

Where Matters II

Walkability and Greenspace Relationships with Health and Climate Change Executive Summary and Policy Brief

February 2024

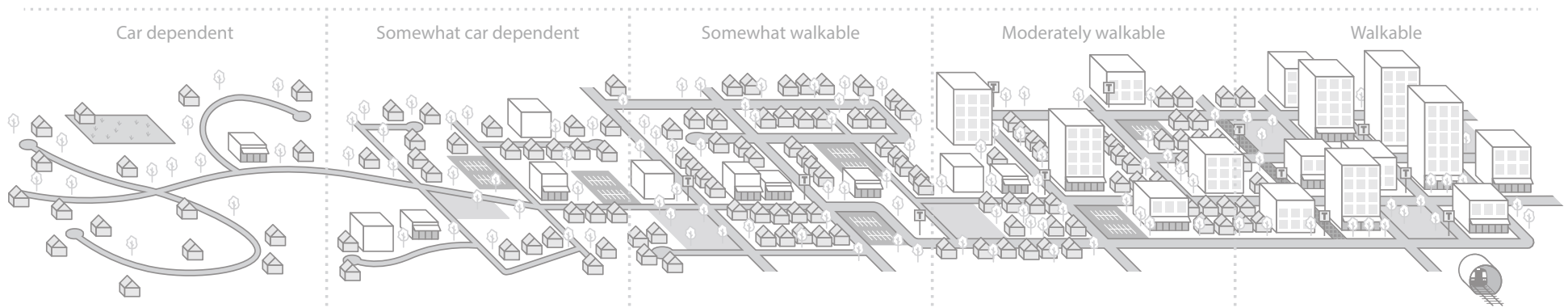
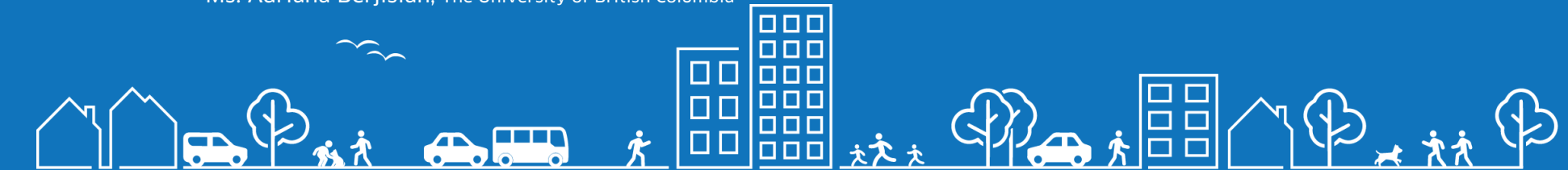
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Introduction

Where Matters II (WMII) documents public health and climate change win-win “co-benefits” from creating walkable communities with access to greenspace. **Where Matters II** investigated relationships between the built and natural environment of where people live and the prevalence of physical and mental chronic diseases and sense of community.

The physical environment of where we live, work, and play shapes our activity and travel patterns, which in turn impacts our wellness and vehicle emissions. Health and climate change are both impacted by the location and design of transportation and land use decisions. Demand for evidence linking built and natural environment features with

our individual health and the health of the planet (e.g. climate change) is featuring more prominently within local, regional, provincial, and federal decision-making contexts to help shape investment priorities.

Where Matters II is a multi-sectoral (government, academia, industry) interdisciplinary (public health, urban planning, transportation) collaboration. Primary funders are the Ministry of Transportation and Infrastructure, and the Real Estate Foundation of BC, who along with Metro Vancouver, TransLink, and the City of North Vancouver, sponsored this project. WMII leverages and spatially integrates physical environment data with health outcome and travel data to assess

causal impacts of transportation and land use actions on chronic disease, and associations with travel patterns and GHG emissions.

Walkability was measured consistently in 2006, 2011, and 2016, creating the ability to document how Lower Mainland communities have changed over time. This data, along with greenspace and other social environment predictors, was spatially joined with health outcome and travel data (see Figure 1).



Figure 1: Health and Climate Impacts of the Built and Natural Environment



Introduction

Where Matters II provides a blueprint to track how communities are changing over time; and tracking how these changes impact public health and climate change. Tracking physical changes to the built environment over time and linking it with travel and health outcome data provides planners and decision-makers with a tool that links the health of a population and the environment with community design. WMII utilizes the Vancouver Walkability Index [1], TransLink's 2017 Regional Trip Diary, the BC Generations Health Survey, Metro Vancouver's greenspace data, and air quality data from the Canadian Urban Environmental Health Research Consortium (CANUE). The conceptual study design shown in Figure 2 captures how transportation, land use, pedestrian design, and greenspace investments through travel and activity patterns affect our behaviours and exposures. These factors result in biological responses such as weight, inflammation, and stress which through time, impact physical and chronic disease and downstream costs.

