Oliver, L.N., N. Schuurman, A.W. Hall. 2007. Comparing circular and network buffers to examine the influence of land use on walking for leisure and errands. *International Journal of Health Geographics*, 6 (41), 1-11.

14 Frank, L.D., J. Sallis, B. Saelens, K. Cain, T. Conway, P. Hess. 2009. The development of a walkability index: Application to the Neighborhood Quality of Life Study. *British Journal of Sports Medicine*.

15 Krizek, K.J. 2003. Operationalizing neighborhood accessibility for land use-travel behaviour research and regional modeling. *Journal of Planning Education and Research*, 22, 270-287.

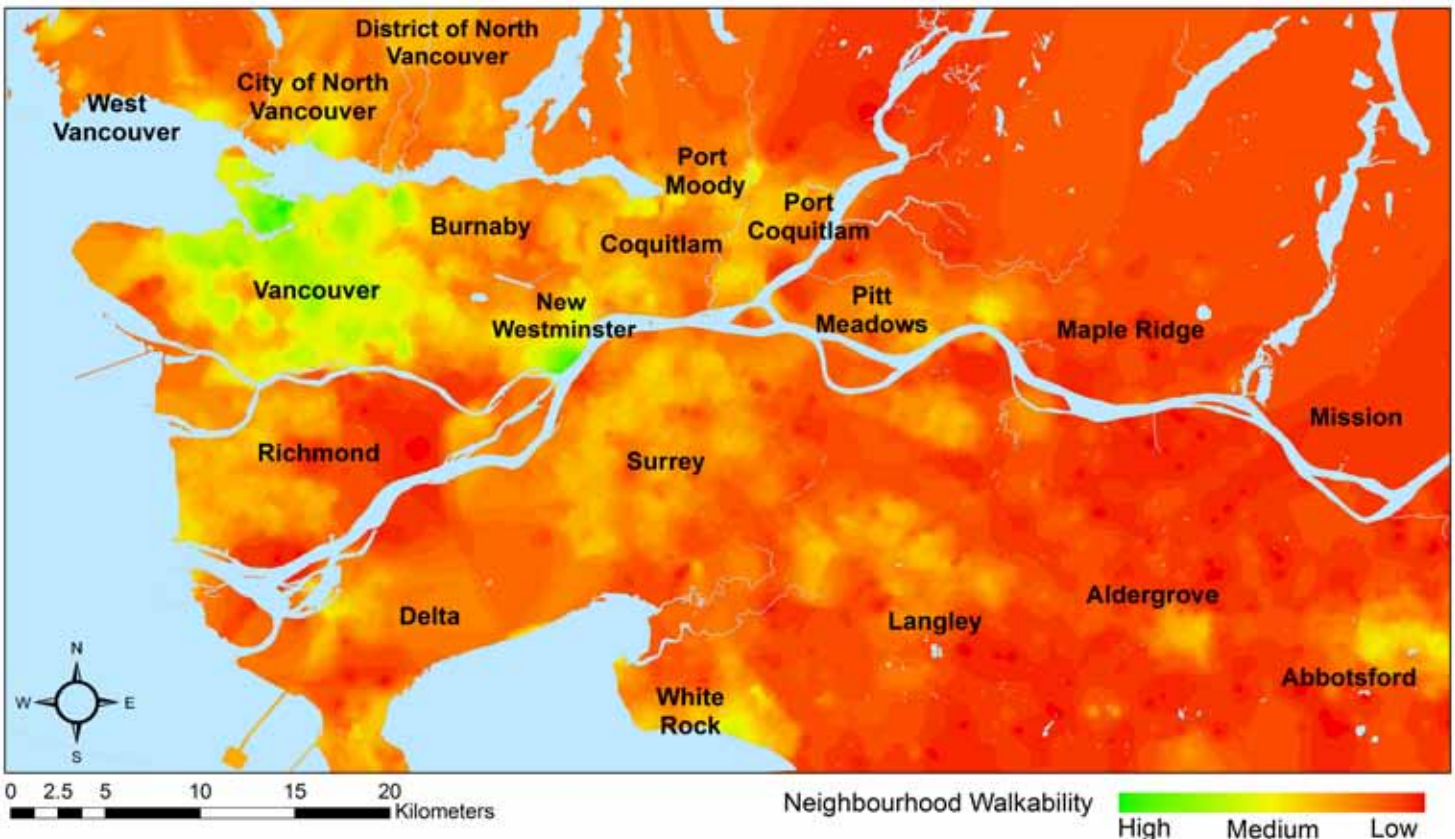


Figure 2 Map showing results from the Metro Vancouver Walkability Index (VWI).