Where Matters I found significant reductions in diabetes, cardiovascular disease rates, and increases in sense of community for those living in more walkable areas of the Vancouver region. Where matters II builds on this work and connects the same measures of walkability and community design with climate impacts. It also provides the ability to evaluate if health relationships with the built environment are causal. We can connect health outcomes more accurately to a person's neighbourhood and assess if a change in neighbourhood results in a change in health.

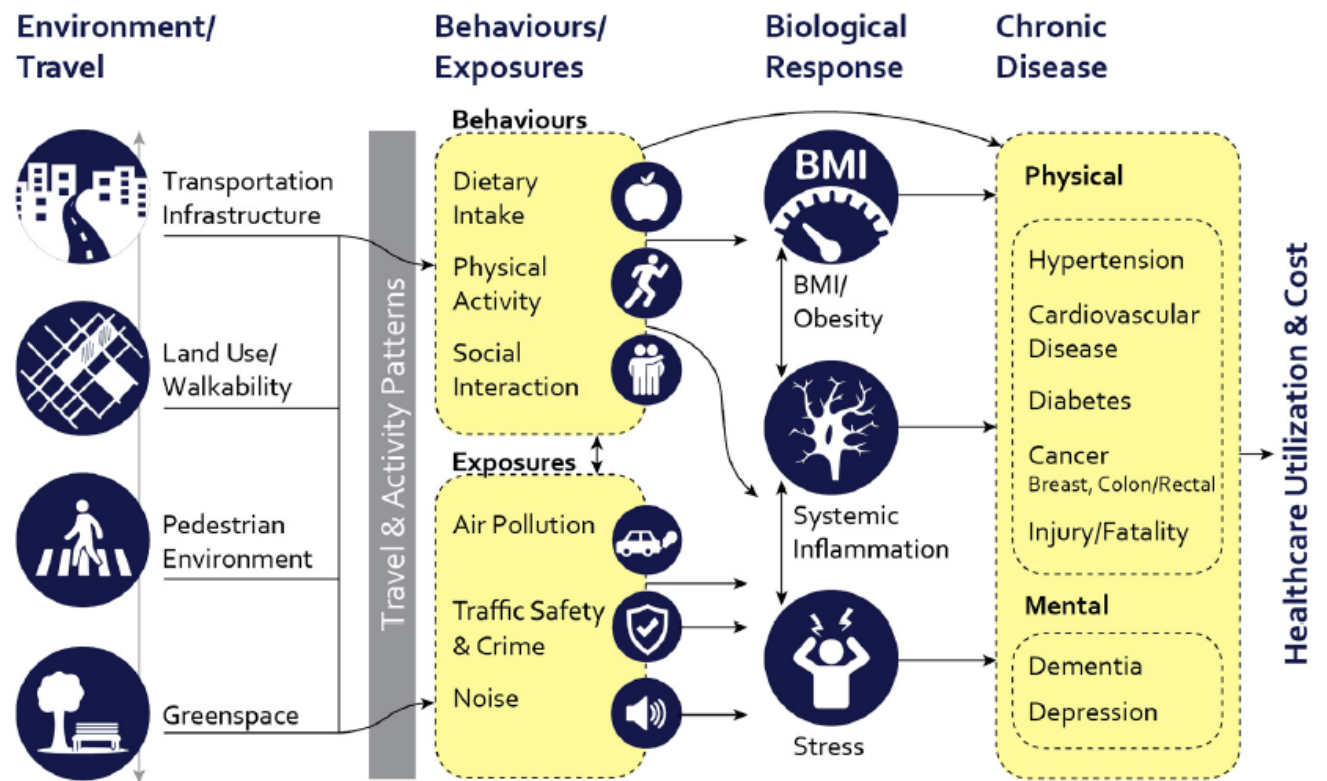


Figure 2: Conceptual Framework [2]

[1] Developed by Dr. Lawrence Frank and researchers at the Health & Community Design Lab (HCDL). Dr. Frank led this work as the Bombardier Chair in Sustainable Transportation over a 17 year period at the University of British Columbia.

[2] Frank, L. D., Iroz-Elardo, N., MacLeod, K. E., Hong, A. The pathways from built environment to health: Connecting behavior and exposure-based impacts. 2016. Journal of Transport and Health.



Tracking Walkability Changes

Figure 3 shows changes in the four main components of walkability between 2011 and 2016 across Metro Vancouver. Increases in residential density were largely concentrated in the Urban Centres and Frequent Transit Development Areas in the region. Changes in commercial floor area ratio (FAR) were widespread for areas with existing commercial and retail land uses with concentrated pockets of high change in some outlying areas in Richmond, Surrey, and Langley. [3]

Land use mix shows relatively stable patterns across existing established mixed-use areas in Vancouver, Burnaby, and New Westminster, with larger changes in outlying and suburban areas. This is due to the fact that these previously single-use areas (e.g., residential subdivisions) are becoming more mixed with floor area from different land uses.

Lastly, relatively limited change in intersection density was detected for the region with the exception of those outlying areas with greenfield development and significant new updates to the road network, especially in areas like Burke Mountain in Coquitlam and South Surrey.

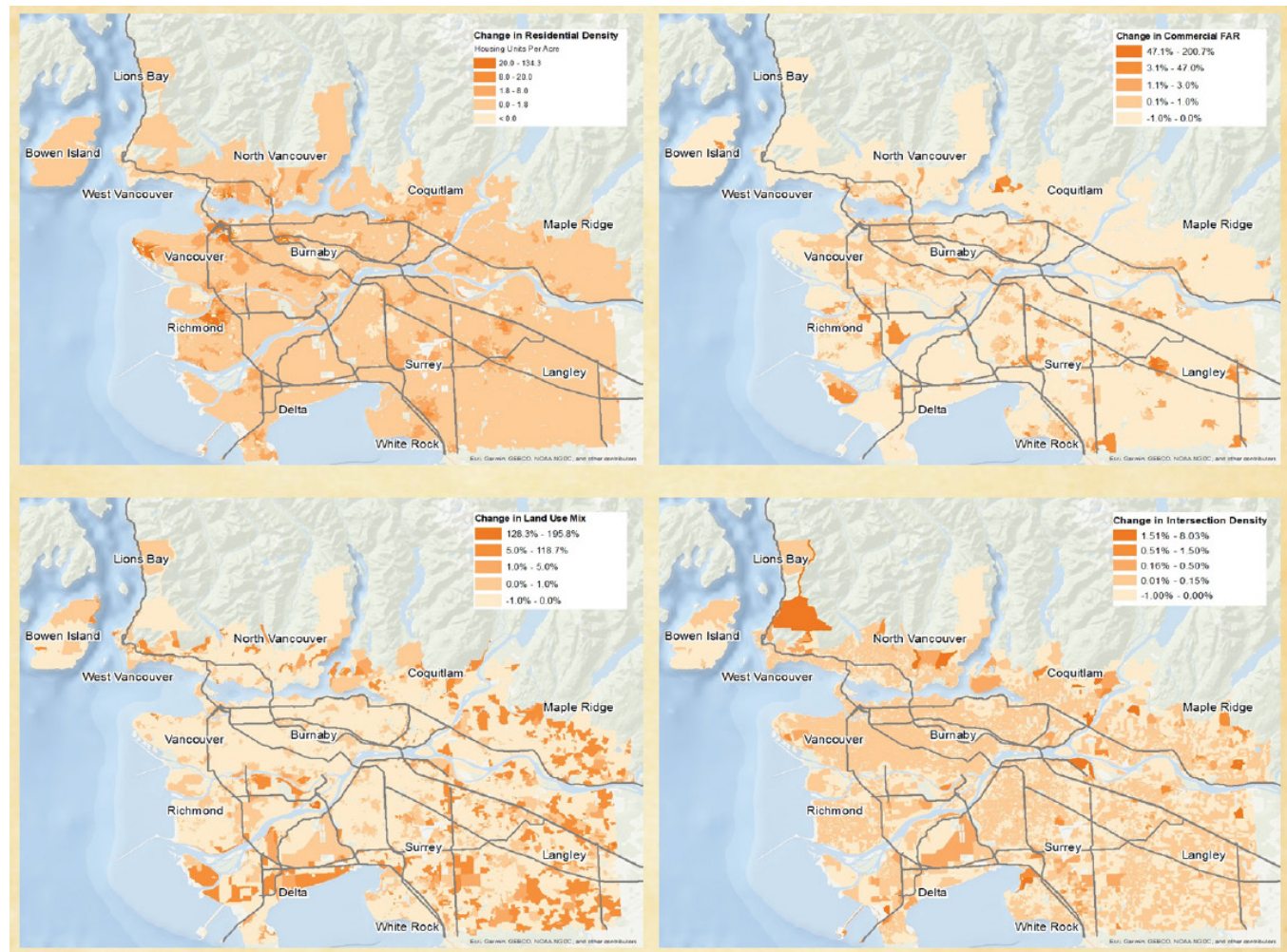


Figure 3: Longitudinal changes (2011-2016) by each component of walkability

[3] Note that these areas may not exhibit high levels of commercial floor area ratio, but have shown large changes towards becoming more neighbourhood retail oriented.