Neighbourhood Profiles

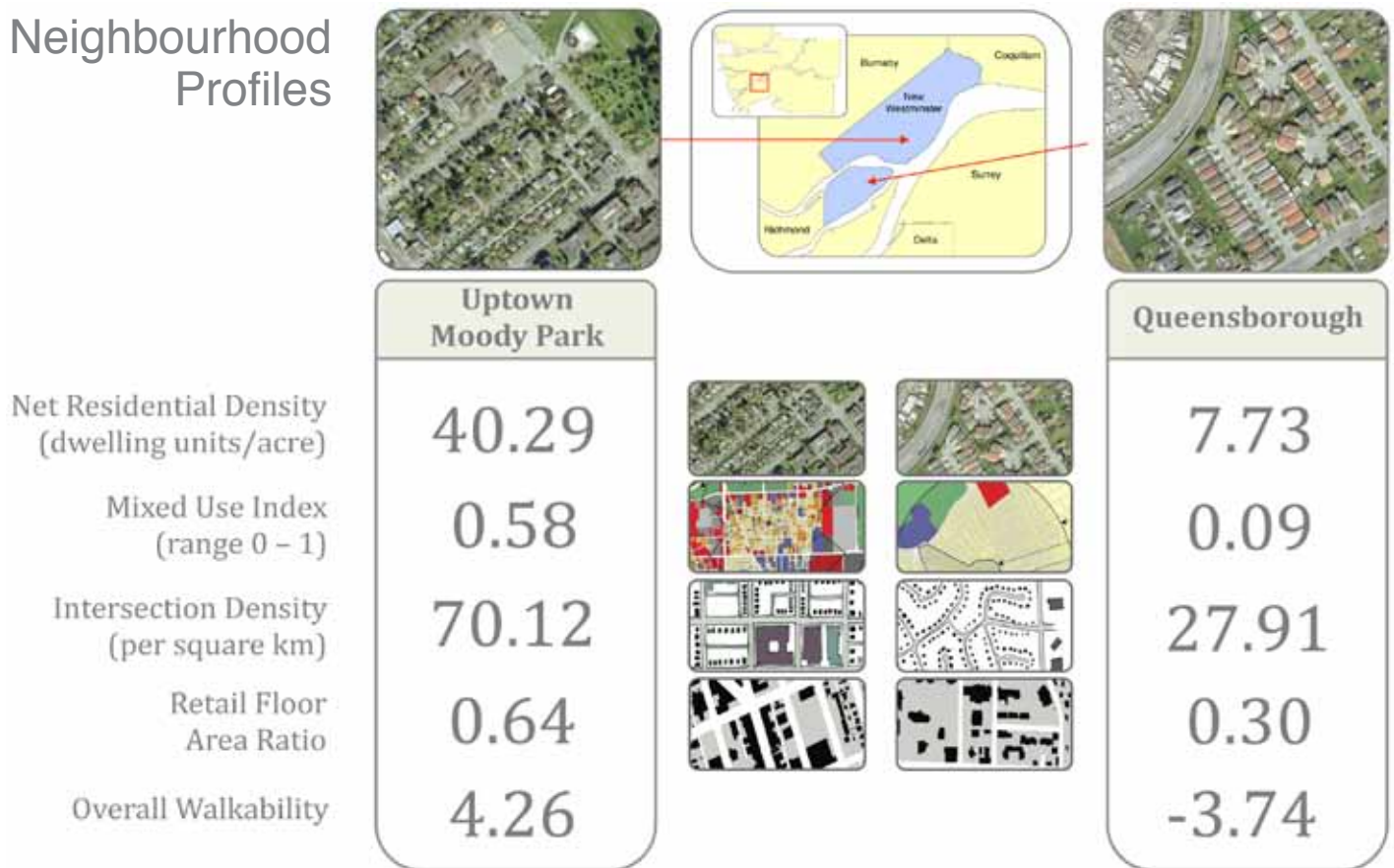


Figure 3 Visualizing walkability and urban form measurements.

Identifying Neighbourhood Types

Characteristics of the **most walkable neighbourhoods** (high walkability values):

- Compact urban form
- Medium to high residential density
- Diversity and concentration of commercial uses, near residences
- Heterogeneous and integrated mix of land uses
- High degree of street connectivity (small block sizes, higher number of intersections)

Characteristics of the **least walkable neighbourhoods** (low walkability values):

- Sprawling development patterns
- Low residential density (mostly single-detached houses)
- Commercial uses are lacking or widely spread, far from residences
- Homogeneous and separated mix of land uses
- Poor street connectivity (large blocks, cul-de-sacs, inconsistent street pattern)

Visualizing Neighbourhood Walkability

The VWI measures walkability and built environment characteristics numerically. For example, the VWI composite walkability measure provides a relative value that varies from -7.5 in the least walkable areas up to as high as 10.0 for the region's most compact and walkable neighbourhoods. When described as a number, it is difficult to picture the urban form characteristics of a specific place. Figure 3 provides two sample neighbourhoods in New Westminster—Uptown-Moody Park and Queensborough—and their associated built environment characteristics, walkability variables, and aerial photographs to help visualize what different levels of walkability may look like in terms of urban form.

Applying the Metro Vancouver Walkability Index

Key Findings from Three Studies