Tracking Walkability Changes

Changes in residential density for four key areas experiencing the most population between 2011 and 2016 are shown in Figure 4 and include Downtown Richmond, Lonsdale in North Vancouver, False Creek/Olympic Village in Vancouver, and the University of British Columbia (UBC). Similar findings can be mapped and quantified for the other metrics where changes were the greatest.

The Where Matters II conceptual framework (see Figure 2) and subsequent analyses show that changes in walkability metrics (e.g. residential density) result in changes in travel and related downstream health and GHG outcomes. Increased density and proximity to shops and services increases land use mix. Density and land use mix, along with

connected street networks and retail built up to the sidewalk without large surface parking lots (higher retail floor area ratio), supports walking and physical activity, less driving and sedentary time, and reduced vehicle emissions.

A 2021 walkability surface is now being created for Metro Vancouver, providing measurement of these same walkability metrics at a fourth time points spanning a 15-year period. Tracking how communities are changing around these key walkability metrics supports the potential for piloting a performance-based approach to transportation funding and once again making the Lower Mainland a global leader in progressive land use and transportation planning. This would explore

the prioritization of active transportation and transit funding based on local government achievement of performance-based goals to meet health and GHG reduction objectives. This is a form of performance-based funding that has been used in education and public health and can fuse a stronger link between regionally and provincially led transportation funding with local government-controlled land use planning.



Figure 4: Longitudinal changes (2011–2016) in residential density for four key areas in the region



Greenspace Access & Exposure

Road-based network buffers were developed to analyze Metro Vancouver's land cover data, which allowed us to more accurately measure the proportion of different types of natural and developed land uses accessible to an individual. Three greenspace indicators were utilized for this study: 1) tree canopy coverage, 2) Normalized Difference Vegetation Index (NDVI), and 3) access to developed parks.

Metro Vancouver had a median proportion of about 25% tree canopy coverage varying from <1% to 96% coverage at the postal code level. [4] Nearly all postal codes evaluated (98.5%) were within 1 kilometre of a park 1-hectare in size or larger. Seventy-four percent of postal codes had a park at least 1-hectare in size within 400 metres. Greenspace was used to predict physical and mental health outcomes.



Figure 5: Metro area land cover

[4] Median tree canopy coverage for the region was 24% for 400-metre buffer neighbourhoods and 26% for 1-kilometre buffer neighbourhoods.



Travel & Climate Change Relationships

Travel data from TransLink's 2017 Regional Trip Diary on over 28,000 households containing 200,000 trips reported over a two-day period was used to evaluate how travel habits and travel-related emissions relate with walkability and other factors.

Higher levels of walkability are associated with increased walking and transit use and fewer motor vehicle trips (see Figure 6). The proportion of trips by car declined from 92 to 44 percent and walking increased from 5 to 35 percent.

percent and transit rose from 3 to 17 percent from the least to the most walkable areas of the region. Results in Chapter 4 convey that overall relationships between travel patterns and walkability remain statistically significant after controlling for regional accessibility, vehicle ownership, income, and other factors.

Travel Mode Share

Proportion of daily trips by mode of transportation for a typical resident by neighbourhood type

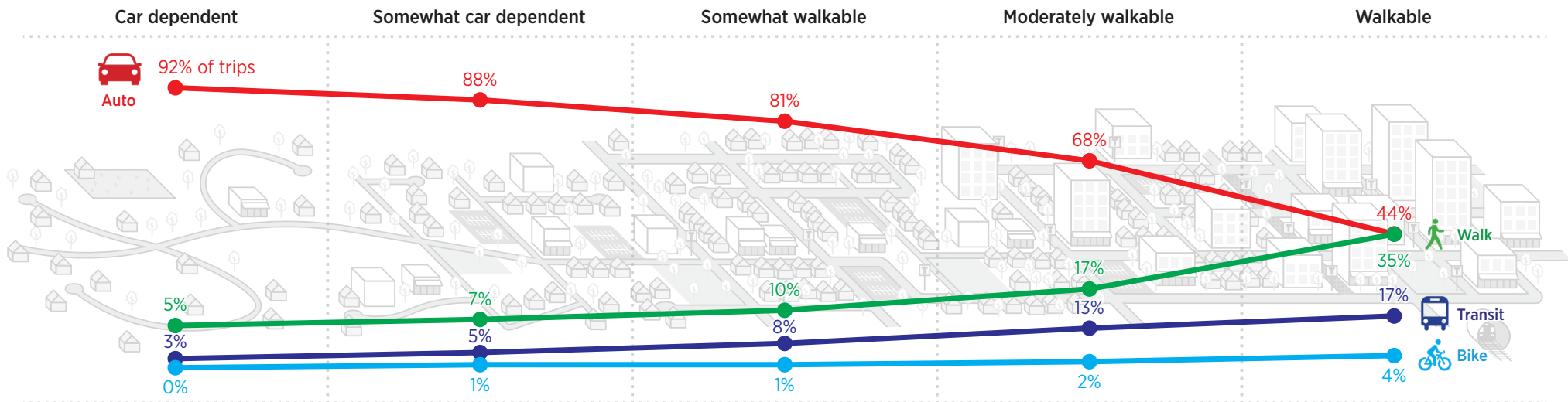


Figure 6: Travel mode share by walkability



Travel & Climate Change Relationships

Results also show that mean per capita vehicle kilometers traveled declined from 23 to 9 kilometres per day from the least to the most walkable areas of the region. Time in cars is a sedentary activity while walking and biking are forms of physical activity. Figure 0-7 shows a decline from 37 to 19 minutes of time in cars and a reduction from 23 to 9 kilometres traveled from the least to the most walkable areas. Conversely, walk and bike time rose from 2 to 14 minutes per day from the least to the most walkable areas.



Trip Distance and Duration

Average daily distance travelled and duration spent travelling by mode of transportation for a typical resident by neighbourhood type

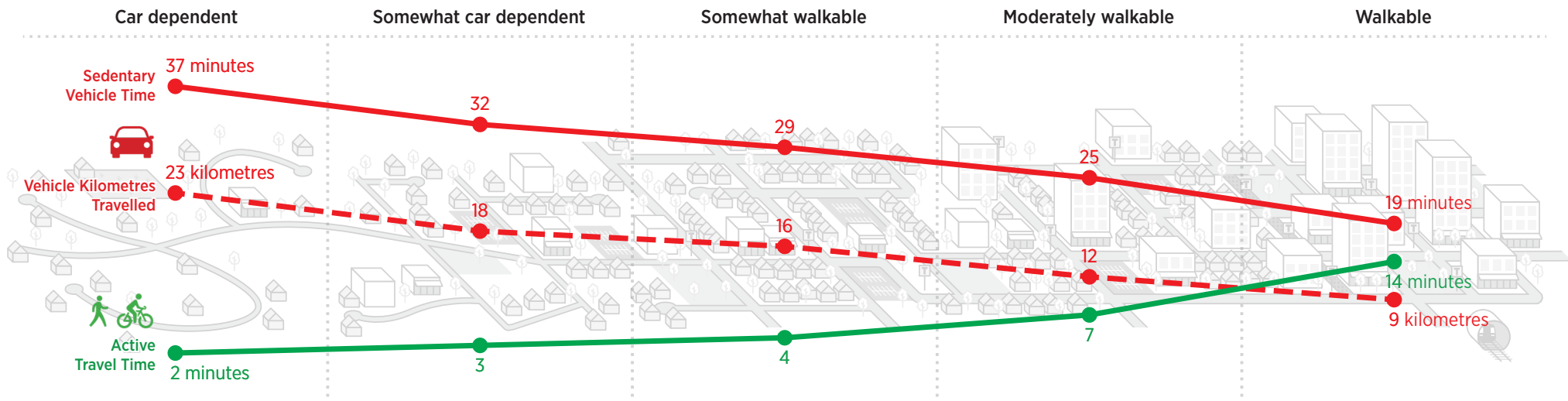


Figure 7: Trip distance and duration by walkability



Travel & Climate Change Relationships

Comprehensive lifecycle emissions estimates were generated for each reported trip, and models were developed for daily greenhouse gas and local air pollutant emissions, dependent on the same explanatory variables.