The VWI provides a predictive, analytical tool in which a variety of data (travel behaviour, social interaction, health, real estate valuation, energy

consumption, vehicle emissions) can be matched to corresponding geographic areas to study relationships with neighbourhood urban form. The research results described here show the potential of the Index to inform local land use and transportation policy and practice.

More Information on Research Findings

For more information on the three studies mentioned here, including their research contexts, methodologies, findings, and discussion, please refer to the full report.

Study 1: Walkability and Active Transportation

The following findings from a 2009 study by the University of British Columbia, funded by the British Columbia Recreation and Parks Association, demonstrate the links between neighbourhood design and the travel patterns of residents in the Metro Vancouver region.¹⁶

Key Findings

- Adults living in the top 25% most walkable areas in Metro Vancouver were between 2 and 3 times more likely to walk or take transit for any home-based trip compared to those in the least walkable neighbourhoods.
- Residing in a neighbourhood with nearby parks and open spaces doubled the chances of an adult walking for a home-based discretionary trip (shopping, recreation, etc.).
- Adults living in the top 25% most walkable neighbourhoods drive approximately 58% less than those in more auto-oriented (less walkable) areas.



Photo: Gordon Price



Photo: Shana Johnstone

¹⁶ Devlin, A., L.D. Frank, J. van Loon. 2009. *Transportation and Physical Activity Benefits of Walkable Approaches to Community Design in British Columbia*. Report prepared for the British Columbia Recreation and Parks Association. Vancouver, B.C.: UBC Active Transportation Collaboratory.