Model results in Chapter 5 show that emissions were significantly lower in more walkable neighbourhoods when adjusting for regional accessibility, vehicle ownership, income, and other factors. Travel-related GHG emissions

declined nearly threefold from 17 to 6 kilograms per person per day (see Figure 8). Travel-related vehicle emissions have well-documented adverse health impacts. Per capita daily travel-related amounts of Volatile Organic Compounds (VOCs), Oxides of Nitrogen (NOx), Small Particulate Matter (PM2.5), and Carbon Monoxide (CO) were estimated. Overall, those living in walkable areas generated between half to a third as much of these pollutants as those in the most car-dependent

areas of the region CO declined from 96 to 39 milligrams, NOx declined from 11 to 4, VOC declined from 6 to 3, and PM 2.5 declined from 5 to 2 milligrams per day. These detailed emissions estimates account for vehicle type and fuel, congestion level, vehicle occupancy, and other key factors.

Emissions

Amount of daily transportation-related emissions by pollutant for a typical resident by neighbourhood type

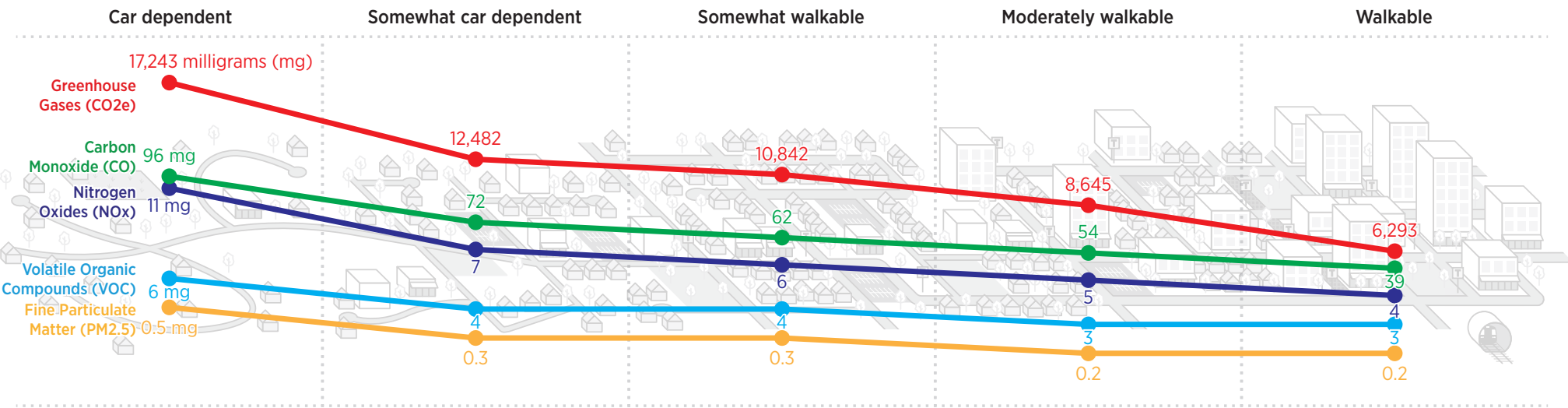


Figure 8: Average daily emissions from travel by walkability



Community Health Impacts

Chronic disease relationships with and impacts of the built and natural environment were estimated using the BC Generations Project (BCGP), a database of 30,000 British Columbians aged 35-69 years. BCGP is a component of the Canadian Partnership for Tomorrow's Health (CanPath) Pan-Canadian prospective health cohort. This dataset was established over the past decade as a research platform for evaluating the genetic, behavioural and environmental causes of cancer and other chronic diseases. BCGP collects health, lifestyle, occupation, residential history, diet and physical activity, socio-demographic, behavioural and health-related data. Walkability datasets were linked with BCGP participants allowing us to investigate the causal impact of exposure to walkable versus car-dependent environments over time and how changes in walkability impact chronic disease and health behaviours.

Obesity, Hypertension & Diabetes

Obesity and obesity-related diseases continue to adversely impact health and economic indicators across low, middle and high income countries. Overweight and obesity are linked to increased risk of numerous chronic conditions, including type 2 diabetes mellitus (T2DM) and high blood pressure (HBP), which are leading causes of cardiovascular disease and premature mortality globally. Living in walkable environments has been linked to significantly higher levels of physical activity

via active travel. Among the Metro Vancouver sample, obesity showed a 16% prevalence rate, with 12% being treated for hypertension, and only 2% being treated for type 2 diabetes.