Study 2: Walkability and Body Weight

The following findings from a 2009 study by the University of British Columbia, funded by the Vancouver Foundation, demonstrate the links between neighbourhood design and body mass index (BMI)—a measure of body weight in proportion to height.¹⁷

Key Findings

- Residents living in the most walkable areas in Metro Vancouver were half as likely to be overweight than those in the least walkable neighbourhoods.
- Residents living in the most connected neighbourhoods (where streets have the greatest intersection density) were half as likely to be overweight than those living in the least connected areas.
- Residents living in areas with the highest retail floor area ratios (and

where retail use is not set back from the street) were half as likely to be overweight as those living in neighbourhoods where retail is set behind surface parking lots.

- Each additional grocery store within a 1-kilometer distance from an individual's residence was associated with an 11% reduction in the likelihood of being overweight.
- Living in a neighbourhood with at least one grocery store was associated with a nearly 1.5 times likelihood of getting sufficient physical activity, as compared to living in an area with no grocery store.
- The presence of either a large or small neighbourhood retail land use was associated with an increased likelihood of getting sufficient physical activity (90% significance level).



Photo: Shana Johnstone

Study 3: Walkability and Air Pollution from Vehicle Emissions

The following findings from a 2009 study by the University of British Columbia demonstrate the links between neighbourhood design and exposure to outdoor air pollution in Metro Vancouver.¹⁸ Neighbourhood walkability levels were matched to concentrations of air pollution and residents' income levels throughout the region. "High" and "low" pollution levels are relative terms describing the range of concentration levels found across the region.

The air pollutant nitric oxide (NO) is found in newly emitted traffic exhaust from gasoline and diesel vehicles. Nitric oxide levels are highest in urban areas of high residential density and on arterial roads where more vehicles in a smaller area result in higher concentrations of this pollutant. Ground-level ozone (O₃) is a secondary pollutant, forming in the atmosphere (not emitted directly). Ground-level ozone is typically found downwind

of higher density urban areas; lower density suburban areas tend to have high levels of ozone occurring over a larger area.

Key Findings

- The least walkable neighbourhoods across Metro Vancouver have the least nitric oxide pollution, but the most ozone pollution. Conversely, the most walkable neighbourhoods have the least ozone pollution, but the most pollution from nitric oxide. This high nitric oxide exposure (a marker for particulates) occurs in some places where walking and cycling activity is highest.
- With the exception of central Vancouver, suburban neighbourhoods are generally more affluent than areas near city centers across the region. Ozone exposure is highest in high-income suburban

neighbourhoods (16%), which tend to be less walkable. Conversely, nitric oxide exposure is highest in low-income areas of high walkability (37%).

- Neighbourhoods with the best of these elements (relatively high walkability and low pollution levels) and those with the worst (relatively low walkability and high pollution levels) exist across the region (figure 4).
- "Sweet-spot" neighbourhoods (relatively high walkability/low pollution) are largely located 4-8 kilometers from downtown Vancouver. These neighbourhoods form only 1.7% of all areas included in the study. About two-thirds (68%) of the postal codes in these sweet-spot

¹⁷ Frank, L.D., M. Winters, B. Patterson, C.L. Craig. 2009. *Promoting Physical Activity Through Healthy Community Design*. Vancouver, B.C.: UBC Active Transportation Collaboratory.

¹⁸ Marshall, J.D., M. Brauer, L.D. Frank. 2009. Healthy neighborhoods: Walkability and air pollution. *Environmental Health Perspectives*, 117 (11), 1752-1759.

Study 3 continued >

neighbourhoods have the region's highest incomes, while just 3% have the region's lowest incomes.

- “Sour-spot” neighbourhoods (relatively low walkability/high pollution) are generally located farther from the regional core. Sour-spot postal codes form 4.6% of all areas included in the study, and those who live in these areas are mostly middle-income earners (from lower-middle to upper-middle income).

Walkability and At-Risk Populations

When the Metro Vancouver Walkability Index is overlaid with socio-economic and demographic information, equity issues can be examined. Evaluating the social and economic issues tied to walkable neighbourhoods provides a mechanism to assess disparities across specific mobility and health outcomes. Figure 5 illustrates the distribution of one such at-risk population—lower-income—across Metro Vancouver relative to neighbourhood walkability levels.