We evaluated how changes in walkability over time impacted obesity. A reduction in the prevalence rate of obesity was observed with increased levels of walkability. **A 1-unit increase in the walkability change score was associated with a 9% reduction in odds of becoming obese.** When compared to the least walkable areas, those participants living in the most walkable areas had a 51% lower odds of becoming obese. This association was further

reinforced by now-published evidence from Where Matters I. Figure 9 shows residents in the most walkable areas of the Vancouver region have a 39 percent lower odds of having diabetes compared with those in the most car-dependent areas. This relationship was tested longitudinally in the current Where Matters II study where change in walkability over a short time frame (5.5 years) was found to be an insufficient duration of exposure to cause downstream chronic health impacts such as type 2 diabetes or hypertension (at the 95% confidence level). However, other studies have begun to document causal relationships.

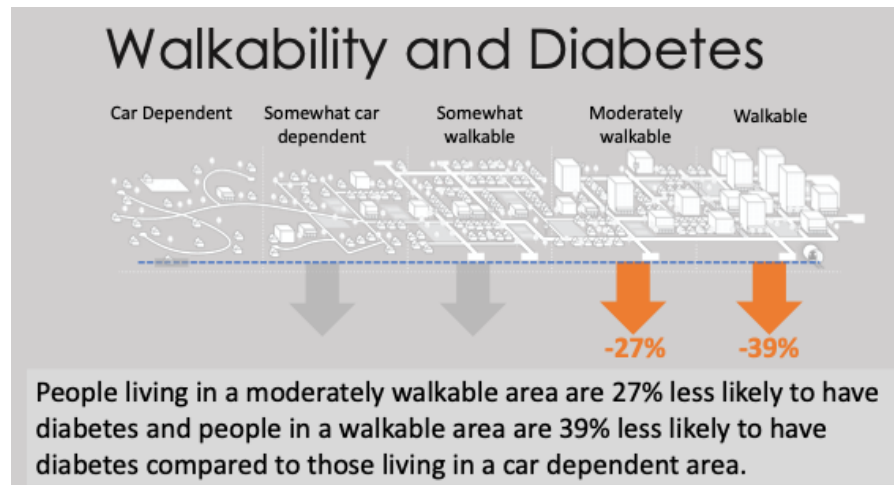


Figure 9: Walkability and diabetes risk [5]

[5] Frank, L.D., Adhikari, B., White, K.R., Dummer, T., Sandhu, J., Demlow, E., Hu, Y., Hong, A., Van Den Bosch, M. (2022). Chronic Disease and Where You Live: Built and Natural Environment Relationships with Physical Activity, Obesity, And Diabetes. Environment International.



Community Health Impacts

Cancer Risk

Cancer is the leading cause of death in Canada with lung, breast, colorectal, and prostate cancer accounting for approximately half of the cancer cases diagnosed. Two out of five Canadians are expected to receive a diagnosis of cancer in their lifetime resulting in one in four cancer-related deaths after diagnosis. Despite advances in detection and treatment, lung cancer is the leading cause of death in Canada with a five-year survival of 19%. Little research has effectively linked built or natural environment features with cancer outcomes.

We found that increases in walkability were linked with decreasing trends for lung cancer hazards while a decreasing trend in risk for colorectal cancer was observed for participants with higher normalized difference vegetation index (NDVI) exposures but neither result was significant at the 95 percent confidence level. Potential protective trends for greenness and walkability were identified for certain cancer types but more research is needed on a larger sample.

Mental Health and Sense of Community

Mental disorders have a significant impact on the global burden of disease, affecting communities and people of all ages in both high and low-income countries. Sense of community and concern over social isolation has become a major mental issue in recent years. In 2023, the US Surgeon General released a major

report on social isolation and similar policy discussions are underway in Canada. Where Matters I found participants living in the most walkable areas of the Vancouver region were 47% more likely to report having a strong sense of community compared with those in the most car-dependent areas. Figure 10 reports these statistically significant results. [6]

Depression stands as a significant public health issue affecting 344 million individuals globally in 2019, and 4.7% of Canadians aged 15 and older exhibited it in 2012. Anxiety disorders stand as the second most common mental disorder globally, affecting approximately 301 million individuals in 2019, and 14%

of Canadians aged 12 in the same year. We did not observe any significant association between walkability and depression. However, participants in the most walkable areas were 1.74 times more likely to report experiencing anxiety compared to those living in the least walkability areas. Participants living in areas with very high walkability had statistically significant increased odds of experiencing anxiety, even after adjusting for demographic, lifestyle, and health-related variables. These results are counter to results suggesting a higher sense of community and social capital in more walkable areas. More work is needed to understand the underlying mechanisms of this potential relationship and its generalizability.