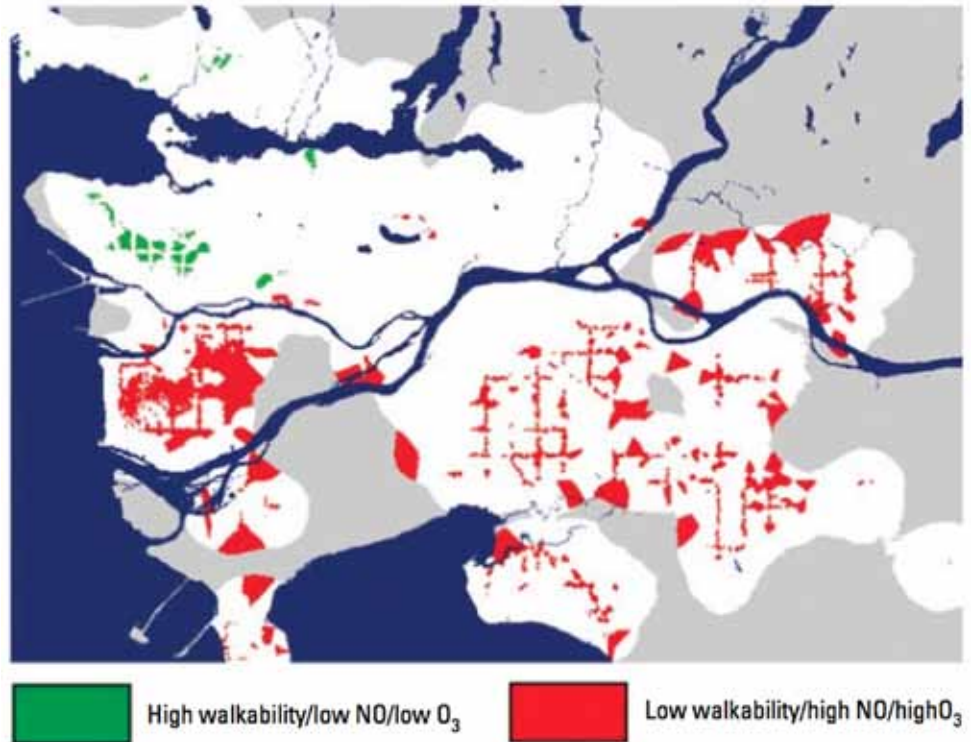


Figure 4 “Sweet-spot” and “sour-spot” postal codes.

Groupings of many at risk populations—including lower-income, youth, and elderly—are often found in the region's least walkable areas. Considering the important benefits that walkable neighbourhoods provide from a mobility and health perspective, lower-income and other at-risk

populations may be poorly situated to experience these benefits compared to more affluent populations. This situation results in socio-economic and demographic disparities region-wide. Failure to address these inequalities through a range of programmatic and regulatory actions may result in further

displacement and neighbourhood gentrification, potentially exacerbating conditions for the most underserved residents.

Please refer to the full report for more on walkability and at-risk populations.



Figure 5 Low walkability postal codes with low average incomes.

Opportunities for Policy, Practice, and Research

Walkable neighbourhoods are shown to be associated with reduced vehicular travel, increased levels of physical activity, and increased vehicle pollution exposure in the Metro Vancouver region. Modest increases in neighbourhood walkability levels result in considerably more active transportation choices made by residents, and the specific presence of nearby grocery stores influences the likelihood of walking and getting sufficient exercise. These trends suggest that municipalities and the region do not have to make dramatic policy and regulatory changes to achieve significant health and environmental benefits.

Despite these benefits, walkable neighbourhoods are not without challenges. The higher densities of these neighbourhoods result in greater pollution levels of nitric oxide, and lower income residents shoulder the most health risk for exposure to such pollution. “Sweet-spot” neighbourhoods boast high walkability but relatively low pollution levels, indicating a starting point for further study to understand how more neighbourhoods can be made healthier, cleaner places.