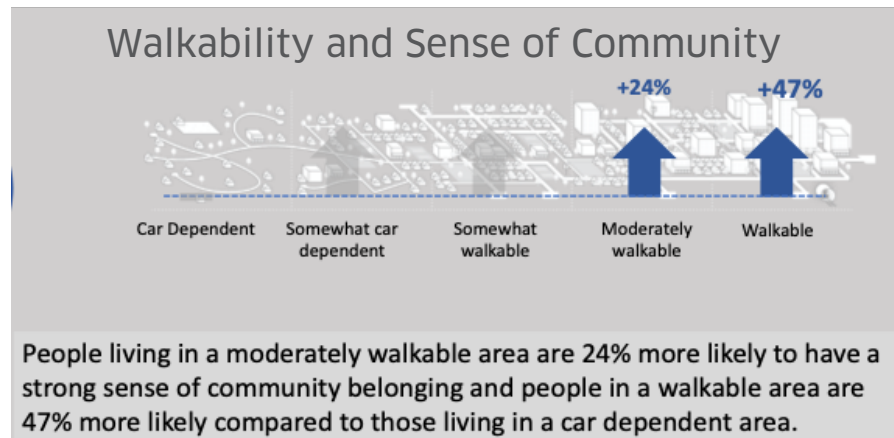


Figure 10: Walkability and sense of community

[6] Results are based on My Health, My Community Survey data collected by Vancouver Coastal Health Authority. Where Matters I: Health & Economic Impacts of Where We Live, University of British Columbia, 2019.



Conclusions

Findings presented in this report support GHG reduction and health promotion policies at the provincial and regional levels. Transportation and public health constitute two of the biggest provincial responsibilities and perhaps the largest expenditures. These two issues are interrelated, yet institutionally separated. Both benefit from walkability and are adversely impacted by car dependence. Transportation investment decisions have considerable public health consequences. Results support Metro Vancouver's Regional Growth Strategy and TransLink's Transport 2050 Regional Transportation Strategy. Results further underpin the Ministry of Transportation and Infrastructure's CleanBC Roadmap to 2030. Findings support recently enacted Provincial Bills 44, 46, and 47, which include a wide range of actions to increase density across most of BC municipalities primarily in association with transit. Bill 44 requires local governments to amend zoning bylaws to increase permitted density in areas currently zoned single-family or duplexes.

Residents within the more walkable areas of the Lower Mainland generated a third to half as much emissions as those in the most car-dependent areas and are at lower risk of several obesity-related chronic diseases. However, the most walkable parts of the Lower Mainland are also the least affordable and the less fortunate are priced out of the places with the best health outcomes. The promotion of walkability as a population health and GHG

reduction solution requires mechanisms to make it more affordable to the less fortunate. Chronic disease is concentrated in the most underserved and constitutes a massive economic burden in BC and across Canada. In 2015, the estimated cost of chronic disease was \$7.8 billion and significant portion of the overall provincial budget (BC Centre for Disease Control). Where Matters I documented higher rates of chronic disease in the most car-dependent areas of the Lower Mainland. The estimated costs of chronic disease are massive. One study by the Chronic Disease Alliance of Canada in 2017 found that the direct cost of chronic disease accounts for about 58% of the annual health spending in Canada (CDPAC / APMCC 2017). Findings from the Where Matters I and II studies documents currently externalized direct and indirect health-related impacts and costs of transportation and land development decisions. It presents a dynamic five-year surveillance approach to quantify and internalize impacts into future decision-making processes.

A broad range of findings presented confirm these relationships built around a dynamic model where changes to walkability over time are captured and related to health and travel-related climate change outcomes. Living in a more walkable environment is associated with generating less harmful emissions, more physical activity, and lower obesity, diabetes, and cardiovascular disease rates. Where Matters provides a model for tracking key

features of the physical environment that impact health and climate change – two of the most pressing societal / provincial mandates. Where Matters has measured walkability at the postal code level using parcel-level land use data at what will soon be four time points and linked with the census in a consistent manner. This project shows how changes in walkability impact obesity and is presented as a test case. Tracking changes in access to greenspace can also be done consistently over time, and along with walkability, can be linked with a broader array of travel, emissions, and health outcomes.

Tracking changes in those features of the built and natural environment that logically impact health and climate change is arguably a necessary form of surveillance given the broad array of population-level consequences of these actions. A dynamic change detection framework is presented that can further be used as a decision support tool to guide infrastructure investments and land use actions. A performance-based approach to transportation funding could be introduced whereby at least some portion of investments in transportation infrastructure is awarded based on the achievement of positive changes to the built and natural environment. This concept is presented as one method to further strengthen the link between local government-led land use decisions and regional and provincially-led transportation investment processes.