Reducing disparities associated with at-risk populations living in less walkable neighbourhoods across the region requires a range of investment strategies spanning transportation investment, housing, recreational amenities, and social services. Underpinning many of these issues is the seemingly age-old issue of housing affordability. Mechanisms are needed to not only increase the supply of walkable neighbourhoods but to also ensure those most at risk

are securely anchored in places with high levels of accessibility; thus near to transit and services. With respect to air pollution exposure, it is the elderly and youth that are the most at risk. Fortunately, there are many strategies to address this issue including setbacks from major transportation corridors, height above street level, and routing freight and goods movement away from where at-risk populations are concentrated.

Walkability is not a solution, but it is a precursor and enabler to realize mobility and health benefits from a range of public investments. As an example, walkability is one of the best predictors of transit demand, while transit use predicts physical activity levels. A recent study showed transit users to be 3.42 times more likely to get recommended levels of physical activity.¹⁹ This close linkage between walkable neighbourhoods, transit demand, and physical activity suggests that neighbourhood design has a place in addressing a variety of issues and helping to realize a range of benefits.

There is tremendous opportunity to advance the application of the Metro Vancouver Walkability Index to inform local policy decisions and planning and engineering practice both within and beyond health issues directly. Opportunities include assessments of:

- Neighbourhood walkability as a predictor of an area’s relative supportiveness for public transit investment.
- Climate change impacts associated with neighbourhood design

and related travel behaviour and patterns.

- The provision of destinations and services, including grocery stores and parks, in areas with higher concentrations of the elderly.
- Neighbourhood walkability associations with mental health, sense of community, and general well-being, and what strategies may contribute to improving overall quality of life.

Some challenges with current research that must also be addressed in future work include:

- Self-selection and causality must be explored to determine whether travel and physical activity behaviours are caused by the neighbourhood environment, or whether residents self-select to live in neighbourhoods that support their pre-existing behaviours.²⁰
- Interrelationships between neighbourhood design and policy or programmatic interventions to influence travel and physical activity outcomes must be untangled to determine the most effective land use and transportation policies for the region.

19 Lachapelle, U., L.D. Frank. 2008. Transit and health: Mode of transport, employer-sponsored public transit pass programs, and physical activity. *Journal of Public Health Policy*, 30 (S1).

20 Handy, S. 2005. Smart growth and the transportation-land use connection: What does the research tell us? *International Regional Science Review*, 28 (2), 146-167.

Next Steps for the Walkability Index

A number of next steps have been identified for the Metro Vancouver Walkability Index to advance the state of knowledge on walkable neighbourhood design and the relationship walkability has with mobility, health and environmental outcomes. The Index is currently being updated with 2010 land use data (from its original 2005 data from BC Assessment Authority) and is supported by other UBC research programs and departments. Opportunities to integrate additional walkability indicators such as sidewalks, topography, transit accessibility, or other specific neighbourhood design characteristics require exploration.

Updating the VWI will keep it relevant to new research projects and will also allow for the monitoring of change in the region over time. The inclusion of new indicators will allow the Index to be further refined and may also allow for research into other topics possibly

linked to neighbourhood design—including diet and access to food, noise and vibration exposure, or the development of social capital—thereby providing a more complete account of residents' overall health and well-being. Above all, new research should be informed by policy makers and practitioners, and be made accessible and relevant to all who are actively addressing the issues in our region and creating more walkable neighbourhoods.

Supportive Partnerships

Creating healthy, equitable and sustainable neighbourhoods and communities requires coordinated action across a number of multidisciplinary actors. The Health and Community Design Collaborative (HCDC) is a partnership of municipal and regional government agencies, health authorities, and members of the University community committed to supporting this approach by enabling knowledge transfer, identifying opportunities in practice and research, and encouraging tool and policy development. The efforts of the HCDC and others are important to realizing a livable region.



Photo: Shana Johnstone



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